RHODES UNIVERSITY

GEOGRAPHICALLY DISTRIBUTED REQUIREMENTS ELICITATION

THESIS

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DECLARATION

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

Nicholas Vat

ABSTRACT

The technology revolution has transformed the way in which many organisations do their business. The resultant information systems have increased the decision making powers of executives, leading to increased effectiveness and ultimately to improved product delivery. The process of information systems development is, however, complex. Furthermore, it has a poor track record in terms of on-time and within-budget delivery, but more significantly in terms of low user acceptance frequently attributable to poor user requirements specification. Consequently, much attention has been given to the process of requirements elicitation, with both researchers and businessmen seeking new, innovative and effective methods. These methods usually involve large numbers of participants who are drawn from within the client and developer organisations. This is a financially costly characteristic of the requirements elicitation process.

Besides information systems, the technology revolution has also brought sophisticated communication technologies into the marketplace. These communication technologies allow people to communicate with one another in a variety of different time and space scenarios. An important spin-off of this is the ability for people located in significantly different geographical locations to work collaboratively on a project. It is claimed that this approach to work has significant cost and productivity advantages.

This study draws the requirements elicitation process into the realm of collaborative work. Important project management, communication, and collaborative working principles are examined in detail, and a model is developed which represents these issues as they pertain to the requirements elicitation process. An empirical study (conducted in South Africa) is performed in order to examine the principles of the model and the relationships between its constituent elements. A *model of geographically distributed requirements elicitation*

(GDRE) is developed on the basis of the findings of this investigation.

The *model of GDRE* is presented as a 3-phased approach to requirements elicitation, namely *planning*, *implementation*, and *termination*. Significantly, the model suggests the use of *interviews*, *structured workshops*, and *prototyping* as the chief requirements elicitation methods to be adopted in appropriate conditions. Although a detailed study of communications technology was not performed, this thesis suggests that each individual GDRE implementation requires a different mix of communication technologies to support its implementation.

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PART I

INTRODUCTION

The aim of Part I is to introduce the research problem, to present a summary of the results of the research, and to explain the organisation of the thesis.

Chapter 1
INTRODUCTION

1.1 The Problem and its Setting

As a result of the industrial revolution of the late 18th century the core concern of nations changed from agriculture to manufacturing. Within the realm of manufacturing there has been, and continues to be, a marked evolution in the way in which the world produces its products. This evolution has at its core, technology, which has slowly changed the role of people in the workplace, and has contributed to the elimination of cumbersome and costly manual procedures. This evolution has been fuelled by a shrinking global market which has placed increasing pressure on organisations to survive through innovation and creativity. In the process of seeking new, innovative and cutting edge solutions to business problems, organisations have continually adapted their processes and procedures, often through the use of modern technology. As a result, part of this technological revolution has been the development of computers. One of the powers of computer technology is its ability to facilitate production procedures, but more importantly is its ability to assist in the decision-making processes of business management. This is done through the generation of useful information.

Information is generated by a specific type of computer technology, namely an *information system*. An information system (IS) is essentially a collection of components (people, hardware and software) which work together to transform data into information. IS's are developed as a result of a specific need for information as expressed by a decision-maker. Hoffer, George and Valacich (1999:24) state that, due to their complex nature “many organisations find it beneficial to use a standard set of steps to develop and support their information systems.” This methodology is commonly known as the systems development methodology, and like many processes, the development of information systems often follows a life-cycle commonly known as the *Systems Development Life Cycle* (SDLC). According to Hoffer *et al* (1999:24), the SDLC is a common methodology for systems development in many organisations, “featuring several phases that mark the progress of the systems analysis and design effort.” In his analysis of hard systems thinking, Lewis (1994:67) notes that original views of the SDLC (most notably those of Royce (1970), Nolan (1973), Gibson and Nolan (1974)) suggested that “phases are time ordered and the ‘ideal’ project will proceed through these stages in a well managed, ordered and uneventful sequence.” As cited in Lewis (1994), Miles (1985) shows that “despite differences in terminology these have the same basic structure and the basic notion has remained remarkably stable.” That structure (*analysis*, *design* and *implementation*) is recognised in industry and is used by authors such as Ahituv and Newman (1990:79) when explaining concepts relating to IS development.

According to Reynolds (1992) *analysis* involves defining the problem, defining the scope of the system to be studied, breaking the system down into basic components, gathering data about each component, identifying and evaluating alternative solutions, identifying the best solution, and evaluating interactions amongst the components of the selected alternative. IS professionals (specifically analysts) and the decision-makers (known as the users) work together during this phase. The output of this phase is the *Software Requirements Specification* (SRS). This specification establishes the goals for the rest of the systems development project and describes what the project will have to deliver in order for the implemented system to meet the requirements of the users. *Design* involves two main activities: logical design, where all functional features of the proposed solution are described; and physical design, where the logical design specifications are represented as part of a technology platform which is chosen as the basis for the implementation of the solution. *Implementation* involves turning the design into a physical system. This includes coding, testing and installation.

It has become increasingly apparent that the most challenging and the most important phase of the SDLC is the analysis phase. Ewusi-Mensah (1991), James (1997), McLeod and Smith (1996) and Whitten (1995) are among the many authors who agree that software development projects are difficult to manage and often end in failure. It is suggested by some that as many as 70% of systems development projects fail. There are many reasons offered for this, but the most common is poor user requirements definition leading to an inaccurate SRS. According to Shelly, Cashman and Rosenblatt (1998:3.5) “a requirement is a characteristic or feature that must be included in an information system to satisfy business requirements and be acceptable to users... they will define the characteristics of the new system... (and) will serve as benchmarks to measure the acceptability of the finished system.” In order to ensure the accurate elicitation of user requirements, the systems analyst is, according to Yeates, Shields and Helmy (1994:108), required to perform a number of different tasks during the analysis phase. These tasks are: i) *investigation*, which is essentially a fact-finding mission facilitated by asking questions, observing users and searching through documentation; ii) *communication with customers* (users), which includes communicating ideas using a variety of communication tools and in a variety of different settings; iii) *documentation*, which includes all written forms of communication ranging from records of conversations (minutes of meetings) to data models; iv) *understanding*, which involves checking and crosschecking facts and recording them as precisely as possible; and v) *preparation and planning*, a group of tasks including the planning of analysis activities and scheduling time and resources for completion of these activities.

In order to perform these different tasks it is obvious that the analyst should possess a wide range of communication skills and should be capable of using those skills effectively to elicit the best possible requirements definition from the users. However, even when possessed of the appropriate communication skills, an analyst is still faced with a challenge. Interpersonal communication is a highly complex process with numerous factors influencing the success of interactions. Over the years, academics and professionals have taken up the challenge of mastering these interactions and have developed a variety of alternative methods which can be adopted in order to facilitate communication in this environment. These *requirements elicitation methods* have evolved to suit the needs of different types of organisations operating within different environments. There is no single method which is used in isolation, but instead, many different methods are often combined throughout the process of requirements elicitation, yielding what should be (if applied correctly) an accurate SRS. These should be handed to the system designers with the full confidence that they are an accurate representation of the system required by the user. Examples of requirements elicitation methods are: document review, interviews, joint application development (JAD), joint requirements planning (JRP), meetings, observation, participatory design (PD), prototyping, questionnaires, rapid application development (RAD), technical review and workshops.

The exact nature of each of these methods is fully explored in Chapter 3 but at this juncture it should be noted that many of these methods have some common characteristics which are of particular importance to this study. Each method is essentially a communication model. With the exception of questionnaires, each method traditionally involves a physical meeting between IS professionals and users. This meeting comes in a variety of guises but, at its core, involves communication between people who are involved in the systems development process. Human communication is described by a variety of different authors and, although there is no single communication model which describes all aspects of human communication, there are some basic concepts which can be found underlying most models. There is a *sender*, who conceives of, encodes, and transmits a *message* (which has meaning), along a *channel* (which could be our voice carried on the air, or by some form of technology) to a *receiver*, who receives, and decodes the message. The communication process could involve two or more people communicating in a face-to-face setting, or in a computer-mediated setting such as via electronic mail.

Traditionally, the requirements elicitation process involves face-to-face communication, requiring participants to physically travel between organisations. Depending on the geographical location of the participants, travel may involve long journeys and overnight stays in foreign locations. Costs linked to this travel are financial (for example car rental, aeroplane tickets, accommodation and food), and psychological (for example decreases in productivity as a result of the journey itself, stress related to travel and time away from home and family).

The Internet and modern telecommunications technology have almost successfully closed the communication gap between people and businesses across the world. Coupled with the rapid development in transportation infrastructures, one would expect that business people today can operate from almost anywhere in the world without wasting too much money, time and energy on non business-critical events. Unfortunately, the fact remains that the costs of running business operations from remote locations are still too high. Time and money are still spent on travelling and accommodation, and productivity is still diminished as a result of changes in location away from the office and the comforts of home.

Many software development projects today involve users and developers from different parts of the world. At some point, these stakeholders (or at least their ideas) need to be brought together to contribute towards the success of the project. This is done at the above-mentioned cost. Groupware technology is an emerging field in the realm of *information technology* (IT), and it has the potential to offer solutions to this problem. This potential remains to be fully realised, and this research project aims to contribute to the ultimate realisation of the potential by answering a number of questions. These questions include: What exactly is communication with respect to requirements elicitation? What is *communication enabling technology*? What are the limitations of communication enabling technology? Can requirements elicitation be done successfully using communication enabling technology? If so, how can requirements elicitation be performed using communication enabling technology? What specific communication enabling technology (which is available today) can be used to facilitate requirements elicitation? And what enhancements need to be made to existing communication enabling technology to make it more suitable to facilitating requirements elicitation?

It is intended that this research project develops a model for geographically distributed requirements elicitation (GDRE), and examines the technological infrastructure needed to facilitate this model. The results of this work present many opportunities for software development projects all over the world, and furthermore, it is expected that the principles of the model and the accompanying technology will, in all likelihood, have a variety of other practical applications in business and in the household.

The value of this work may be carried into other areas of business, and life in general. The advantages of *virtual working* are described by Hulyalkar (1998) to be: saving of daily commuting by thousands of workers all over the world, saving of paper, better decision making due to faster flow of information, avoidance of material and energy wastage, reduction of the burden on civic amenities in cities, reduction of migration from villages to cities, and improved literacy levels through distance learning.

1.1.1 The Statement of the Problem

This study evaluates the process of information systems requirements elicitation to determine the key factors which characterise it, and examines the process of distributed communication in order to develop a geographically distributed information systems requirements elicitation model for South African companies.

1.1.2 The Sub-Problems

1. To evaluate information systems requirements elicitation methods in order to determine their characteristics.

2. To evaluate geographically distributed communication in order to determine its characteristics.
3. To evaluate the critical success factors of different information systems requirements elicitation methods in order to determine which characteristics must be preserved in a geographically distributed information systems requirements elicitation environment.
4. To develop a geographically distributed information systems requirements elicitation model for South African companies.

1.1.3 The Hypotheses

1. Different information systems requirements elicitation methods (some which are more effective than others) have different characteristics.
2. Geographically distributed communication has distinct characteristics which restrict communication.
3. The critical success factors of different requirements elicitation methods can be isolated and re-amalgamated to form a new requirements elicitation method.
4. A geographically distributed information systems requirements elicitation method can be developed for South African companies.

1.1.4 The Delimitations

This study will not evaluate the requirements analysis techniques employed during the use of information systems requirements elicitation methods, but will be limited to the communication tools used by those methods.

This study will not evaluate existing communication technologies.

This study will not evaluate the practical and technical implementation of combining existing communication technologies.

This study will be limited to South African companies which have recently been involved in or are currently involved in software development projects.

This study will not include projects where more than 50% of the project schedule is hardware development, selection and installation.

1.1.5 Assumptions

The need for joint information systems requirements elicitation will continue.

The need for customised software development approaches will continue.

Technically, groupware technology can be developed to meet the needs of a geographically distributed information systems requirements elicitation model.

In order to make it viable as a tool, the cost of using groupware technology will be sufficiently small in comparison with the total cost of the project.

South Africa is representative of both the third world African and the first world economies; technological deficiencies at present make the technological infrastructure difficult to compare with most other first world countries.

1.2 The Definitions of Terms and Abbreviations

1.2.1 The Definition of Terms

Technique: MacDonald (1967:658) describes a technique as a method of performance, manipulation, or execution, as in music or art: individualised execution: formal construction (for example, of poetry). The Concise Oxford Dictionary (Fowler and

Fowler, 1956:1308) submits a similar definition: mode of artistic execution in music, painting, etc.; mechanical skill in art. Checkland (1993:162) offers different wording and different examples but essentially provides the same meaning: a precise specific programme of action which will produce a standard result: if you learn the appropriate technique and execute it adequately you can, with certainty, solve a pair of simultaneous equations or serve a tennis ball so that it swerves in midair.

Method: MacDonald (1967:395) describes a method as “the mode or rule of accomplishing an end: orderly procedure: orderly arrangement: system: classification.” The Concise Oxford Dictionary (Fowler *et al*, 1956:749) states that a method is a “special form of procedure in any branch of mental activity.” Kotarbinski (1966) (as cited in Checkland, 1993:161) supports these definitions: the path of a person pursuing another: a path: a way of doing something: behaviour in formulating one’s thoughts.

Methodology: A methodology is defined by The Concise Oxford Dictionary (Fowler *et al*,1956:749) as an “orderly arrangement of ideas; orderliness, regular habits; scheme of classification.”

According to Checkland (1993:162), the outcome of research is not a method but a set of principles of method which in a particular situation have to be reduced to a method uniquely suitable to that particular situation. A methodology is intermediate in status between a philosophy, using that word in a general rather than a professional sense, and a technique or method.

Furthermore, Checkland (1993:162) explains that a methodology will lack the precision of a technique but will be a firmer guide to action than a philosophy. Where a technique tells you ‘how’ and a philosophy tells you ‘what’, a methodology will contain elements of both ‘what’ and ‘how’.

Requirements Elicitation Method: The requirements elicitation method is the manner in which a Systems Analyst would set about eliciting the system requirements of the users.

Requirements Analysis Technique: The requirements analysis technique is the framework /toolset which a Systems Analyst would adopt in order to represent the system requirements as expressed by the users.

Geographically Distributed: Geographically distributed implies that the locations of two or more communicating parties are remotely distinct.

Groupware Technologies : Groupware technologies refers to the set of existing technologies which attempt to allow communication between two or more geographically or temporally distributed parties.

1.2.2 Abbreviations

AI	Artificial Intelligence	GSS	Group Support Systems
ANOVA	Analysis of Variance	IS	Information Systems
CAD	Computer-aided Design	IT	Information Technology
CASE	Computer-aided Software Engineering	JAD	Joint Application Development
CMC	Computer mediated communication	JRP	Joint Requirements Planning
CMS	Configuration Management Systems	LAN	Local Area Network
crud	created, read, updated, or deleted	LSD	Least Significant Differences
CSCW	Computer Supported Cooperative Work	MANOVA	Multi-factor Analysis of Variance
DTS	Defect Tracking Systems	MUD	Multi-user Dungeon
EIP	Executive Intensive Planning	PD	Participatory Design
EIS	Executive Information Systems	PLC	Project Lifecycle
EMS	Electronic Meeting Systems	RAD	Rapid Application Development
ERD	Entity Relationship Diagram	RECM	Requirements Elicitation Communication Model
ESS	Executive Support Systems	RFC	Request for Comments
GCSS	Group Communication Support Systems	SDLC	Systems Development Life Cycle
GDRE	Geographically Distributed Requirements Elicitation	SRS	Software Requirements Specification
GDSD	Geographically Dispersed Software Development	UIA	User Intensive Analysis

GDSS Group Decision Support Systems

1.3 Summary of Results

This investigation shows that requirements elicitation can be conducted in a distributed environment and lends some hope that the costs of traditional face-to-face requirements elicitation can be reduced without compromising the quality of the Software Requirements Specification.

This investigation includes:

- A study of the literature to identify process management related problems and their solutions, and to determine the exact nature of the communication processes incorporated by the requirements elicitation process.
- The development of a *requirements elicitation communication model* to describe the requirements elicitation process.
- An empirical study (conducted in South Africa) to examine the principles of the requirements elicitation communication model and the relationships of the elements within the model.
- The development of a *model of geographically distributed requirements elicitation* based on the findings of the empirical study.
- An investigation of the issues associated with the technological implementation of the model of geographically distributed requirements elicitation.

Requirements elicitation is an organised and rational process of the investigation of requirements for the development of an information system. The investigation predominantly involves extensive and complex communication between a large group of stakeholders whose express purpose is to define and record, quite unambiguously, information systems requirements as expressed by the users of the system. The process of requirements elicitation is as important as the documents which result from it, and should foster trusting relationships among participants, ultimately leading to user 'buy-in'.

Given the natural tension between the time taken for, and the cost of, the requirements elicitation process, and the quality of the results, the requirements elicitation process is difficult to manage. This is accentuated by the complexity of the interpersonal interaction and communication processes which characterise the requirements elicitation process. The *requirements elicitation communication model* (RECM) represents and explains the requirements elicitation process in a succinct, yet detailed and unambiguous manner.

The RECM is a two-dimensional graphical representation of requirements elicitation from a communication perspective. The model is based on communication concepts and factors from a variety of linear, relational and convergence communication models each specifically selected for its unique contribution to our understanding of the communication process. Furthermore, the RECM is accompanied by a taxonomy of requirements elicitation communication factors which provides an extremely detailed and specific reference to low-level communication concepts and factors which are associated with the requirements elicitation process. The RECM represents the requirements elicitation process in such a way that the process is contextualised in terms of its environments and its outcomes, and the relationships between elements involved in the process are explained. Furthermore, "best practices" are presented as part of the model, thus making it a representation of the 'ideal' approach to the requirements elicitation process.

The RECM shows that good project management techniques, and the effective facilitation of interactions and communication, will ensure the success of the requirements elicitation process. The analyst (designated to lead the process) is responsible for the success of the process.

Further complexity is introduced to a requirements elicitation process when participants are not co-located. Due to a lack of direct contact between participants, process management is made more difficult. Furthermore, human interactions and communications are expected to occur in an unnatural environment. The *model of geographically distributed requirements elicitation* (GDRE) proposed by this thesis enables the analyst (as leader) to implement requirements elicitation in a distributed environment, and to overcome these additional complexities. The model of GDRE incorporates strict project management principles, significant lessons from documented attempts at globally dispersed software development (GDSD), and the RECM. The model is presented as a 3-phased approach to requirements elicitation, namely *planning*, *implementation* and *termination*. The planning and termination phases consist of a sequential set of steps to achieve the requirements elicitation process objectives. Significantly, the model of GDRE proposes the use of *interviewing*, *structured workshops*, and *prototyping* as the main requirements elicitation methods. The model also suggests approaches to GDRE for extremely large systems development projects where more than one group of users and developers concurrently performs requirements elicitation for a particular project.

The process-centred nature of the model provides a logical link to the selection of a technological infrastructure to underlie its implementation. However, it is not possible to associate specific technologies to the model of GDRE. This is primarily due to the generic nature of the model. Instead, it is suggested that in each individual instance of GDRE any one (or a combination of) The Denver Model for Groupware Design, The Arizona Groupware Grid, the Collaborative Framework, the EWG/IVC Services Taxonomy, and the Conceptual Framework for Studying the Impact of Technology on Groups be used to evaluate groupware technologies in respect of their suitability for supporting that unique instance of GDRE. Due to the complex nature of the GDRE process and the relative immaturity of communication technologies, there is no single communication technology to support the process. It is suggested that for each individual implementation of GDRE, a mix of communication technologies be employed to form the GDRE technology infrastructure.

1.4 Thesis Organisation

This thesis is divided into four (4) Parts. **Part I** (Chapter 1) introduces the research problem; **Part II** (Chapters 2 to 6) builds a model of geographically distributed requirements elicitation; **Part III** (Chapters 7 and 8) investigates technology for the implementation of the model of GDRE; and **Part IV** (Chapter 9 and Appendices) concludes the work and presents the appendices.

Chapter 2 reviews the literature relating to requirements analysis and communication. The discussion centres on the key issues associated with requirements elicitation, namely, project management and communication. This discussion forms the foundation for subsequent discussion.

Chapter 3 explores (in detail) the requirements elicitation methods, and models of communication. The chapter culminates in a requirements elicitation communication model which is tested empirically in the South African context.

Chapter 4 presents the empirical study which examines the principles of the requirements elicitation communication model and the relationships of the elements within the model. All of the details pertaining to the empirical study are described. The results of the empirical study relate to the communication processes which constitute requirements elicitation, as well as a perspective on the technology which would be required to implement a requirements elicitation process in a distributed environment.

Chapter 5 presents a modified requirements elicitation communication model based on the results of the empirical study. This modified model forms a foundation for the development of a model of *geographically distributed requirements elicitation*.

Chapter 6 uses the project management and communication foundations, together with an examination of literature regarding distributed communication and globally dispersed software development, to build a model of GDRE.

Chapter 7 investigates the literature regarding communication technologies. Discussion centres around specific types of communication technology. The technologies are described and classification schemes are explored. Frameworks for evaluating these technologies are then discussed. This discussion forms the foundation for subsequent discussions.

Chapter 8 draws GDRE and communication technology together. Specific communication scenarios and GDRE support functions are identified as needing technological support. The capability of communication technology to meet these demands is then examined, and additional issues introduced by technology *per se* are discussed.

Chapter 9 concludes the study by summarising important findings and suggesting areas for future study.

The **Reference Appendix** is a list of all previous work referred to and/or referenced in this study.

The **Glossary** is a list of terms and definitions relating specifically to the requirements elicitation communication model discussed in Chapters 3, 4 and 5. The Glossary should be consulted for clarification on the meaning of communication factors which appear in the requirements elicitation communication taxonomies shown in Appendices A and C.

Appendix A is a *requirements elicitation communication taxonomy* which accompanies the requirements elicitation communication model presented in Chapter 3. This taxonomy forms an important part of the explanation of said model.

Appendix B is the *questionnaire* used to collect data for the empirical study presented in Chapter 4.

Appendix C is a *revised requirements elicitation communication taxonomy* which accompanies the *modified requirements elicitation communication model* presented in Chapter 5. This taxonomy forms an important part of the explanation of said model.

Appendix D is *Coleman's groupware taxonomy* which gives a more detailed representation of some of the groupware categories (important issues relating to that groupware and examples of sample products) than the taxonomy presented in Chapter 7.

Appendix E is the *EWG/IVC Services Taxonomy* which contributes to literature relating to the classification of groupware technologies. This taxonomy should be read in conjunction with the discussion relating to it in Chapter 7.

PART II

BUILDING A MODEL OF GEOGRAPHICALLY DISTRIBUTED REQUIREMENTS ELICITATION

The aim of Part II is to build a model of GDRE. The model is built on the foundation of an extensive literature survey of the appropriate elements making up the model. The requirements elicitation process is contextualised as a part of the requirements analysis phase of the SDLC.

The process of requirements elicitation is explored, introducing key concepts and concerns which will shape the model of GDRE. Key concepts and concerns relate mainly to issues regarding the management of the requirements elicitation process (project management), and the communication processes which collectively make up a requirements elicitation process. Solutions to, and control measures for, the project management issues are presented, and the concept of distributed communication is discussed in detail. Requirements elicitation is identified as being predominantly a set of specialised communication processes. Project management issues are covered extensively in the literature; relevant issues are identified and discussed. Experiences presented in the literature to date regarding *globally dispersed software development* (GDSD) projects are explored. Communication issues are discussed in the literature at a general level, and are not explored in adequate detail to provide an accurate image of the exact nature of the requirements elicitation process. Traditional requirements elicitation methods represent the communication aspects of the requirements elicitation process. These methods are explored, evaluated and compared, with a view to improving understanding of their underlying communication processes. Communication models are used to represent key communication factors identified in this analysis, and a model of communication in the requirements elicitation process is developed. The requirements elicitation communication model is then evaluated on the basis of information gathered in an empirical study conducted in South Africa. A modified requirements elicitation communication model arises from this empirical evaluation.

Finally, a three-phase model of GDRE is presented. The model reflects the project management and communication issues encapsulated in earlier discussion and in the requirements elicitation communication model, and accounts for the problems associated with GDSD.

Chapter 2
REQUIREMENTS ANALYSIS AND COMMUNICATION

2.1 Introduction

The previous chapter contextualised the research project, briefly explaining the need for information systems. It focussed the research project on the analysis phase of the SDLC, and in particular, the elicitation of user requirements which forms a part of that phase. This chapter explores the process of requirements elicitation, introducing key concepts and concerns which shape the model of GDRE.

This chapter begins by introducing IS development as part of an IS project. *Requirements analysis* is then defined as it is intended to be understood in this thesis. The importance of the requirements analysis phase is examined, with particular attention given to the requirements elicitation aspect of this phase. Management of the requirements elicitation process, and the communication processes which collectively make up a requirements elicitation process, are identified as being key elements in need of further investigation. Issues of managing this process are examined in detail, and these issues are then viewed (with a focus on identifying problems and associated solutions) in the light of a GDSD project. Finally, foundational concepts of human communication are introduced.

The following chapter presents a detailed examination of traditional requirements elicitation methods which represent the communication aspects of the requirements elicitation process. An analysis of existing communication models is then combined with knowledge of the requirements elicitation process and used to produce a requirements elicitation communication model (RECM).

2.2 The Project Life-cycle (PLC) and the SDLC

Kerzner (1979) describes a project as comprising four phases: project formation, project build-up, main program and phaseout. Kerzner (1979) explains that these phases are distinctive by the *conflict sources* prevalent in those stages of the project life-cycle (PLC). According to Kerzner (1979:251), conflicts are “a natural occurrence resulting from the differences in the organisational behaviour of individuals, the differences in the way that functional and project managers view the work required, and the lack of time necessary for project managers and functional personnel to establish ideal working relationships.”

Lockyer *et al* (1996) also explain that a project comprises four phases: conception, development, realisation and termination. Lockyer *et al* (1996) define the PLC from the perspective that project management “is concerned wholly with the introduction and management of change.”

McLeod *et al* (1996) present a generic PLC which can be applied to “virtually all types of IT projects” (McLeod *et al*, 1996:74). As shown in **Figure 2.1** the project life-cycle is defined by a series of project management activities aimed at initiating, planning, scheduling, controlling and terminating an information systems development project. The SDLC adopted by the project specifies the specific software development tasks which will be performed. The exact SDLC adopted is irrelevant when viewed at task level, and the project management activities (as shown in **Figure 2.1**) remain the same.

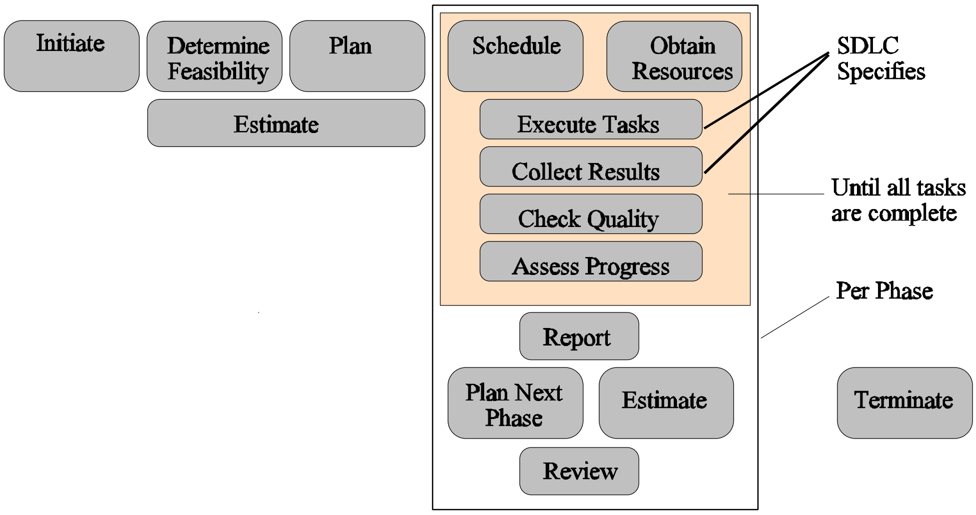


Figure 2.1: Project Life-cycle (McLeod *et al*, 1996:74)

McLeod *et al* (1996) draw particular attention to the *initiation* and *termination* phases of the PLC. *Initiation* includes all of the activities which occur at the outset of a project. McLeod *et al* (1996) describe project definition, feasibility, justification, plan and design, scope, standards, techniques, methods, task and skill determination, and time and cost estimation as activities which make up the initiation phase. *Termination* (as described by McLeod *et al*, 1996) involves evaluating the process, reviewing what has been learnt with a view to using this knowledge in future projects, and reallocating resources to other projects. An information systems development project can thus be represented (in a simplified manner) as comprising an initiation phase, an SDLC, and a termination phase (as shown in **Figure 2.2**[1]).

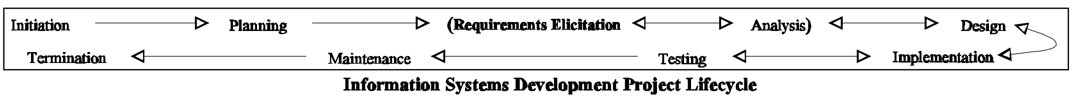


Figure 2.2: The SDLC as part of a PLC

[1]The requirements elicitation phase is highlighted here as this is the phase with which this research project is primarily concerned. Requirements elicitation is usually considered a part of the analysis phase of the SDLC, the brackets indicate this relationship: this is discussed in detail later in this chapter.

Dewdney (1998)[2] examined the field of virtual work, and in particular, virtual systems development with respect to project management. Dewdney developed a model for the management of a virtual systems development project which was based largely on the PLC model presented in McLeod *et al* (1996). Dewdney concludes that managing a virtual (distributed) systems development project is significantly more complex than managing a traditional systems development project. As a result, there are more considerations which need to be accounted for. Of particular relevance to this study is the need for a specialised approach to people management, and the need to use structured methodologies in the project approach (this is discussed in more detail in Chapter 6). The *model of project management in a virtual environment* (as shown in **Figure 2.3**) illustrates the management of individuals and teams operating in different locations.

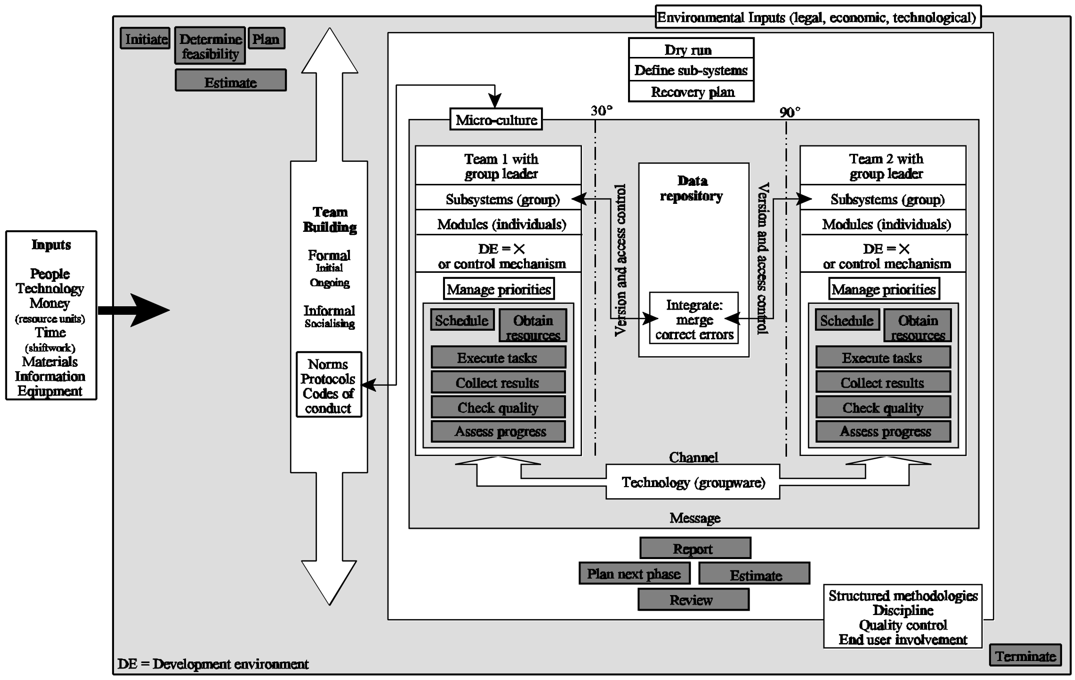


Figure 2.3: Model of project management in a virtual environment (Dewdney, 1998:59)

[2]Information Systems Honours research project supervised by Nicholas Vat.

2.3 Requirements Analysis

2.3.1 What is a User Requirement?

There are a variety of definitions of *user requirements* offered by numerous authors. Many are quite similar, but many have subtle differences which tend to confuse one's understanding of exactly what a user requirement is. *Webster's Ninth New Collegiate Dictionary* (Webster, 1984) defines a requirement as "something required; something wanted or needed." The IEEE Standard 729 (IEEE, 1983) defines it as a condition or capability needed by a user to solve a problem or achieve an objective; and a condition or capability that must be met or possessed by a system... to satisfy a contract, standard, specification, or other formally imposed document. Davis (1990:17) defines it as "a complete description of the external behaviour of the software to be built... this... includes documenting all interfaces between the software and its environment." Sommerville (1989:88) states that a requirement is "a service which the system is expected to provide" (functional system requirements), and the "constraints under which the system must operate and the standards which must be met by the delivered system" (nonfunctional requirements). Shelly *et al* (1998:3.5) state that "a system requirement is a characteristic or feature that must be included in an information system to satisfy business requirements and be acceptable to users... they will define the characteristics of the new system... (and) will serve as benchmarks to measure the acceptability of the finished system." Furthermore, Shelly *et al* (1998:3.6-3.7) state that system requirements fall into five categories: outputs, inputs, processes, timings, and controls. To identify specific requirements, the systems analyst will need information about current and future volumes, sizes, and frequencies for all outputs, inputs, and processes.

Although there is some consistency, it is clear that the term *requirement* holds different meanings for different organisations in the software industry. In summary, and as so ably put by Sommerville (1995:64), "in some cases, a requirement is seen as a high-level abstract statement of a service that the system should provide or a constraint on the system." And in other cases, "it is a detailed, mathematically formal definition of a system function." Sommerville (1995:64) warns that failure to make a clear distinction between the different levels of description can lead to problems in the requirements engineering process, and hence suggests using the following distinguishing terms:

- *requirements definition*: the high-level abstract description of requirements;
- *requirements specification*: the detailed description of what the system should do; and
- *software specification*: an even more detailed description which bridges the requirements engineering and design activities.

Due to its universal appeal, the requirements definition offered by Shelly *et al* (1998) is most appropriate for the purposes of this study. Furthermore, it is important to note that this study is limited to the *requirements definition* and *requirements specification* as specified by Sommerville (1995) above.

2.3.2 Determining User Requirements

According to Hoffer *et al* (1999:241) the process of determining requirements (requirements elicitation) involves gathering information from a variety of sources, that is users of the current system, reports, forms, and procedures. As mentioned earlier, the information gathered will need to be about current and future volumes, sizes, and frequencies for all outputs, inputs, and processes (Shelly *et al*, 1998:3.7). Whitten and Bentley (1998:99) call this "fact-finding" and refer to the process of using research, interviews, meetings, questionnaires, sampling and other techniques to collect information about systems, requirements, and preferences. Essentially, requirements elicitation is an investigation which is performed by a systems analyst, which uses a variety of investigation methods, and which draws on a variety of communication techniques. Whitten *et al* (1998:99) add that, during this investigation, the systems analyst (and indeed the project team in general) "learn about the business's and system's vocabulary, problems, opportunities, constraints, requirements, and priorities." According to Hoffer *et al* (1999:241) the primary deliverables of requirements elicitation are the various forms of information gathered during the process: transcripts of interviews, notes from observation and analysis of documents, analysed responses from questionnaires, sets of forms, reports, job descriptions, and other documents, and computer-generated output such as system prototypes. The amalgamation of all of these gives rise to the *requirements definition* which, as defined by Sommerville (1995:64) is "a statement, in a natural language plus diagrams, of what services the system is expected to provide and the constraints under which it must be done. It is generated using customer (user) supplied information."

The requirements elicitation process is a complex task and is constrained by a number of factors which, as stated by Yeates *et al* (1994:118-121), will ultimately "enable the analysis team to determine which fact-finding methods are most appropriate, as well as helping them to put together a detailed plan for the investigation." These constraints are depicted in **Figure 2.4**.

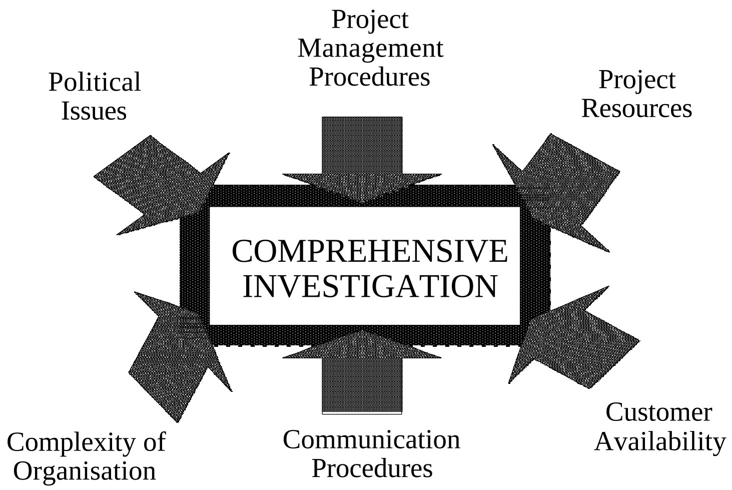


Figure 2.4: Constraints on the investigation (Yeates *et al*, 1994:120)

Yeates *et al* (1994:119-121) describe the constraints as follows:

- *Project resources* available: this includes all resources ranging from people to enabling technology;
- *customer (user) availability*: it is important to know if appropriate staff will be available for discussion;
- *political issues* important in the customer's organisation: it is important to know what politically sensitive issues may be encountered during the requirements elicitation;
- *complexity* (and size) *of the organisation*: this will influence the choice of fact-finding techniques used;
- *project management procedures*: initially, customer expectations will need to be explored and understood; and
- *communication procedures*: agreement will need to be reached on appropriate channels of communication and the identification of named individuals as 'contacts'.

2.3.3 Analysing User Requirements

Requirements analysis involves structuring the information gathered during requirements elicitation, or building prototypes. Hoffer *et al* (1999:240) suggest that inconsistencies and deficiencies are discovered and eventually (through this iterative process) the discoveries converge on a thorough and accurate depiction of current operations and what the requirements are for the new system. This depiction comes in the form of a requirements specification and a software specification. The *requirements specification* as defined by Sommerville (1995:64) is "a structured document which sets out the system services in detail. This document, which is sometimes called a functional specification, should be precise." The *software specification* is "an abstract description of the software which is a basis for design and implementation. This specification may add further detail to the requirements specification" (Sommerville, 1995:65). These depictions of the requirements are collectively known as the Software Requirements Specification (SRS).

2.3.4 Representing the User Requirements in the SRS

There are a number of approaches to developing the SRS, and there is some disagreement amongst leading authors on this subject regarding exactly what should be included in the SRS. Sommerville (1989:58) recommends that the SRS sets out what the system should do without specifying how it should be done. Davis (1990:180) describes the SRS as "a complete description of the external behaviour of the software system" but is quick to point out that there are indeed two approaches to producing an SRS: i) that which is written by the user, and ii) that which is written by the IS professional. Davis (1990:181) states that in the first instance the SRS merely defines the needs of the user, and in the second, its purpose is to provide a means of: i) communication among customers, users, analysts, and designers, ii) supporting system-testing activities, and iii) controlling the evolution of the system.

Sommerville (1989:58) and Davis (1990:184) describe the characteristics of a good SRS as being (amongst others):

- *correct*, if every requirement stated therein represents something required of the system to be built;
- *unambiguous*, if every requirement stated therein has only one interpretation;
- *complete*, if everything that the software is supposed to do is defined, if definitions of the responses of the software to all input data in all situations are defined, and if all word processing is complete;
- *verifiable*, if there is a means by which the as-built software can be checked to determine whether or not every requirement has been met;
- *consistent*, if no subsets of individual requirements conflict;
- *valid*, if the requirements are stated in such a way that the design may be validated; and
- *understandable by non-computer specialists*, if it is not written in extremely formal notations only.

Davis (1990:184) and Sommerville (1989:58) agree that this is an extremely difficult task to achieve. According to Davis (1990:195), "There is no such thing as a perfect SRS!" and Sommerville (1989:58) states that, "it must simply be accepted that errors and omissions will exist in the document." To add to this, despite efforts to ensure good quality SRS production, De Marco (1979:13) believes that inevitably an SRS is of an "unwieldy size", is "redundant, wordy, physical, tedious to read and unbearable to write."

2.3.5 The Importance of the Requirements Analysis Phase of the SDLC

2.3.5.1 The Cost of Poor Requirements Analysis

Gause and Weinberg (1989:17) state that, "billions of dollars are squandered each year building products that don't meet requirements, mostly because the requirements were never clearly understood." Boehm (1981) (as cited in Gause *et al*, 1989:17), in a study of 63 software development projects, determined the ranges in cost for errors created by false assumptions in the requirements phase but not detected until later phases. **Table 2.1** and **Figure 2.5** show the relative cost to fix an error detected in a later phase of the SDLC.

Table 2.1: Relative cost to fix an error (Boehm, 1981)

Phase in Which Error was Found	Cost Ratio
Requirements	1
Design	3-6
Coding	10
Development Testing	15-40
Acceptance Testing	30-70
Operation	40-1000

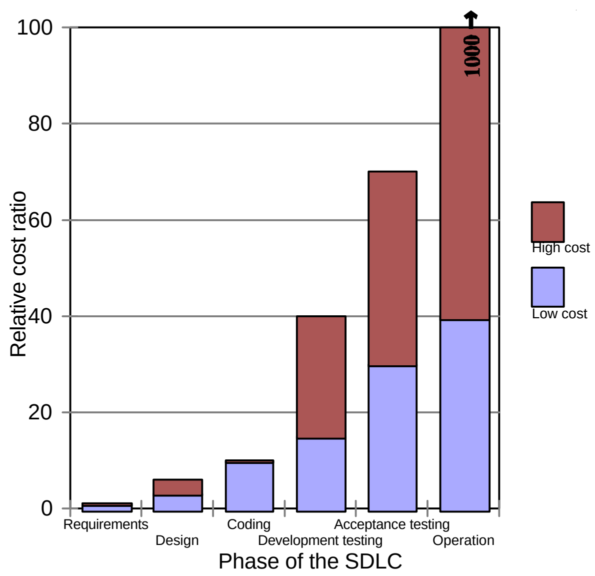


Figure 2.5: Relative cost to fix an error (Boehm, 1981)

Gause *et al* (1989) suggest that Boehm's figures may be conservative. If this is indeed the case (and if this situation has not changed dramatically since 1981), then there can be no doubting the importance of the requirements phase of the SDLC. It is clear that if the requirements phase is not completed successfully, the entire systems development project will be seriously affected. The onus lies on the systems development Project Manager to ensure that the necessary measures and controls are put into place to prevent this.

2.3.5.2 Requirements Elicitation and Project Success

In their book *Exploring Requirements: quality before design,* Gause *et al* (1989) offer a thorough and detailed investigation of requirements elicitation. This text is considered by the current author to be pioneering work, addressing many of the key factors of the requirements elicitation process in a unique and insightful manner. The following issues are examined (in each case the issue is explained, the factors relating to that issue are discussed, and some sound advice is offered on how to deal with those factors):

- ambiguity in stating requirements;
- participant selection;
- communication in meetings (idea-generation, brainstorming, and dealing with conflict);
- clarifying and managing expectations;
- user satisfaction; (Gause *et al* (1989:238) state that, "Perhaps ninety percent of product development efforts fail. About thirty percent fail to produce anything at all, but most of the failures don't have that problem. They do produce a product, but people don't like it. They may not use it at all, or if they do, they may grumble endlessly"); and
- decision making and agreement.

Commentary on the failings of systems development efforts is found predominantly in the field of project management. The concerns expressed by authors in this field have an impact on many areas of systems development *per se*, but given the significance of the requirements phase, they are particularly relevant to analysts embarking on a requirements elicitation process. There is agreement amongst authors such as De Marco (1982), De Marco and Lister (1987), Ewusi-Mensah and Przanyski (1991), Ewusi-Mensah (1997), Gilb (1988), Humphrey (1989), James (1997), Johnson (September 1997), Kerzner (1992), Kerzner (1979), Lockyer and Gordon (1996), McLeod and Smith (1996), Vandersluis (January 1998) and Yeates (1991) that IS projects are doomed to failure. There is a wide range of reasons offered. Those specifically relating to requirements elicitation are:

- Poorly established specifications and design.
  - poor preparation;
  - poor participant selection and training;
  - poor use of enabling technology;
  - lack of creativity, impertinence, impartiality, flexibility, and attention to detail on the part of the systems analyst;
  - IS professionals second-guess the end-users;
  - poor communication;
  - poor interpersonal interaction;
  - poor problem solving;
  - poor decision making;
  - unclear goals;
  - poor scope management;
  - poor quality controls;
  - poor expectations management;
  - unrealistic schedules;
  - unrealistic cost estimates; and
  - poor documentation.
- Lack of stakeholder “buy-in” or commitment.

There are two main points which need to be highlighted for the purpose of this study. If the establishment of the system specifications is poor (as a result of any of the reasons offered in the list above), the SRS will not provide the system designers with the best information possible to produce a solution to the clients' needs. If an accurate SRS is produced but there is a lack of stakeholder "buy-in" or commitment to the document, the system which is developed is not likely to be accepted.

In essence, it is important for the reader to note that the requirements elicitation process is a complex one, and if performed poorly (although perhaps contributing to the production of an accurate SRS) it could lead to the downfall of the development project as a whole.

2.3.5.3 Preventing Project Failure

From a project management perspective, Kerzner (1979:210), Lockyer *et al* (1996), McLeod *et al* (1996:8), and Yeates (1991) offer the following suggestions which the author believes are particularly relevant to avoiding those problems specifically relating to the development of the SRS:

- encourage openness and honesty from the start from all participants;
- create an atmosphere that encourages healthy, but not cutthroat competition, or "liars" contests;
- develop clear understandings of the relative importance of cost, schedule and technical performance goals;
- obtain, allocate, coordinate and control resources;
- implement quality controls;
- develop short and informal lines of communication and flat organisational structures;
- communicate with the users;
- delegate sufficient authority to the principal client contact and let them promptly approve or reject important project decisions;
- develop close (not meddling) working relationships with project participants;
- avoid arms-length relationships; and

- avoid excessive reporting schemes.

A close examination of all of these suggestions reveals that effective communication among all participants is the key to project success.

Based on the discussion thus far, the following key factors need attention during the requirements elicitation phase of a systems development project in order to ensure that an accurate SRS is produced and that the various stakeholders are committed to the rest of the development efforts:

Communication: this is the essence of the entire requirements elicitation process. The systems analyst needs to have good communication skills and should be able to apply those skills in a variety of different situations. The specific skills which will be put to use will be dependent on the requirements elicitation method(s) chosen, the types and abilities of the participants selected, and the enabling technologies employed;

Preparation: the systems analyst needs to be properly trained and prepared for the requirements elicitation process. This not only involves becoming skilled in the necessary areas of communication, problem solving, decision making, and the use of enabling technology, but also involves such things as preparing venues, timetables, teas and all other factors which will enable the process to take place;

Dealing with ambiguity: much of the communication which takes place during the requirements elicitation process will be subject to ambiguity. Ambiguity leads to misunderstanding which will ultimately erode the quality and acceptance of the SRS;

Interpersonal interaction: there needs to be at least some face-to-face interpersonal interaction between participants. Participants should be encouraged to develop personalised business relationships with one another, and should be open and honest with one another at all times. Healthy competition should be encouraged, and authority gaps between supervisors and subordinates should be closed as far as possible during the process;

Systems analyst approach: the systems analyst needs to be creative, impertinent, impartial, flexible, and meticulous. His/her approach should encourage a similar response from all other participants;

Awareness of the complexity and size of the organisation: this is important as it will affect the choice of fact-finding techniques used;

Respect for the organisation: the systems analyst needs to be aware of politically sensitive issues of the organisation, and should harbour respect for all members of the organisation (not necessarily only those who are involved in the project or who may be directly affected by it);

Respect for the end-user: IS professionals should not second-guess the end-users as this is likely to create conflict, decrease user confidence in the development team and destroy trust;

Participant selection: the correct participants need to be selected for the requirements elicitation process. A wide range of people is often required to offer their thoughts regarding their needs, and it is important to include all of these people at appropriate times and in an appropriate fashion;

Participant scheduling: the chosen participants need to be scheduled into the requirements elicitation process. Meeting times need to be carefully planned, and participants should be kept abreast of changes to the schedules;

Participant training: all participants should be properly briefed on the nature of the method(s) to be used for requirements elicitation. They should be trained where necessary in order that they may fully understand the documentation which is produced during the requirements elicitation process;

Resource sourcing and scheduling: necessary resources must be sourced and scheduled well in advance;

Use of enabling technology: apart from being skilled in the use of enabling technology such as e-mail or CASE tools, the participants should be encouraged to use it appropriately;

Problem solving: facts need to be checked and crosschecked before being recorded as precisely as possible. This can only be done once the facts are all available and are fully understood. Due to the complexity of many problems and the complex nature of communication in general, problem solving techniques will need to be employed in order to achieve this;

Decision making: sufficient authority should be delegated to an appropriate participant. The said participant should possess the appropriate decision making skills, and should be enabled (via appropriate technology and sufficiently knowledgeable participants) to employ specialised decision-making techniques when appropriate;

Goal setting and definition: without clearly defined goals and objectives, the requirements elicitation process will go awry, causing confusion and ultimately a loss of commitment and enthusiasm on the part of the participants;

Expectations clarification and management: if the expectations of participants are not fully discussed and understood, and if they are not realistic, participants will become disappointed with the project as a whole and may ultimately reject the project entirely;

Documentation: this includes all written forms of communication ranging from records of conversations to data models. Documentation should be impeccably prepared with attention to detail and an accurate reflection of the requirements as discussed, understood and agreed upon by the participants. It should be presented in a manner and style which can be understood by all participants (normally a mixture of natural language, tables and diagrams), and should be distributed timeously to all participants;

User satisfaction: user satisfaction should be measured along the way, and responded to appropriately;

Stakeholder commitment: without the absolute "buy-in" or commitment of all stakeholders, particularly the end-users, the project is destined to fail. The development team needs to foster the *trust*, *loyalty* and *confidence* of the users, as without this the necessary information sought during the requirements elicitation process will not be released, the SRS will be inaccurate, and ultimately, the system will be rejected.

2.4 Globally Dispersed Software Development (GDSD)

Information systems development projects can be completed in a dispersed (distributed) environment. GDSD implies the use of communication technology (discussed in Chapter 7) to facilitate the implementation of the software development project. From a project management and communication perspective, this approach introduces additional challenges and complications. The aim of this section is to identify issues which have been encountered in distributed software development efforts to date, and to learn from the experiences of others thus far. The views of prominent authors in the field are presented, with a particular focus on the benefits and the problems of GDSD, and some solutions to those problems. A case example is used to show how technology can be implemented to solve some of the problems covered.

2.4.1 Benefits of GDSD

Carmel (1999), in an introductory discussion entitled ‘Globally Dispersed Software Development’, presents three ‘idealised’ reasons for engaging in GDSD. These are:

- the ability to employ the best developers in the world regardless of their geographic location. The current author argues that this could be applied to all members of the development team, and not just the developers;
- the ability for geographically distant colleagues to work together as if they were in the same room together. This is referred to as *location transparency*; and
- the ability for a project to ‘*follow-the-sun*’, that is, to be worked on around–the-clock, taking advantage of time zone differences (this is referred to by Gorton and Motwani (1996) as *software shift work*). This leads to the *overnight gain effect* as described by Gorton *et al* (1996:649).

2.4.2 Problems with GDSD

There are problems relating to GDSD. As suggested by Carmel (1999), and supported by Gorton *et al* (1996) and Rothman (1998), the main problems can be summarised as follows:

- the *distance* of developers from one another and from the users;
- *culture* differences which include language, national traditions, customs, and norms of behaviour, organisational norms, and local systems development norms;
- *time-zone differences* which lead to coordination problems; and
- staff required to work unsociable hours.

2.4.3 Suggested Solutions

Rothman (1998) presents some ideas on what can be done to contribute to an effective GDSD project. These are:

- to define complementary processes and agree on the meaning of important terms;

- to use Configuration Management Systems (CMS) and Defect Tracking Systems (DTS). According to Rothman (1998:38), communication problems and other pitfalls of GDSD can be avoided with configuration management, requirements management and conferencing tools;
- to formally inspect requirements documents with all development teams;
- to provide all team members with project plans;
- to organise project teams by product feature; and
- to use collaborative tools to bring the project together.

Gorton *et al* (1996) suggest additional general solutions, as well as solutions specifically aimed at solving the problems of distance and time zone differences, human communication and human interaction. These are:

- to set up an environment which results in a low level of interdependence amongst participants; and
- to re-engineer the software production process. Gorton and Motwani investigate, in some detail, the project management, inter-team communications and software process aspects of global development teams. They look to utilise specialised coordination and communication support tools only when they are proven, commercially available technology and can be exploited or rapidly customized to support distributed working.

With regard to *shift work*, Prasad, Morenc and Rangan (1993) (as presented in Gorton *et al* (1996:648)) suggest:

- dividing the project into sizeable chunks of semi-independent activities;
- assigning these activities to project teams which can proceed in parallel with each other;
- performing each assigned team activity as quickly as possible;
- simultaneously starting as many activities as possible;
- minimising interdependencies between activities; and
- transparency of communications between and across parallel activities.

With regard to *communications*:

- a basic communications infrastructure (high speed computer networks with e-mail and file sharing) and telephone, teleconferencing and facsimile facilities should be set up. Video-conferencing would be a further asset if available. Gorton *et al* (1996) predict that new high-speed networks, multimedia workstations and multimedia software development tools will profoundly influence virtual team communications in years to come;
- the precise relationships and roles of each group which comprises the virtual team must be clearly established. Three models are suggested: i) cooperative virtual teams comprise homogeneous distributed development groups which share the ongoing process of developing a product, ii) delegation structure virtual teams comprise a supervisor group (which assumes the responsibility for allocating tasks and setting schedules) and a worker group which performs the tasks, and iii) consultative virtual teams rely upon the existence of distributed expert service groups which can be called upon to carry out a specific task within their area of expertise. The three models are not mutually exclusive;
- information must be exchanged via: i) project development documents (including requirements specifications, design documents, program code, test specifications and data, and product documentation); ii) ad hoc intergroup communications (e-mails, discussions, queries, alerts to problems or unexpected changes in development documents); and iii) project management information (task specifications, status reports, current schedules, resource requests and project plans). This points to the need for a large repository for the documentation, either residing permanently at one location, or replicated (with appropriate control mechanisms) amongst some or all locations;
- preparation for formal and informal information flows between groups must be included. These flows may be formally set up, exist for a given length of time, and then be dissolved, or they may be set up on an ad hoc basis for unspecified periods of time; and

- with regards to virtual teams and specific development tasks, modern approaches to requirements specification and architectural design techniques emphasize cross-functional teams, group collaboration and consensus decision-making techniques. It is suggested that video- or teleconferencing technology can sufficiently support this. Hrones, Jedrey and Zaaf (1993) describe a project in which teams from the USA and Europe collaborated using teleconferencing to define the requirements for a complex software product. The same two teams were not necessarily involved in the rest of the development effort.

Doppke, Heimbigner and Wolf (1998) tackled the problem of 'Software Process Modelling and Execution within Virtual Environments'. Although this work does not deal specifically with requirements elicitation, or many of the significant areas of software development *per se*, there are some interesting and relevant concepts explored. Technologies which are collected together to facilitate the modelling and execution of processes are referred to as *process-centred environments* (this is discussed in detail in Chapter 7). Doppke *et al* (1998:3-5) suggest that the process-centred environments must address all of the aspects of the process and model them in a convenient and systematic way. They must support *activities* (or *tasks*) executed by people or tools as part of a software process, and *actions* (or *transactions*, for example a decision made by a person). The execution of an action may require the use of an appropriate *tool*, and this in turn must be supported. *Agents* (humans or machines) involved in the process will assume a *role* associated with an activity. Roles must be supported and managed. Part of any process is the need to secure *resources* (time and money), and parts of any system are *artifacts* (parts of a system being developed) which are usually related. The process-centred environment should support resource acquisition and should define relationships between artifacts. As the process concerns the *product* itself, which may be viewed as a collection of *subproducts*, so the process-centred environment should be appropriately designed.

Doppke *et al* (1998) describe a system that permits multiple users to connect to it (via some network) and that presents a virtual world to these users in which each user is represented as a *player*. This system is known as a multi-user dungeon (MUD), and its architecture is shown in **Figure 2.6**.

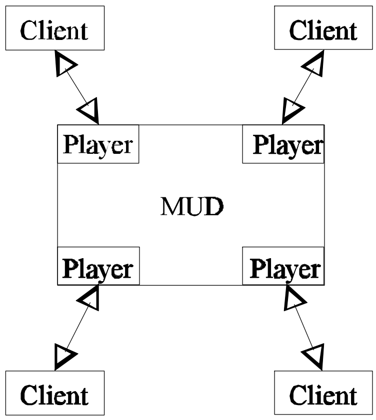


Figure 2.6: Client-server architecture of a typical MUD

The MUD provides a set of rooms, within which a myriad of objects including other players, is located. According to Doppke *et al* (1998), the MUD's world represents space by means of spatial relationships amongst objects (for example, connections between rooms) but not specific distances or directions. In other words, there is no accurate representation of three-dimensions. The specific technology used in the study is known as LambdaMOO which supports (amongst others) the following objects: rooms and exits, correspondence (allows appropriate access to artifacts), collaboration (among people executing the process), and realism (all be it limited).

Research in the area of distributed work is ongoing. There have been, and still are, numerous studies aimed at examining specific types of technology (and in some instances, specific software products) which support collaborative work. At present there is no single technology which is capable of supporting all of the needs of a particular collaborative work environment.

2.5 Requirements Elicitation and Communication

Thus far it has been shown that the system requirements elicitation process is a comprehensive investigation of the needs of people within an organisation. Apart from needing good communication skills to administer the requirements elicitation process, the systems analyst needs the communication skills to ensure the effective elicitation of information from the people (users) themselves. Furthermore, it would be extremely beneficial if the users also had good communication skills, as they will be called upon to express their thoughts and feelings in an unambiguous manner, and in an environment and context in which they might not be comfortable.

The concept of communication is introduced here, primarily with a view to providing the reader with an understanding of the issues involved in communication, and more specifically, the issues associated with representing communication as a process. Communication will be explored in more detail in Chapter 3.

2.5.1 The History of Human Communication Studies

Debate over exactly what human communication is, has been ongoing for many years, and numerous authors have tackled the subject from a variety of different angles. Charles S. Pearce (a philosopher in the mid 19th century) inquired into the nature of signs and meaning and thereby laid the foundation for the *convergence model of communication* which has since been investigated by numerous authors. Sapir (1935:78), an anthropologist, argued that society is “a highly intricate network of partial or complete understandings between the members of organisational units... reanimated or creatively affirmed by particular acts of a communicative nature which obtain [occur] among the individuals participating in it”. It was suggested that the focus of communication should thus be on the development of mutual understanding that emerges over time between those who share information with one another.

Sereno and Mortensen (1970), in the preface of their book entitled *Foundations of Communication Theory,* outline some other angles. For example, in the years following the publication of *The Mathematical Theory of Communication* by Shannon and Weaver (1949), scientists considered communication theory as strictly mathematical. A close parallel was developed with information theory, where for example, the essence was to measure the amount of information that could be sent over channels in technology-based systems. Ultimately it was hoped that the results of such work could be carried into the realm of psychology and be applied to human information transmission and reception. This proved to be unsuccessful, but served to highlight the need for a behaviourally oriented theory of human communication.

Since then a variety of theories of communication have been developed and studied extensively. For example, Wayne E. Brockreide (in Sereno *et al*, 1970:25-39) uses the notion of rhetoric to formulate a multidimensional framework of human communication. According to Brockreide, each communicative act is the unique result of an interplay of the *interpersonal, situational,* and *attitudinal* dimensions of human interaction. The result is that human communication is expressed as an intricate activity involving many different behavioural processes. This is a descriptive perspective of human communication.

From a psychological viewpoint Franklein Fearing (in Sereno *et al*, 1970:40-54) examines the same variables as Brockreide and conceives of communication as an act occurring in a matrix of social and individual forces. This is an explanative theory which considers communication as an event occurring in a *situational field*. Fearing insists that the individual's tensional states lead to the production of communication (signs and signals) aimed at achieving a more stable form of social organisation.

Harvey B. Sarles (in Kendon *et al,* 1975:19-45) presented a human ethological approach to communication, and Ludwig von Bertalanffy, Anatol Rapoport, Kenneth Boulding and Talcott Parsons were instrumental in developing systems theory and subsequently a systems theory approach to communication. In a business environment, communication theory receives attention in the field of *organisation behaviour* with authors such as Wagner III and Hollenbeck, Robbins, Greenberg and Baron, Carrel, Jeannings and Heavrin (amongst others) all making a contribution through the production of textbooks. Their work is based on the research presented in research papers such as Argyle (1978), Driskell and Salas (1991), Hackman (1979), Ilbarra (1993), Kiesler and Sproull (1992), Miller (1976), Mintzberg (1973), Ostroff and Kozlowski (1992), Parry (1970), Rogers and Rogers (1978), Saavedra, Earley and Lan Dyne (1993), Shannon and Weaver (1948), Sommer (1969), Van Maanen and Schein (1979),and Williams (1989). Theories on group communication and interpersonal interaction have been applied specifically in the field of Information Systems and Systems Development, with authors such as Tony Warner, in his book *Communication Skills for Information Systems* (Warner, 1996), pioneering the drive to link IS and interpersonal communication.

In short, there have been numerous approaches to explaining the concept of communication. Each has been investigated and debated extensively, and each has its merits, demerits, strengths and weaknesses. But all of these approaches have contributed in some way to our current understanding of communication. The net result of these investigations has been numerous definitions of communication which are predominantly represented in the form of communication models.

2.5.2 Communication Models

At the outset it is important to note that a communication model is not the only way to view communication. Models do have their shortcomings. Wenburg *et al* (1973:62) note that "any view of communication is incomplete... when we organise and highlight certain parts of the communication process, we are ignoring other parts... the selective nature of any communication model necessitates overlooking some elements. Any single view of man's communication behaviour is partial." Nevertheless, viewing communication in terms of a model is a valid exercise.

Sereno *et al* (1970:7-9) describe a communication model (or system) as "an idealized description of what is necessary for an act of communication to occur. A model represents or replicates, in abstract terms, the essential features and eliminates the unnecessary details of communication in the 'real world'." Sereno *et al* (1970) go on to explain that models differ widely. Those based upon mathematical conceptions describe communication as analogous to the operations of a computer; that is an *event* occurs in which a *source* or *sender transmits* a *signal* or *message* through a *channel* to some *destination* or *receiver*. The social sciences generally add to this model such factors as the *nature* of the interaction, the *response* to the message, and the *context* in which the interaction occurs. A systems approach abstracts what is common to all modes of human communication and presents a frame of reference from which a better understanding of the communication process is made. This comprises *decoding-encoding behaviour*, *interaction*, and *social context*.

All of these models describe, to some extent, the process of communication. Collectively, they make reference to factors such as the psychological makeup of the individuals engaged in the process, the communication tools used to construct a message, the nature of the message sent, the channel along which it was sent, the factors which influence the appropriate and accurate receipt and understanding of the message, and the environmental factors influencing the process.

2.5.3 Communication Definitions

Many authors accompany a model of communication with a formal definition. As with the models, definitions of communication do not fully explain the process of communication. In order to delimit the specific area of communication theory of interest in this study, it is necessary to define exactly what is intended by the use of the word *communication*. Nilsen (1957), in his paper entitled, *On Defining Communication,* divides communication definitions into two categories, and offers definitions from the Webster's New International Dictionary of English Language (2nd edition), Wilbur

Schramm, Mapheus Smith, Charles Morris, George Lundberg, Edward Sapir, Theodore Newcomb, Jurgen Ruesch, Henry Lindgren, Charles Cooley, S. S. Stevens, and Warren Weaver. These definitions indicate a range of interpretations and one of the more modern definitions, as suggested by Du Plooy (1991), states that "communication is an interpersonal and/or social interaction between at least one communicator and at least one recipient, which implies: a message, a medium, a context in which the process of sharing of meaning occurs, an intentional purpose to express, to interpret, to provide and/or to receive feedback." Shannon *et al's* (1949:95) definition is certainly a compelling one to use: communication includes "all of the procedures by which one mind may affect another... In some connection it may be desirable to use a still broader definition... which would include the procedures by means of which one mechanism... (automatic equipment to track an airplane...) affects another mechanism... (guided missile...)." Nilsen (1957) concludes that Stevens' (1950) definition is the most appropriate:

> *"Communication is the discriminatory response of an organism to a stimulus... This definition says that communication occurs when some environmental disturbance (the stimulus) impinges on an organism and the organism does something about it (makes a discriminatory response). If the stimulus is ignored by the organism, there has been no communication. The test is differential reaction of some sort. The message that gets no response is not a communication."*

In writing a book entitled *Communication Management,* Kaye (1994) encountered the problem of defining communication and eventually resolved to placing the concept within the realm of some assumptions (Kaye, 1994:17-19). The current author considers this to be an appropriate approach and offers the same assumptions to be read together with the definitions of Stevens (1950) and Shannon *et al* (1949) in order to fully understand what is meant by *communication* for the purposes of this thesis, that is:

- Human communication is fundamentally a social activity;
- Human communication is also a matter of how people construe images of themselves and of others (perception and self-perception);

- Human communication is a two-way process;
- Human communication is situational and thus subject to the influence of intervening variables;
- Human communication is emotional as well as logical;
- Human behaviour is complex; and
- Human communication is inevitable.

2.5.4 Communication Terminology

Perhaps partly in an attempt to overcome the shortcomings of models and definitions of communication, the following works have attempted to describe communication in terms of the terminology relevant to it, irrespective of the nature of the communication process: i) *500 Communication Concepts: English/Afrikaans* (Du Plooy, 1991); ii) *Webster's New World Dictionary of Media and Communications* (Weiner, 1996); iii) *Webster's College Dictionary* (Webster, 1991); and iv) *A Dictionary of Communication and Media Studies* (Watson and Hill, 1993). The authors of these works have taken care to produce terminology out of the extensive theoretical research base, from dictionaries of modern language, and only where absolutely necessary, have relied on their own understanding of factors which have not been formally documented elsewhere.

There are, quite literally, thousands of words, terms and phrases (hereafter referred to as *factors*) which are used to describe aspects of communication theory. Chapter 3 presents some of these factors.

2.6 Conclusion

This chapter introduced IS development as part of an IS project. It has defined *requirements analysis* as it is intended to be understood in this thesis. The importance of the requirements analysis phase was examined, and particular attention was given to the requirements elicitation aspect of this phase. The research project was scoped to focus only on the *requirements definition* and *requirements specification* aspects of the SRS. Management of the requirements elicitation process, and the communication processes which collectively make up a requirements elicitation process, were identified as being key elements in need of further investigation. Issues of managing this process were examined in detail, and some of these issues were viewed (with a focus on identifying problems and associated solutions) in the light of a GDSD project. Finally, foundational concepts of human communication were introduced. The means for expressing a communication process were identified as communication models, definitions, and the use of specific terminology.

The following chapter presents a detailed examination of traditional requirements elicitation methods which represent the communication aspects of the requirements elicitation process. An analysis of existing communication models is then combined with knowledge of the requirements elicitation process to produce a requirements elicitation communication model.

Chapter 3
REQUIREMENTS ELICITATION COMMUNICATION MODEL

3.1 Introduction

The previous chapter introduced IS development as part of an IS project, and defined requirements analysis as it is intended to be understood in this thesis. The importance of the requirements analysis phase was examined, and particular attention was given to the requirements elicitation aspect of this phase. Management of the requirements elicitation process and the communication processes which collectively make up a requirements elicitation process were identified as being key elements in need of further investigation. The process management issues were examined in detail and some of these were viewed in the light of a GDSD project. Finally, foundational concepts of human communication were introduced.

In attempting to define requirements elicitation from a communications perspective, the author has chosen to build a model as described in Chapter 2. It is intended that this model describes, in general, the requirements elicitation process; it is understood from the outset that current methods of requirements elicitation use different communication techniques and can be modelled in different ways. However, for the purposes of this project, and as will become apparent later, it is only necessary to describe the communication process generally, and to explicitly show particular aspects of communication which are relevant to all methods of requirements elicitation. The basic premise is that all requirements elicitation methods aim to achieve the same result, which is to elicit a user requirement.

The chapter begins with an examination of traditional requirements elicitation methods with emphasis on identifying the general communication characteristics of those methods. This is followed by an exploration of existing models of communication which describe the general communication characteristics identified, and which would support the key factors for project failure prevention identified in Chapter 2. The concept of distributed communication is then discussed. Each method is then evaluated and compared on the basis of those general communication characteristics. A graphical model (the *requirements elicitation communication model* (RECM)) which describes the requirements elicitation communication process will then be presented. Finally, a taxonomy of communication terminology which describes the graphical model is developed.

The following chapter presents an empirical study designed to examine the principles of the RECM and the relationships of the elements within the model, in the South African context. The empirical study is used as a basis for presenting a modified RECM which represents the communication aspects of requirements elicitation in South Africa.

3.2 Requirements Elicitation Methods

A requirements elicitation method is the manner in which a Systems Analyst would set about eliciting the system requirements of the users. Essentially, it is a formally defined communication process, specifically geared to achieving a particular communication objective (information elicitation.) Requirements elicitation methods have grown out of the demands of various systems development methodologies. With the advancement of the technological era, these systems development methodologies have tended towards automation. According to Gause *et al* (1989:3), many information systems professionals believed that in order to do a better requirements definition job, one should remove the people from the systems development process and instead use an automated methodology. Further advancement would be to extend that methodology to the point where the final product is also generated automatically. Hence the development of computer-aided software engineering (CASE) and computer-aided design (CAD) tools. CASE has proven to be one of the most noticeable failures of the software engineering industry, not because of its inability to facilitate the process of software engineering, but rather, because of a misunderstanding on the part of those applying such tools. According to Gause *et al* (1989:4) a typical CASE tool would have three components: i) analysis and design workstations that facilitate the capture of specifications; ii) dictionaries that manage and control the specification information; and iii) generators that transform specifications into code and documentation. The most difficult function is performed by the generators, where the computer would somehow have to resolve the 'mess' produced by the analysis and design workstations and the dictionaries. In theory, the generators could do their part, provided that the systems analysts did their part, that is elicit requirements effectively.

Inevitably, all of the systems development methodologies which are in existence today comprise a variety of methods which define the systems development process. Very few of these methods are applied only to one aspect of the systems development process. The methods which are either specifically requirements elicitation methods, or which contain components which cater for requirements elicitation are listed below:

- Document Review;
- Interviews;
- Joint Application Development (JAD);
- Joint Requirements Planning (JRP);
- Meetings;
- Observation;
- Participatory Design (PD);
- Prototyping;

- Questionnaires;
- Rapid Application Development (RAD);
- Technical Review; and
- Workshops.

In this authors experience, a few other terms have been used which may describe a requirements elicitation method. They are: Executive Intensive Planning (EIP), Ad hoc (as opposed to formal) meetings, and User Intensive Analysis (UIA). Furthermore, in *open source* projects, requirements are raised through *request for comments* (RFC's). No doubt there are others. Due to the lack of reference to such methods in the literature surveyed and reviewed, these methods have not been studied.

Bearing in mind that it is the communication aspects of requirements elicitation which are of interest here, what follows is a brief description of each method, the identification of those aspects of the method which are relevant to communication, an evaluation of their differentness, and a description of the method in terms of its communication characteristics.

3.2.1 Document Review

Hawryszkiewyzcz (1991:48-49), Hoffer *et al* (1999:253-257), Shelly *et al* (1998:c.13) Texas Instruments (1988:19-20), Whitten *et al* (1994:793-795) and Yeates *et al* (1994:145) all contribute to the discussion on document review.

The aim of document review is to contribute towards the development of a full understanding of the current systems which are to be redesigned, and to contribute to the understanding of the way in which the organisation does its business. Document review is most useful in the instance where an existing system is to be redesigned.

All written documents about the organisation areas relevant to the systems under design or redesign are useful. Such documents can be categorised as those which describe the problem, the business functions, or previous systems. These documents include interoffice memoranda, organisational mission statements and strategic plans, manual and computerised files, and documentation of previous systems studies and designs.

Information can be found about problems with existing systems, opportunities to meet new needs, organisational direction, titles and names of key individuals, organisation and individual values, special information processing circumstances, the reasons why current systems are designed as they are, data, rules for processing data, and information- or data-related principles by which the organisation operates.

In order to fully understand a document, its purpose and its importance to the business, the document review should be accompanied by some form of analysis, that is the systems analyst should ask questions about how, where, and when the document gets used.

The advantages and disadvantages of document reviews are:

Advantages

- Lots of data can be collected with minimal interference in the workplace;
- A wide variety of information can be found; and
- Document reviews provide a basis for effective, knowledgeable interviewing at a later stage.

Disadvantages

- Documents may be out of date or no longer used;
- Documents may not be available;
- Documents may not be used in the manner in which they were intended; and
- In the event that the system under scrutiny is large and complex, sampling techniques will need to be applied - these may lead to bias.

General human communication characteristics are:

- Dialogue between analyst and user to arrange a search for, and delivery of, appropriate documentation; and
- Dialogue (in the form of an informal interview) between analyst and users to gain a better understanding of the documentation.

3.2.2 Interviews

Authors such as Burch (1992:163-172), Gause *et al* (1989:261-267), Goles (1997), Hawryszkiewyzcz (1991:52-58), Hoffer *et al* (1999:243-252), Kendall *et al* (1999:101-123), Mason and Willcocks (1987), Newman *et al* (1995:94-99), Shelly *et al* (1998:3.7-3.13), Texas Instruments (1988:20-23), Whitten *et al* (1994:800-804),Whitten *et al* (1998:632-636) and Yeates *et al* (1994:128-141) offer some discussion on interviews as a requirements elicitation method.

The aim of the requirements elicitation interview is to provide a congenial and fast way to gather, verify and clarify facts, generate enthusiasm, get the user involved, identify requirements, and more importantly, solicit opinions and feelings. During an interview the systems analyst will not only gather verbal information, but will observe body language, emotions, and other signs of what people want, and what they think about the existing system. It is a directed conversation with a specific purpose; the systems analyst will seek to gather opinions of the interviewee, and his or her feelings about the current state of the system, organisational and personal goals, and informal procedures.

According to Newman *et al* (1995:94), an interview is a “social event that can, if conducted sensitively, gather vital data while helping to make the prospective user feel positive towards the proposed system.” A relationship, which is based on trust and understanding, is forged between the systems analyst and the user, allowing the exchange of relevant information in both directions. However, the systems analyst must maintain control at all times.

The advantages and disadvantages of interviews are:

Advantages

- They give the analyst an opportunity to motivate the interviewee;
- They allow probing for more feedback;
- They allow adaptation or rewording of questions to resolve ambiguity or misunderstanding; and
- They allow observation of nonverbal communication.

Disadvantages

- They are time consuming, and therefore costly;
- Their success is dependant on the analyst's communication skills; and
- They may be impractical due to the location of interviewees.

General human communication characteristics are:

- Dialogue between analyst and user to schedule the interview;
- Dialogue between analyst and user to elicit user requirements. This is a structured process which involves a question and answer session, with probing by the analyst where necessary; and
- Usually in a face-to-face setting.

3.2.3 Joint Application Development (JAD)

Numerous authors have investigated JAD as a requirements elicitation method, and those consulted for this research are: August (1991), Burch (1992:18-19), Carmel, Whitaker and George (1993), Hoffer *et al* (1999:258-265), Martin (1990:127-142), Martin (1991:138-171), Shelly *et al* (1998:3.22), Whitten *et al* (1994:155-157, 804-805), Whitten *et al* (1998:125-126) and Wood and Silver (1995).

JAD is a highly structured workshop which brings IS professionals, users and managers together jointly to define and specify user requirements, technical options, and external designs. Users are encouraged to do most of the talking, while the systems analysts translate the user needs into structured specifications and design. This is done in such a way that the users can understand and discuss the results. Furthermore, JAD recognises that IS professionals have difficulty understanding the subtleties of user requirements and it facilitates the communication processes necessary to achieve this understanding.

Ultimately the JAD session establishes the detailed design of the system, which is the data model and process model, detailed specifications, screen and report designs, and possibly rough prototypes.

According to Carmel *et al* (1993:41), there are a variety of generic names for JAD. They are: Joint Application Development, Joint Application Design, Joint Application Requirements, Joint Requirements Planning (JRP), Interactive JAD, Interactive design, Group design, Accelerated design, Team analysis, and Facilitated team techniques.

The advantages and disadvantages of JAD are:

Advantages

- It improves the relationship between users, management, and IS professionals;
- It harnesses the end users into the development process;
- It helps to integrate and unify the needs of different parts of the organisation;
- It replaces voluminous paper specifications;
- It improves computer literacy of users and managers as well as the business and application literacy of IS professionals;
- It places the responsibility for conflict resolution on the shoulders of users and management;
- It decreases development time;
- It improves productivity of the development process;
- It decreases the cost of development;
- It results in greater system value and user/management satisfaction;

- It increases user and management confidence and support for the systems development project as a whole;
- It increases quality and business value of the resultant system; and
- It decreases maintenance costs of the system.

Disadvantages

- It is costly, both financially and in terms of time commitments required by participants; and
- The structure of the JAD process requires full commitment from all participants, and may need a ‘champion’ to convince participants that the process is appropriate and effective.

General human communication characteristics are:

- Dialogue between IS company representative (could be a secretary or an administrator, for example) and user company to schedule the JAD session(s);
- Structured workshop involving representatives of the IS company and the user company;
- Face-to-face setting;
- Agenda and minutes are devised and generated;
- Dialogue, discussion, and debate between the users, facilitated by the analyst (facilitation is particularly important to the success of JAD). Probing by the analyst where necessary; and
- Formal documentation techniques used to represent ideas generated.

3.2.4 Joint Requirements Planning (JRP)

James Martin pioneered JRP as a requirements elicitation method: Martin (1990:127-142), and Martin (1991:138-153).

JRP is a structured workshop which progresses through a set of steps for planning a system. It brings IS professionals, users and managers together, but the emphasis is placed on higher level (perhaps even top level) management. JRP establishes the requirements and justification for a system and the detailed functions that the system will perform. Users are encouraged to do most of the talking.

Martin (1990:127) suggests that JRP and JAD can be combined into one activity, but that a JRP session is usually shorter than a JAD session, without technical detail, and involving higher management levels.

The advantages and disadvantages of JRP are:

Advantages

- It harnesses top business executives into the system planning process;
- It links system planning to the top level analysis of goals, problems, critical success factors and strategic systems opportunities;
- It encourages brainstorming of what the most valuable systems functions are likely to be;
- It eliminates functions of questionable value;
- It encourages creative thinking; and
- It helps to specify the requirements correctly the first time around, thus decreasing the cost of the systems development process.

Disadvantages

- It is costly, both financially and in terms of time commitments required by participants;
- It is difficult to schedule top level managers for a meeting of this nature; and
- The structure of the JRP process requires full commitment from all participants, and may need a ‘champion’ to convince participants that the process is appropriate and effective.

General human communication characteristics are:

- Dialogue between IS company representative (could be a secretary or an administrator, for example) and user company to schedule the JRP session(s);
- Structured workshop involving representatives of the IS company and the user company (mainly high level management);
- Face-to-face setting;
- Agenda and minutes are devised and generated;
- Dialogue, discussion, and debate between the users, facilitated by the analyst. Probing by the analyst where necessary; and
- Formal documentation techniques used to represent ideas generated.

3.2.5 Meetings

There are many works which have been produced which discuss meetings, however, there are only a few which discuss meetings with respect to systems development, and at best the discussion is cursory. Two of these which were used for this study are Gause *et al* (1989:80-91), and Whitten *et al* (1994:839-842). There is no mention made by either of these authors of the use of meetings specifically for requirements elicitation.

Whitten *et al* (1994:839) define a meeting as “an attempt to accomplish an objective as a result of discussion under leadership”, and list the following possible objectives for a meeting: presentation, disseminating information, problem solving, conflict resolution, progress analysis, gathering and merging facts, decision making, training, and planning. Gause *et al* (1989:89) add to this list: to raise people’s spirits, and to encourage creativity. Irrespective of their objective, Gause *et al* (1989:89) suggest that there are some general rules which should be applied to all meetings in order to ensure their success.

Where no formally defined method is used to elicit user requirements, but a gathering of people is called, either informally or on an ad hoc basis, to discuss user requirements, this is known simply as a meeting.

Information regarding the advantages and disadvantages of meetings was obtained from Stewart, de Kock, Smit, Sproat and Storrie (1996:49-71) and Warner (1996:49-53).

The advantages and disadvantages of meetings are:

Advantages

- They allow a variety of views to be expressed;
- They allow individuals to participate in decision making;
- They allow individuals to pool their resources and expertise to come up with a solution to a problem and as a result often lead to lateral thinking and creativity;
- They allow assessment of the support for ideas;
- They enable the dissemination of information to a large group of people at one time, thus saving time;
- They build working relationships; and
- They establish collective responsibility.

Disadvantages

- They may be perceived as unnecessary and therefore poorly attended; and
- They can be chaotic if not properly managed or facilitated.

General human communication characteristics are:

- Dialogue between IS company representative (could be a secretary or an administrator, for example) and user company to schedule the meeting(s);
- May be structured or unstructured, formal or informal;
- Involves representatives of the IS company and the user company;
- Face-to-face setting;
- Agenda and minutes may be devised and generated; and
- Dialogue, discussion, and debate between the users, facilitated by a leader of some description (for example, chairman).

3.2.6 Observation

Observation is a popular requirements elicitation method and is described by many authors. Those referred to for information presented here are: Burch (1992:172-173), Hoffer *et al* (1999:252-253), Kendall *et al* (1999:163-181), Newman *et al* (1995:99-103), Shelly *et al* (1998:3.14), Whitten *et al* (1994:795-797),Whitten *et al* (1998:628-630) and Yeates *et al* (1994:143).

According to Whitten *et al* (1994:795), "Observation is a fact-finding technique wherein the systems analyst either participates in or watches a person perform activities to learn about the system." Kendall *et al* (1999:) focus on the decision maker as the subject under observation and suggest that it is possible to gain insight into what is actually done, to see firsthand the relationships among decision makers in the organisation, to understand the influence of the physical setting on the decision maker, to interpret the messages sent by the decision maker through clothing and office arrangement, and to comprehend the influence of the decision maker on others. Yeates *et al* (1994:144) submit that all relevant users may be observed at some time, and the working conditions, office layout, ergonomics, supervision, workload, and pace and method of working are all relevant factors to be observed.

Whitten *et al* (1994:795) suggest that this method is often used when the validity of data collected through other methods is in question, or when the complexity of certain aspects of the system prevents a clear explanation by the end users. Hoffer *et al* (1999:252) suggest that people cannot always be trusted to reliably interpret and report their own actions, and that observation is a supplement to corroborate what people report in other methods of requirements elicitation.

Newman *et al* (1995:99-103) submit five approaches to observation, each with its own merits and demerits: video recording, concurrent verbal accounts, passive observation, ethnographic field study, and action research.

The advantages and disadvantages of observation are:

Advantages

- It provides highly reliable data;
- Complex tasks which are difficult to describe can be 'seen';
- A wide variety of data can be gathered;
- It is relatively inexpensive; and
- It allows the systems analyst to do work measurements.

Disadvantages

- Peoples' behaviour may change under observation (Hawthorne effect);
- Data gathered may be subject to observer bias;
- The work being observed may not involve the necessary level of difficulty;
- It may involve inconvenient scheduling;
- Tasks may be interrupted;
- Some tasks may not always be performed in the manner in which they were observed;
- It provides only a snapshot image of the task or procedure under observation is possible (in most cases); and
- Task performance, which in the past may have violated standard operating procedures, may be altered as a result of the observation.

General human communication characteristics are:

- Dialogue between the analyst and the appropriate user company representative to schedule the observation(s);
- May or may not involve dialogue between the analyst and the user (this is dependant upon the observation approach adopted); and
- May or may not involve a face-to-face setting (a video camera may be used).

3.2.7 Participatory Design (PD)

Participatory design (a more specific term for *user-participative methods*, or the *Scandinavian approach* to systems development) does not receive much attention in the literature on requirements elicitation. References used for this discussion are Carmel *et al* (1993), Greenbaum and Kyng (1991), Herlea (1999), Hoffer *et al* (1999:33-34), Mumford (1981:5-19) and Newman *et al* (1995:131-136).

PD involves study (investigation which takes place in a meeting situation), model-building (which may take the form of scenarios or envisionments, and which uses techniques ranging from prototyping to videos), and analysis (of current and potential future systems).

PD advocates an extremely strong form of user involvement in the systems development process. PD may involve the entire user community, or where this is not possible, at least representatives from each group within the community. Each user has an equal voice in determining system requirements. Systems analysts work for the users, and the organisations management and outside consultants provide advice rather than control. Usually the IS professionals involved are not called upon to facilitate the process.

The advantages and disadvantages of PD are:

Advantages

- PD effectively addresses matters relating to the interactive aspects of system design;
- PD is highly effective in gathering data;
- PD generates accurate models of activities;
- Analysis of designs is more ‘real’ as it is conducted by the users themselves; and
- User acceptance is very high.

Disadvantages

- PD is only suited to in-house development;
- PD lacks confidentiality and representativeness;
- User understanding can affect the quality of the outcome;
- Interference with the normal work of large numbers of employees;
- PD is too idealistic;
- User contributions may not receive due recognition from management;
- PD is biased towards workers;
- PD lacks method or model; and
- IS professionals need to rely strictly on experience.

General human communication characteristics are:

- Dialogue between IS company representative (could be a secretary or an administrator, for example) and user company to schedule the PD session(s) (which usually take the form of a meeting);
- Usually unstructured, and formal or informal;
- Involves representatives of the IS company and the user company (usually user representation is far reaching);
- Face-to-face setting;
- Agenda and minutes may be devised and generated;
- Dialogue, discussion, and debate between the users, facilitated by a leader of some description (for example, chairman). The leader is normally a user representative and not an IS professional. Probing is done by the analyst where necessary; and
- Formal documentation techniques used to represent ideas generated.

3.2.8 Prototyping

The following authors were consulted for information on prototyping: Allen (1991:261-314), Boehm (1984:290-303), Burch (1992:14-16), Davis (1990:343-355), Hoffer *et al* (1999:32-33, 264), Kendall *et al* (1999:185-207), Macro and Buxton (1987:42-43), Martin (1991:160-188), Martin (1990:107-124), Newman *et al* (1995:189-214), Playle and Schroeder (1996:2), Sommerville (1989:109-122), Sommerville (1995:137-156) and Whitten *et al* (1994:157-159).

Prototyping is done for a variety of reasons, the most relevant of which is, in this case, requirements prototyping (as described by Davis (1990:343)). Davis defines prototyping as "the technique of constructing a partial implementation of a system so that customers, users, or developers can learn more about a problem or a solution to that problem." According to Davis (1990:344), requirements prototypes can be constructed and given to a user in order to determine the feasibility of a requirement, validate that a particular function is really necessary, uncover missing requirements, or determine the viability of a user interface. This is supported by Hoffer *et al* (1999:32) who describe prototyping as an iterative process of determining initial requirements, prototyping, feedback (initial requirements validation), and determining requirements. According to Whitten *et al* (1994:158) the implementation may involve the analyst "painting" sample screens or reports, and soliciting user feedback on their content (not their format).

Prototyping is considered by some authors to be a form of RAD, where the prototype itself serves as a working description of the user needs.

The advantages and disadvantages of prototyping are:

Advantages

- Users become more active participants in the requirements elicitation process;
- Users' enthusiasm is enhanced by the working prototypes as opposed to paper specifications;

- Prototyping simplifies the detailed requirements;
- The likelihood of design approval is increased;
- It decreases development time (although this is disputed);
- It provides a vehicle of communication which is powerful (because it is tangible and real) and which lends itself to iteration required in channelling the learning process in the right direction;
- It introduces early reality testing into a systems development project;
- It encourages creativity; and
- When using and reviewing a prototype users tend to be unbiased by existing systems.

Disadvantages

- Users become overly concerned with the format of screens and reports;
- Users consider the form of the prototype to be the form of the system;
- Prototyping tends to skip through analysis phase too quickly, thereby reducing understanding of problems and requirements;
- It discourages consideration of alternate technical solutions;
- Resultant systems suffer from lack of flexibility;
- It is not always easy to change;
- Prototyping technology can inhibit user comprehension and thus discourage participation;
- It can inflate user expectations;
- It can lead to too much iteration; and
- The user may be too casual about the prototype and not take the time to identify its potential flaws.

General human communication characteristics are:

- Dialogue between IS company representative (could be a secretary or an administrator, for example) and user company to schedule the prototyping meeting(s);

- May be structured or unstructured, formal or informal;
- Involves representatives of the IS company and the user company;
- Face-to-face setting;
- Agenda and minutes may be devised and generated;
- Dialogue, discussion, and debate between the users, facilitated by a leader or facilitator. Probing by the analyst where necessary; and
- “Documentation” is in the form of a prototype, which is examined and evaluated by the user.

3.2.9 Questionnaires

Hawryszkiewyzcz (1991:58-59), Hoffer *et al* (1999:248-251), Kendall *et al* (1999:135-159), Mason *et al* (1987), Shelly *et al* (1998:3.15-3.17), Whitten *et al* (1994:797-800), Whitten *et al* (1998:630-632) and Yeates *et al* (1994:141-143) were referred to for information on questionnaires.

Questionnaires are used to get information about attitudes, beliefs, behaviours, organisation, people, or system characteristics, some system component, the quality and performance of systems. Questionnaires can also be used to quantify what was found using other requirements elicitation methods, to determine how widespread or limited a sentiment really is, or to sense problems or raise important issues before other requirements elicitation methods are employed. Questionnaires provide a means of reaching a large user base and gathering enough data to perform statistical analyses.

The advantages and disadvantages of questionnaires are:

Advantages

- They can be effective when the same kind of information is sought from a number of users (particularly where the information is quantitative in nature);
- They are very effective at getting information about the quality and performance of systems;

- They are useful for gathering numerical data;
- They can be answered quickly;
- They are inexpensive;
- They allow anonymity; and
- Responses can be tabulated and analysed quickly.

Disadvantages

- They are suited to closed (not open) questions;
- Questions are usually not answered completely;
- Answers will usually express a current as opposed to a long-term concern;
- A set of follow-up questions is usually necessary;
- They are difficult and time consuming to design;
- The number of respondents is often low;
- No guarantee that all questions will be answered, and that those that are answered are done so adequately;
- They tend to be inflexible;
- They allow no opportunity for observation of body language; and
- No immediate feedback and reflection (clarification) loop.

General human communication characteristics are:

- Dialogue between the analyst and the appropriate user company representative to distribute and return the questionnaires(s); and
- Dialogue between analyst and user to clarify any ambiguity or concerns which the user may have on responding to the questions, or which the analyst may have on interpreting the user responses. May or may not involve dialogue between the analyst and the user.

3.2.10 Rapid Application Development (RAD)

The following authors were consulted for information on RAD: Hoffer *et al* (1999:485-498), Martin (1991), Shelly *et al* (1998:3.23), Whitten *et al* (1994:159), and Whitten *et al* (1998:636-637).

Martin (1991:vii) states that, "RAD refers to a development life cycle designed to give much faster development and higher-quality results than those achieved with the traditional life cycle. It is designed to take maximum advantage of powerful development software that has evolved recently." According to Hoffer *et al* (1999:485) there are many different RAD approaches, where organisations have developed their own RAD 'methodologies'. Indeed, Hoffer *et al* (1999:486) point out that RAD is not a methodology, but rather a general strategy of developing information systems.

The deliverables and outcomes of RAD are: a systems development plan (which includes the application being developed), a description of user and business process requirements, logical and physical designs, and the eventual systems construction and implementation.

RAD relies on bringing together several systems development methods, particularly those which rely on extensive user involvement. Prototyping, JRP and JAD are the preferred requirements elicitation methods.

The advantages and disadvantages of RAD are:

Advantages

- It decreases overall development time;
- It requires smaller development teams;
- It results in significant cost savings;
- It involves high user involvement;
- It provides high quality system data and process discovery and documentation; and

- The high speed of development results in the system delivered being closer to business needs at the time of delivery.

Disadvantages

- It stresses the mechanics of the system itself without enough attention to the company's strategic business needs;
- It only works well for systems which need to be developed quickly;
- Where speed is a goal, other important aspects of systems development are left out;
- It leaves little room for understanding the business area; and
- It is characterised by high reliance on high involvement of key users, and takes those users away from their normal work.

As this is a IS development strategy, more than a specific requirements elicitation method, general human communication characteristics are all of those which apply to:

- JRP;
- JAD; and
- Prototyping.

3.2.11 Technical Review

According to Gause *et al* (1989:225-237) a technical review is a principle tool which customers can use throughout the requirements process to test whether requirements contain all and only reliable information. It is a testing tool for indicating the progress of the requirements work. A technical review provides feedback of issues to the system analysts to help improve the product, and feedback to management on the actual technical status of the systems development project.

The technical review is normally done in a meeting situation, and involves the users, management, and the IS professionals. Its main objective is to answer the fundamental question: *Does this requirement do the job it's supposed to do?* The answer is conveyed in a review report.

The advantages and disadvantages of technical reviews are:

Advantages

- They are an excellent requirements validity check;
- They save money in the long-run;
- They contribute towards user "buy-in" and management support; and
- They can reveal patterns among issues (over time).

Disadvantages

- Participants may be averse to criticism and if a technical review is done poorly it can be highly demoralising.

General human communication characteristics are:

- Dialogue between IS company representative (could be a secretary or an administrator, for example) and user company to schedule the technical review(s) (these normally occur in the form of a meeting);
- Usually structured and may be formal or informal;
- Involves representatives of the IS company and the user company;
- Face-to-face setting;
- Agenda and minutes may be devised and generated; and
- Dialogue, discussion, and debate between the users, facilitated by a leader of some description (for example, chairman).

3.2.12 Workshops

Workshops is a general term used by Davis (1997), Wood and Silver (1995) and Martin (1991) to describe a structured meeting. Davis (1997) suggests that users and developers come together in workshops to conduct planning, analysis and design activities. Wood *et al* (1995:291) state that a facilitated workshop is used as a method to revisit requirements, whereas Martin (1991:138) suggests that JRP and JAD are, in themselves, workshops.

Knowles (1980:136) provides a comprehensive definition of a workshop: “A workshop is a series of educational and work sessions. Small groups of people meet together over a short period of time to concentrate on a defined area of concern.” Knowles (1980) explains that purposes for workshops may vary, and offers the examples of: informing, problem-solving, and training. Knowles (1980) suggests that typically, a workshop has two components: i) technical example presenting theory in lectures and readings; and ii) applied examples doing a project, producing a product, or writing a paper.

The exact meaning associated with the use of the term in the South African requirements elicitation context is not fully understood, but discussion with people in the industry has led this author to the following conclusions. In South Africa the formal implementation of JAD (for example) is moulded to suit company needs. Workshops are operated on similar principles to JAD, however, they do not adhere strictly to the JAD process in terms of the phases of JAD (August, 1991) and particularly in terms of the tools and techniques used in JAD. Structured (implies *facilitated*) workshops allow the group session approach principles encompassed in JAD to operate, but with flexibility in terms of the process itself (phases) and the tools and techniques used. The exact implementation of a workshop is left to the analyst, but is predefined at least in terms of process, tools and techniques.

3.3 Communication Networks and Models Relevant to Requirements Elicitation

As shown in Chapter 2, numerous authors have been consulted for information regarding communication models. A variety of models were examined, and those which have particular significance to the requirements elicitation process are discussed below.

3.3.1 Communication Networks

Communication is a process which takes place between two or more individuals. Authors such as Rogers and Kincaid (1981) have written comprehensive works which examine, in detail, the communication networks and the networks of interpersonal interaction which influence the communication process. The importance of this field of work is highlighted by the extensive attention given to it by authors such as De Vito (1988), Frost and Dreyer (1993), Sereno *et al* (1970) and Shaw (1971).

According to McGrath (1964), a group's communication structure "may be considered as the set of possible or permissible communication links or as the pattern of communication channels actually utilized during group activity." Shaw (1971) indicates that this communication structure arises as a result of spatial relationships which exert a significant influence upon the perception of status, the patterns of participation, leadership activities, and the effective reaction of group members.

Shaw (1971:139) shows various five-person communication networks used in experimental investigations. These can be seen in **Figure 3.1**. The dots represent each of the participants, the lines represent the possible two-way communication channels which may exist between participants, and the lines with arrows indicate that communication only flows in one direction.

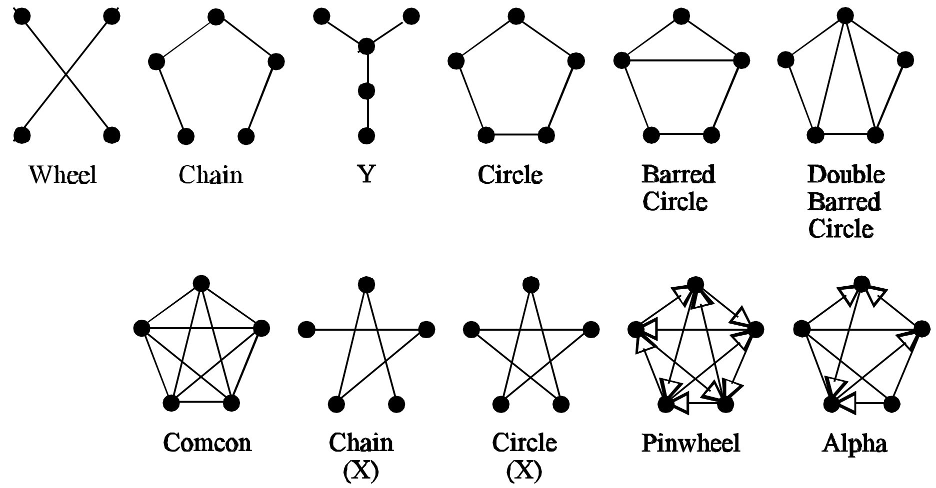


Figure 3.1: Communication networks (Shaw, 1971:139)

In addition to these networks, Frost *et al* (1993) have proposed the *"circle with leader"* network structure shown in **Figure 3.2**. According to Frost *et al* (1993:158), this structure allows for equal communication between every member of the group, with a leader who can intervene and guide the discussion, clarify points, seek a consensus and summarise decisions.

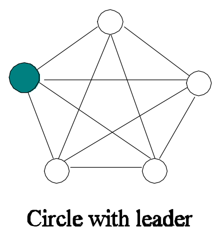


Figure 3.2: Communication network (Frost *et al*, 1993:158)

The communication structures can be divided into centralised and decentralised networks. With regards to group performance and participant satisfaction, the main differences can be found between centralised structures (such as *wheel*, *chain*, and *Y*) and decentralised structures (such as *circle* and *comcon*).

3.3.2 Communication Models

Rogers *et al* (1981:35) describes three types of communication models:

i) *linear*, defined by Berlo (1960) (as cited in Rogers, 1981) as "a process by which a source intentionally changes the behaviour of a receiver";

ii) *relational*, defined by Schramm (1973) (as cited in Rogers *et al*, 1981) as "a set of communication acts focussed on a set of informational signs within a particular relationship"; and

iii) *convergence*, defined by Kincaid (1979) (as cited in Rogers *et al*, 1981) as "a process of convergence in which information is shared by participants in order to reach a mutual understanding".

3.3.2.1 Linear model

As shown in **Figure 3.3** Shannon *et al* (1948) present a simple linear model of communication where the main emphasis is on the message and the changes which may occur to the message from the time it is transmitted until the time it is received.

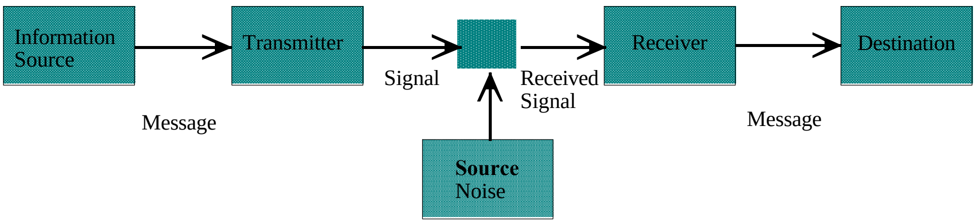


Figure 3.3: Shannon-Weaver model of communication (Wenburg *et al*, 1985:51)

This model describes the communication process as having an *information source* (person A), a *message* (which may be a statement, a basic theme, or significance,... a group of characters [that is, letters, numbers, and symbols] or a unit of information; a single transmission of data in one direction), a *transmitter* (a tool chosen by person A as appropriate to encode and deliver the message), a *signal* (an encoded message travelling on a chosen medium), a *receiver* (a tool chosen by person B which decodes the message), a *destination* (person B), and *noise* (an interference that distorts and renders a message difficult or impossible to interpret).

Noise is a particularly significant phenomenon introduced by Shannon *et al* (1948) as, according to Gause *et al* (1989:92), it may ultimately result in ambiguity, misunderstanding and conflict in the requirements elicitation process.

3.3.2.2 Transactional Model of Communication

Transactional communication as described by Boone *et al* (1994:37) involves "two or more participants who act and react to one another and, in the process, create meaning." The emphasis of communication in this case lies in the message, and more specifically, the successful transmission, receipt and understanding of that message; "a message can be successful only when both the sender and the receiver... perceive it in the same way."

This process relies on *feedback* from the receiver to the sender, and is influenced by both the context in which the communication process occurs, and the channel chosen for the transmission of that message. This is illustrated in **Figure 3.4**.

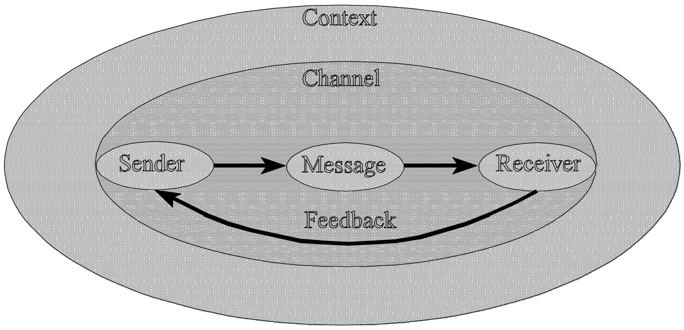


Figure 3.4: Transactional model of communication (Boone *et al*, 1994:37)

Although only at a cursory level, Boone *et al* (1994) also note that the *perception* of the receiver is critical in effective communication. It is suggested that this is a possible *barrier* (problem that arises during the communication transaction and raises the possibility of misunderstanding and confusion) which may not only hinder communication, but could actually alter meaning.

Descriptions of the elements of communication are of a less abstract nature than those offered by Shannon *et al* (1948), and offer some important insights into the nature of the communication process.

3.3.2.2.1 The Sender

Boone *et al* (1994:38-41) explain that a message is influenced by *sender credibility* (the extent to which the sender is perceived to be believable, ethical, trustworthy, competent, responsible, sincere, or authoritative). The suggestion is that the sender's personal reputation will affect the way the receiver reacts to the message. The credibility can be seen in three guises:

- *Initial credibility* refers to the receiver's judgement of the sender prior to hearing the sender speak or reading what he or she has written;
- *Derived credibility* is determined while the oral or written message is being communicated; and
- *Terminal credibility* is the receiver's evaluation of the sender after the message has been delivered.

It is further noted that "in business communication, the sender's credibility is closely linked to his or her knowledge of the material, audience, and the context in which the message is communicated. It is also linked to position and title, which communicate whether the sender has the *authority* to send the message and whether communication is taking place between the right people."

Boone *et al* (1994) go on to explain that everything about a person sends a message. Personality, clothing, handshake, quality of stationary, error-free copy of a letter, and tone of voice all communicate not only intention but also competency and sincerity.

3.3.2.2.2 The Message

Boone *et al* (1994:41-42) explain that a message is the written, oral, or nonverbal communication that the sender transmits to the receiver. This includes words and tone, organization of thoughts, soundness of argument and emotional impact. The message is also what the sender chooses to communicate and what the sender chooses not to communicate.

A message has both intellectual and emotional components. Boone *et al* explain that, "through the use of reason and evidence, we seek to inform or convince... (and) through the use of emotional or motivational appeals, we seek to arouse feelings, change minds, and encourage action."

3.3.2.2.3 The Channel

According to Boone *et al* (1994:43), a channel is the medium through which the message sender and the message receiver communicate. Generally speaking, written messages are transmitted in one of three forms: *letter, memo,* or *report.* Spoken messages may be transmitted in a face-to-face setting or via some form of communication enabling technology (for example, a telephone).

3.3.2.2.4 The Receiver

Boone *et al* (1994:43-45) state that, "as a rule, receivers enter every communication transaction with a preconceived set of ideas and feelings that influence how they respond." It is suggested that the most successful communicators take these needs into account and use them as the starting point in their effort to communicate.

3.3.2.2.5 Feedback

Boone *et al* (1994:45-46) explain that feedback consists of messages which the receiver sends back to the sender. Feedback may cause the sender to either alter the presentation of the message or cancel it entirely. As shown in **Figure 3.4**, feedback creates a circular rather than linear communication transaction that involves both sender and receiver.

3.3.2.2.6 Context

According to Boone *et al* (1994:46-49), the communication context refers to the situation in which communication takes place and to every factor affecting its transmission. This context may include anything in the immediate environment and anything in the broader culture of the organisation.

3.3.2.3 Shared Background

Bruckmann (as cited in Frost *et al*, 1993:27) defines a person's background as "the information s/he acquires through his/her contact with the external world." Frost *et al* (1993:23) explain that this background develops through a process of socialisation, where a person becomes aware of society and relationships with others. Schramm (as cited in Morgan and Welton, 1986:8) states that, when communicating, one is attempting to influence someone to perform a specific task. Communication is thus more than just expression, but actually requires participants to start communication with what they share (for example: language, experience, cultural values and knowledge). As shown in **Figure 3.5**, the area where person A's life overlaps with person B's is the setting for communication between them.

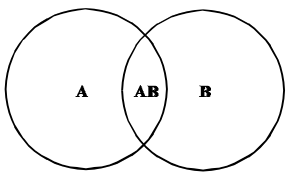


Figure 3.5: Shared background (Schramm, as cited in Morgan *et al*, 1986)

Schramm states that “we have to identify those parts of our experience which we share with our audience, and use this common pool of experience and ideas to provide equivalents for any novel ideas from beyond these limits.” This approach may be particularly applicable in a requirements elicitation scenario where users, in particular, may ‘feed’ off one another in explaining their needs.

Bruckmann represents this background in the context of other elements of communication (see **Figure 3.6**), and lists a number of components which describe the *background* (see **Table 3.1**).

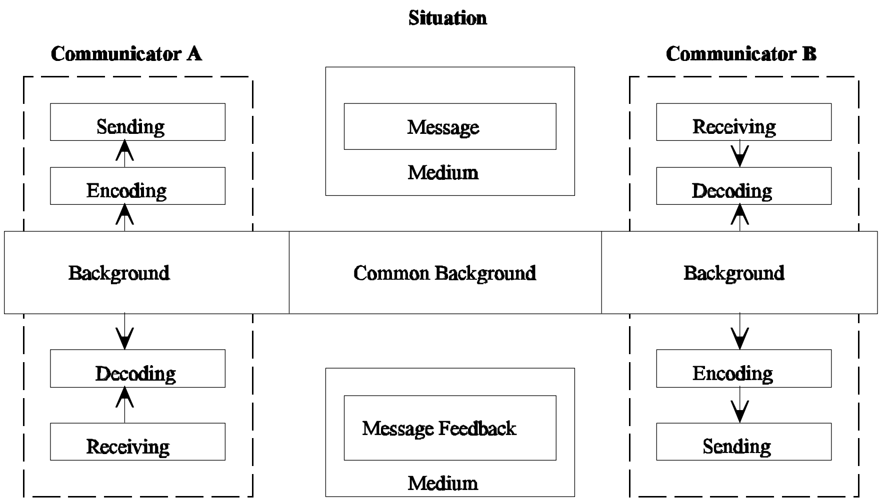


Figure 3.6: Common background (Bruckmann, as cited in Frost *et al*, 1993:23)

Table 3.1: Bruckmann’s background components

Component	**Description**
Codes	Linguistic (languages, for example: English) Numerical/mathematical (can be translated back into English) Kinesthetic (body language: gestures and movement) Proxemic (body language: personal space)
Information	Facts, Inferences, Judgements, Opinions, Beliefs, Mathematical, Probability
Attitudes/Feelings (referring specifically to the communication situation)	Towards: Audience, Subject, Situation, Self, Medium
Personal Features	Culture, Age, Sex, Status, Education, Class

3.3.2.4 Context and Experience

De Vito (1988) presents a model which includes many of the components already discussed (see **Figure 3.7**).

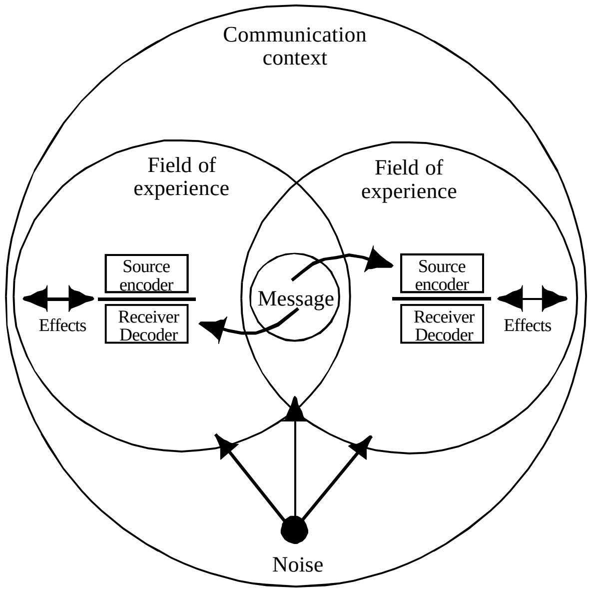


Figure 3.7: Context and experience (De Vito, 1988:5)

Of particular interest in this model is De Vito's thoughts on the communication context. De Vito (1988:4) explains that every communication occurs within a particular context, and that this context can be divided into three main dimensions (this view is supported by Book, 1992:22). The *physical* dimension refers to the physical environment in which the communication occurs and may exert some influence on the content as well as the form of the message (for example, a poorly organised physical environment will result in distracted participants, which may reduce the effectiveness of the message). The *social-psychological* dimension reflects the relationships between the participants and the norms and cultures of the society which may influence the communication between them. The *temporal dimension* refers to the time at which the communication takes place. According to De Vito (1988:4), the "appropriateness, importance, impact and effectiveness" of the message will depend on the timing of the communication act.

Furthermore, De Vito (1988) also refers to *communicative competence*, another facet of the communication context which describes the participant's knowledge of the more social aspects of communication.

De Vito (1988:4) states that these dimensions of context interact with one another, each influences and is influenced by the others.

3.3.2.5 Human Factors

Berlo's model of communication (Wenburg, 1985) focuses on the interpersonal context of human interaction, and specifies significant elements of the communication process. As shown in **Figure 3.8**, the four main elements are the source, message, channel and receiver. Each has specific characteristics, most of which have already been discussed in previous models. The most significant is the channel which is described as being any of the five human senses (seeing, hearing, touching, smelling and tasting).

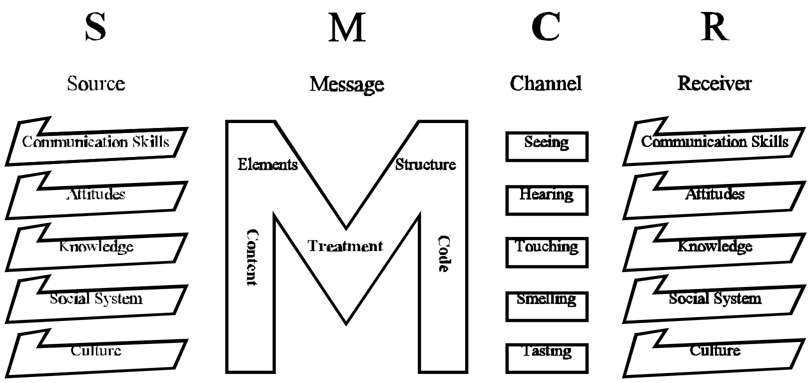


Figure 3.8: Human factors (Berlo, as cited in Wenburg, 1985:50)

Robbins (1986:91) shares Berlo's view of the channel but points out that different people rely to different degrees on each of their senses. This is particularly significant when one considers that should a sender be aware of the preference of a receiver for the use of a particular channel. This could improve the communication process.

3.3.2.6 PERCEPTION AND PERSONALITY

Kerzner (1995) adds to De Vito's model, incorporating a perception and personality screen for each participant in the communication process (**Figure 3.9**).

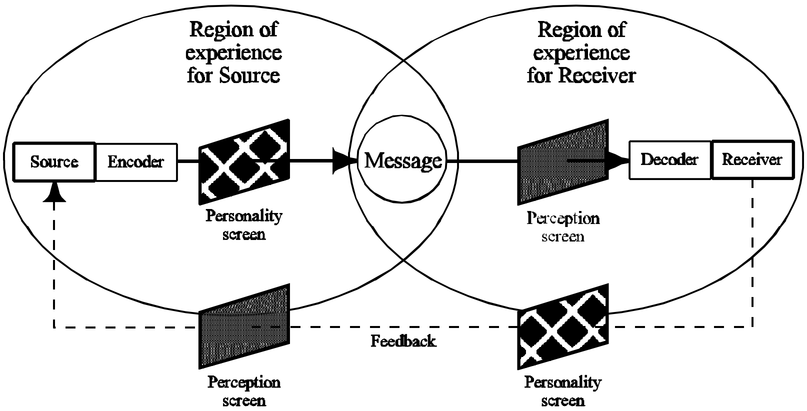


Figure 3.9: Perception and personality (Kerzner, 1995:277)

The thrust of Kerzner's argument is that a message will be encoded with factors of the sender's personality and perceptions of the environment, the context, the message, and the receiver, and their self-perceptions. The receiver will receive the message which will in turn be influenced by their own perceptions and personality. The screens may act as barriers to communication since the message may be distorted. For example, Kerzner (1995:276) explains that people tend to listen carefully to topics of interest, but not to unfamiliar and boring topics.

3.3.2.7 Cues

Barnlund (1970), as shown in **Figure 3.10**, explains that cues are signals which a person processes from the environment (that is the person's "immediate surroundings, his background and experiences, his physical state and so on" [Barnlund, 1970:99]).

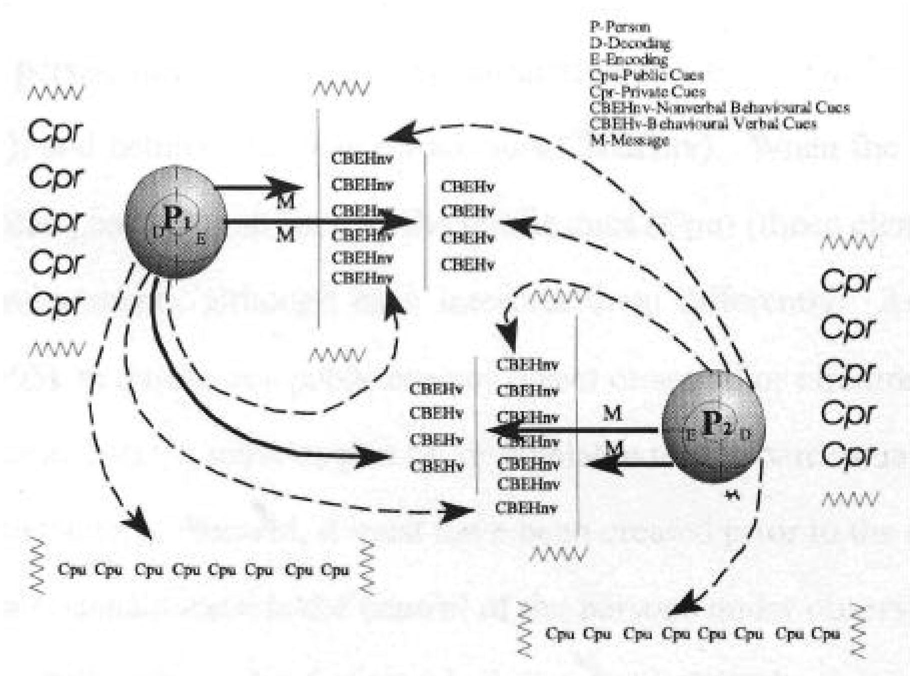


Figure 3.10: Cues (Barnlund, 1970:99)

Each person sees the public cues (C_{PU}) (those elements of the immediate environment, though different people perceive them differently), is aware of private cues (C_{PR}) (those aspects of himself such as fatigue, which alter his perception), is producing and observing behavioural cues (C_{BEHNV}) that are nonverbal (such as movements, posture, smells, spatial distance, and facial expressions), and is utilising behavioural cues (C_{BEHV}) that are verbal (the actual words of a message). Furthermore, Barnlund represents communication as a dynamic, continuous and complex process.

3.3.2.8 Infinite Process

The Wenburg *et al* (1985:56) model illustrates many of the communication elements already discussed but, as shown in **Figure 3.11**, represents the communication process as an infinity symbol.

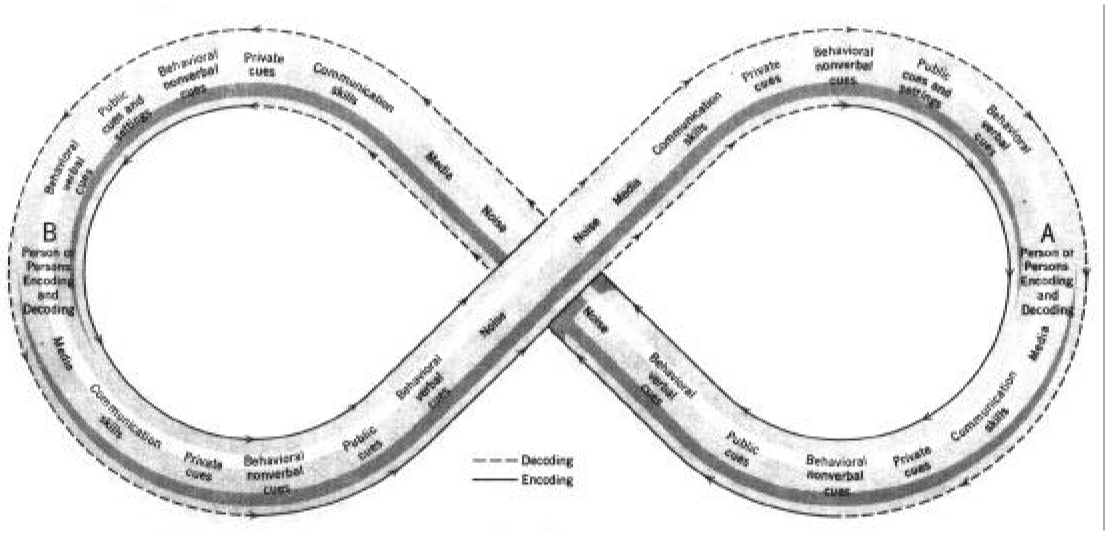


Figure 3.11: Infinite process (Wenburg *et al*, 1985:55)

According to Wenburg *et al* (1985:55), seeing human communication as a process implies that:

- it is an ever-changing, ongoing phenomenon;
- to select a source and a receiver is an artificial decision and must be recognised as such;
- it really has no beginning or end (each part is a beginning or end depending on where you are in the process); and
- its essence is a transaction between or among persons and, as stated by Watzlawick, Beavin and Jackson (1967:31), the "behaviour of each person affects and is affected by the behaviour of each other person".

3.4 Distributed Communication

As discussed previously, human beings use a variety of tools and techniques when communicating with one another. According to Berlo (as cited in Wenburg *et al*, 1985:50) there are five recognised channels of communication (as indicated in **Figure**

3.12). These are essentially, the five senses, although it can be argued that there are other, extrasensory channels used too.

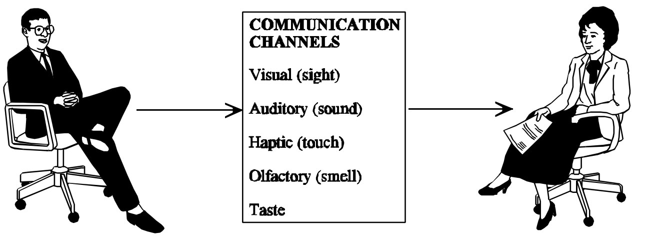


Figure 3.12: Communication channels used during face-to-face interactions

There are numerous tools used to activate these channels, for example, written, verbal and nonverbal communication. As opposed to the face-to-face environment where, quite literally, the air is used as the carrier for communication signals, in a distributed communication environment, technology is used as the carrier for these signals (as shown in **Figure 3.13**).

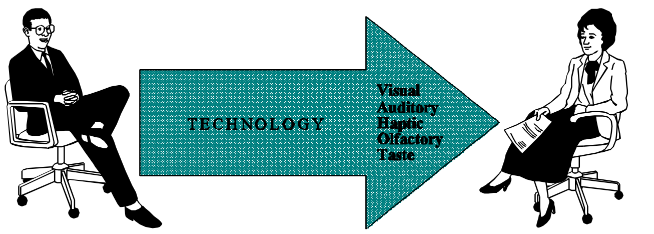


Figure 3.13: Distributed communication technology attempts to cater for the communication channels used during face-to-face interactions

The model of communication presented by Shannon and Weaver (1948:17) (and as discussed in detail in Section 3.3.2) describes communication as a linear process (see **Figure 3.14**), where an *information source*, supplies a *message* to a *transmitter*, which converts the message into a *signal*, which is transmitted to a *receiver*, which converts the signal back into the form of the original message before it reaches its *destination*. The information source may be a human being who chooses either to encode the message and send it along a channel such as the sound waves (message encoded into a language such as English and sent as a sound wave over the air), or to supply the message to some form of computer technology (for example, e-mail), which converts the message for transmission as a digital signal (message encoded into a language such as English and sent as a digital signal over copper wire).

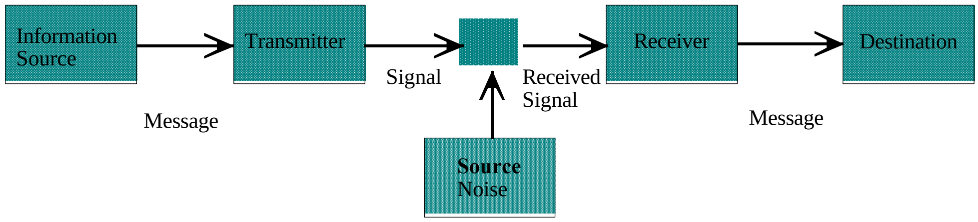


Figure 3.14: Shannon-Weaver model of communication (Wenburg *et al*, 1985:51)

Research and development efforts in the realm of distributed communication enabling technologies are ultimately geared to enabling the normal face-to-face communication channels, the premise being that to restrict the use of any of the natural tools and techniques would hinder communication. In the future, it is likely that with the use of technology as a medium of signal transmission, communication may be improved or enhanced. Today however, it is generally accepted that by and large, such technologies restrict a person's ability to use his/her available tools and techniques for communication. Interestingly, there are a number of studies which have shown that despite this restriction, the desired outcomes of a communication process can be achieved, and significantly, with some real benefits with respect to the nature of the interactions. For example, Beauvais (1999), who studied the completion of certain task types using video conferencing technology, found that for certain task types, the speed and accuracy of a communication process was improved as compared with the face-to-face environment. Valacich and Schwenk (1995), in a study on devil's advocacy and dialectual inquiry effects on face-to-face and computer-mediated group decision making, found that computer-mediated groups were more satisfied with the decision making process than face-to-face groups, but no differences were found in satisfaction with decision outcomes.

As technology evolves, more and different options are available to support the processes of interaction and communication, and there are several mechanisms by which these technologies can affect these processes. The most fundamental influence relates to the communication medium itself. There are three theories which are particularly relevant to the examination of communication enabled by technology. *Social Presence Theory*, as described by Short, Williams and Christie (1976) is a goal of technology mediated communication to establish a sense of presence, like that of a face-to-face meeting. It is understood that media such as audio offer less presence than video, which in turn offer less presence than face-to-face interactions. *Media Richness Theory*, as described by Daft and Lengel (1986) states that the richness of a medium affects the richness of the communication which it supports. For example, the video medium is rich and the text medium is poor. The degree of richness impacts a group's ability to resolve uncertainty among members in attempting to complete a task, or achieve an objective. *Social Information Processing Theory*, as described by Fulk, Steinfeld, Schmitz and Powers (1987) states that the dynamics and past experiences of a group, and of an individual, play an important role in the acceptance of various communication media.

The distributed communication process arises out of a need to communicate with a person or persons who are not physically located at the same place at the time at which the communication needs to occur. Common situations result in the use of one-to-one technology such as the common telephone for purely verbal communication. Conference telephones allow similar communication but with additional participants. E-mail allows similar interaction, but mainly in a written medium (modern developments allow the electronic mailing of video and voice). More advanced technology allows communication between multiple participants, and using numerous media. There appears to be no set terminology which refers to such technology. Terms such as *geographically distributed communication enabling technology*, *distributed communication technology*, *virtual communication technology*, *group support systems (GSS)*, *computer supported cooperative work (CSCW)*, *computer mediated communication (CMC)*, *executive information systems (EIS)*, *electronic meeting systems (EMS)*, *executive support systems (ESS)*, *group communication support systems (GCSS)*, *group decision support systems (GDSS)*, *orgware*, and *groupware* are often used to describe the same thing. The most common term used is *groupware*, and although this describes many forms of technology which enable communication, it does not describe any communication enabling technology that does not involve a computer and some form of communication software (this is explored in more detail in the next section.) For the purposes of this research, *'communication technologies'* will be used to describe all communication enabling technologies. 'Communication technologies' is intended to describe all technologies which in some way either enable, assist, or enhance the processes of human communication and interaction. This is necessary, as such technologies will be explored in the realm of distributed requirements elicitation.

3.5 Evaluating and Comparing the Requirements Elicitation Methods

Information presented in this chapter thus far is disjoint, making it difficult to effectively compare the requirements elicitation methods. This section aims to present the information in an organised fashion, so that the requirements elicitation methods can be easily compared. Particular attention is given to the communication factors associated with these methods. Communication factors used for comparison are drawn from the discussion in Sections 3.4 and 3.5. Furthermore, a statistical analysis is conducted for the purposes of ranking the methods in terms of their effectiveness. In Chapter 4, this ranking is compared with the results of a requirements elicitation method ranking conducted by representatives of the South African IT industry. It is also used in Chapter 6 as a building block for the model of GDRE.

3.5.1 Method

Thus far, this chapter has identified factors/issues which are considered to be of particular relevance to the requirements elicitation methods (relevance in terms of the nature of the method itself, as well as the implementation of the method). It has also identified common sentiments expressed regarding those factors identified.

Requirements elicitation method comparisons have been conducted by some authors. Carmel *et al* (1993) compared PD and JAD, Hoffer *et al* (1999:251, 259) performed two comparisons, interviews and questionnaires, and observation and document analysis (review). Allen (1991) discusses prototyping 'versus' structured techniques. Kendall *et al* (1999) discuss document review, interviewing, questionnaires and prototyping. Yeates *et al* (1994) discuss interviews, questionnaires, observation and document review. Martin (1991) analyses JRP, JAD and prototyping as methods used conjointly as part of RAD.

Where direct comparisons do not exist in the literature reviewed, comparisons of pro's and con's (advantages and disadvantages) are used extensively as a source of reference.

These comparisons were done using descriptive terminology, for example **Table 3.2** represents an extract of the comparison table in Hoffer *et al* (1993:259).

Table 3.2: Comparison of Observation and Document Analysis

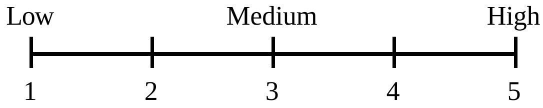
Characteristic	**Observation**	**Document Analysis**
Information Richness	High (many channels)	Low (passive) and old
Time required	Can be extensive	Low to moderate
Expense	Can be high	Low to moderate

Hoffer *et al* (1993) also describe other methods using similar terminology, although this is not done in a comparative manner.

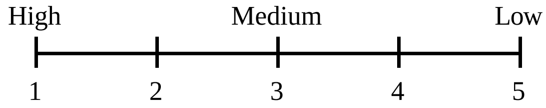
3.5.2 Representing the results

In order to facilitate the comparison of the methods, the results have been presented in a table using descriptive terminology or a numerical value representing a measure on a high-low scale (as shown below) where appropriate. Two types of high-low scale have been used: i) a *positive* scale where a low rating is considered to be a positive attribute of the requirements elicitation method, and ii) a *negative* scale where a low rating is considered to be a negative attribute of the requirements elicitation method.

Negative Scale



Positive Scale



Assigning a value was done using the descriptive terminology of the relevant works. For example, the comparison of observation and document analysis shown in **Table 3.2** would result in a quantitative representation as shown in **Table 3.3**.

Table 3.3: Comparison of Observation and Document Analysis (with values)

Characteristic	Observation	Value	Document Analysis	Value
Information Richness	High (many channels)	1	Low (passive) and old	5
Time required	Can be extensive	4	Low to moderate	2
Expense	Can be high	4	Low to moderate	2

Calculation of the actual values was done as follows:

- The type of scale (positive or negative) to be used was determined. *Information richness* is a positive feature of a method. Therefore, a positive scale was applied. *Time required* and *expense* are both negative features of a method, therefore a negative scale was applied;
- The method was assessed in respect of the factor. An appropriate value was assigned. If the method provided high *information richness* then the value was 1. If the method required a great deal of *time*, and was *expensive*, the method was rated with a value of 5;
- A comparison was done of the assessments of all methods in terms of the strength of the terminology used to describe the factor. The assessment value was adjusted accordingly. For example, 'can be extensive' was adjusted from a value of 5 to

a value of 4 as other methods may be described as 'extensive' in respect of the factor in question; and

- The results were evaluated on the basis of general literature dealing with matters related to these factors, and in respect of the methods in question. The results were adjusted where appropriate. For example, interviews, JAD and PD are all described as expensive. JAD is described by Carmel *et al* (1993) as being more expensive than PD. It would thus seem logical to assign a value of 4 to JAD and 5 to PD. However, interviews are considered to be more expensive than JAD, but not as expensive as PD. Therefore, a value of 3 was assigned to JAD, 4 to Interviews and 5 to PD. The integrity of this method may be questioned as a result of an unclear definition of 'expensive'. This is negated as long as the results for all methods are considered to be relative only. So a value of 1 (for technical review) does not mean that technical review is not expensive, but rather, that relative to other methods technical review is not expensive.

Abbreviations have been used to represent the descriptive terminology (these can be seen in the *Key* to **Table 3.4**).

3.3.3 Results

Factors which were identified have *relevance to*[3] one of three 'phases' of the requirements elicitation process: *setup* includes all activities related to preparing for a requirements elicitation session; *process* includes all activities related to the actual investigation which will yield the description of a user requirement; and *results* refers to a description of the requirements document produced as a result of the process.

A requirements elicitation method will be either *structured* or *unstructured* (*structure*), and will facilitate a *focus* either on the *current* system, or on the *future* system.

[3]Words or phrases in italics can be found in Appendix A: Requirements Elicitation Communication Taxonomy. This taxonomy is discussed in detail in Section 3.6.2.

A requirements elicitation method either affords the analyst the ability to *choose* all of the relevant *participants* or simply to select a *sample* to represent the participants. A requirements elicitation method can be described by *linear, relational* or *convergence communication models* (Rogers *et al*, 1981:35). Communication among those participants will be structured according to the *group communication structure* (Shermerhorn, Hunt and Osborne, 1994) which is implicit in the requirements elicitation method. Furthermore, the requirements elicitation method will also influence the *interaction and patterns of interdependence* (Wagner *et al*, 1994) of the participants. The *communication network* will involve either *direct (face-to-face)* or *indirect* channels of communication. **Table 3.4** represents a full summary of the results.

For the purposes of further analysis, factors have been associated with either contributing to the *complexity* of the requirements elicitation method, or as describing the *effectiveness* of the requirements elicitation method.

Table 3.4: Results of Detailed Requirements Elicitation Methods Analysis

Phase	Complexity/Effectiveness	Factor name/description	What is being measured?	Document review	Interviews	JAD	JRP	Meetings	Observation	PD	Prototyping	Questionnaires	RAD	Technical review	Scale type
S_1	E	Complexity and size of organisation	Influence on ...	3	5	5	5	5	5	5	5	5	5	4	Negative
S_1		Participant selection		S_2	S_2	C_1	C_1	C_1	S_2	C_1	C_1	S_2	C_1	C_1	
S_1	C	Participant scheduling	Complexity of ...	1	3	5	5	5	1	5	5	1	5	5	Negative
S_1	C	Resource sourcing and scheduling	Complexity of ...	2	2	4	3	4	1	4	4	1	5	3	Negative
P_1		Focus		C_4	C_4/F	F	F	F	C_4	F	F	C_4/F	F	F	
P_1	E	Structure		U	U	S_4	S_4	U	U	U	U	U	S_4	U	
P_1		Group communication structure		n/a	W	Cl	Cl	Cl	W	Cc	Cc	W	Cc	Cc	
P_1		Communication network		I	D	D	D	D	I	D	I	I	D	D	
P_1		Interaction and patterns of interdependence		n/a	R_3	C_3	C_3	C_3	S_3	C_3	C_3	R_3	C_3	C_3	
P_1	C	Interpersonal interaction	Number of interactions	5	3	1	1	2	5	1	2	5	1	2	Positive
P_1	E	Potential audience (target)	...of target for that method	n/a	3	3	3	3	5	3	3	1	3	1	Positive
P_1	E	Involvement of subject	Engaged throughout process or not	5	1	1	1	2	3	1	2	5	1	2	Positive
P_1	E	Follow-up and probing	Chance for ...	4	2	1	1	1	2	1	1	4	1	1	Positive
P_1	E	Goal setting and definition	Facilitates ...	5	5	1	1	1	5	1	2	5	1	4	Positive

Key
C - Complexity
C_1 - Choose
C_3 - Comprehensive
C_4 - Current
Cc - Completely Connected
Ch - Chain
Ci - Circle
Cl - Circle with leader
D - Direct: Face-to-face
E - Effectiveness
F - Future
I - Indirect
P_1 - Process
P_2 - Pooled
R_1 - Results
R_3 - Reciprocal
S_1 - Setup
S_2 - Sample
S_3 - Sequential
S_4 - Structured
U - Unstructured
W - Wheel
Y - Y

Phase	Complexity/Effectiveness	Factor name/description	What is being measured?	Document review	Interviews	JAD	JRP	Meetings	Observation	PD	Prototyping	Questionnaires	RAD	Technical review	Scale type
P_1	E	Expectations clarification and management	Facilitates ...	5	4	1	1	2	5	1	2	5	1	1	Positive
P_1	E	Dealing with ambiguity	Sensitivity to ambiguity	5	3	1	1	1	5	1	2	4	1	1	Positive
P_1	E	Problem solving	Enables problem solving	5	4	1	1	1	5	1	1	5	1	3	Positive
P_1	E	Decision making	Facilitates ...	5	5	1	1	1	5	1	2	5	1	1	Positive
P_1	C	Preparation	Tasks to be performed	5	3	1	1	1	5	1	1	1	1	3	Positive
P_1	E	Participant training	Need for training	5	5	2	4	4	5	1	4	5	2	3	Positive
P_1	C	Use of enabling technology	Degree of ...	5	5	2	3	3	4	3	1	5	1	5	Positive
P_1	E	Contribution to SRS production	Reliance on other methods	1	2	4	1	5	1	5	4	1	1	1	Positive
R_1	E	Quality of documentation produced	Effectiveness of SRS	5	3	1	1	2	5	1	1	4	1	3	Positive
R_1	E	Information richness	Degree of ...	5	1	1	1	1	1	1	1	4	1	2	Positive
R_1	E	Stakeholder commitment	Degree of ...	5	3	1	1	2	5	1	1	5	1	1	Positive
R_1	E	User satisfaction	Degree of ...	5	3	1	1	3	5	1	1	5	1	1	Positive
R_1	E	Confidentiality	Degree of ...	1	5	5	5	5	5	5	5	1	5	5	Positive
R_1	E	Time required	Relative ...	2	4	3	3	4	4	4	3	2	3	1	Negative
R_1	E	Expense	Relative ...	2	4	3	3	4	4	5	3	3	3	1	Negative

Analysis of the quantitative data was done using a Multi-factor Analysis of Variance (MANOVA) which compared each method in terms of both the complexity and the effectiveness of the method. A multiple range test (95% least significant difference (LSD)) was then performed yielding the results shown in **Table 3.5**. Software used was Statgraphics (v7).

Table 3.5: Results of qualitative data analysis

Results				**Trends**
Rank	**Method**	**LS Mean**	**Homogenous Groups**	**Participation**
1	RAD	2	X	Group
2	JRP	2.09	X	Group
3	JAD	2.13	X	Group
4	PD	2.3	X	Group
5	Technical review	2.35	X	Group
6	Prototyping	2.43	X	Group
7	Meetings	2.7	XX	Group
8	Interviews	3.39	XX	User and Analyst
9	Questionnaires	3.57	XX	User and Analyst
10	Document review	3.91	X	Analyst
11	Observation	3.96	X	Analyst

The methods can be ranked in terms of their complexity and effectiveness as shown in **Table 3.5**. There are three homogenous groups of methods which emerge (as shown by the relative position of the '*X*'s in the column, *homogenous groups*): there was no significant difference between those methods ranked 1 to 7, 7 to 9 and 8 to 11. The distinguishing characteristic which marks the difference between these groups is participation, where methods 1 to 7 are group methods, methods 8 and 9 involve a user and an analyst in a one-to-one communication setting (although questionnaires are indirect), and methods 10 and 11 involve the analyst only (with the potential for interaction with a user only if necessary).

This evaluation draws together many of the issues (particularly communication factors) relating to the requirements elicitation methods discussed previously. Apart from combining otherwise disjoint information, this serves to highlight the important communication factors, and to identify the specific communication characteristics of each method. Determining the ranking of the methods in terms of their complexity and effectiveness places in the forefront those methods where communication characteristics should be given more focus in the development of the RECM in the next section. Furthermore, the trend analysis provides an important insight into the general nature of the ranked requirements elicitation methods.

In Chapter 4, the ranking is compared with a similar ranking analysis performed using data collected in industry. The results of this comparison are used to inform the development of the *geographically distributed requirements elicitation* model developed in Chapter 6. This model suggests the use of specific requirements elicitation methods during the requirements elicitation process in a distributed environment.

3.6 Requirements Elicitation Communication Model

No previous work has been done where the requirements elicitation process is represented in the form of a communication model. Given the discussion in Chapters 2 and 3, this author proposes a representation of communication in the requirements elicitation environment as shown in **Figure 3.15**. The RECM represents communication between a sender and a receiver within the requirements elicitation process, and draws in relevant communication factors identified in the discussion of communication models in Sections 3.3 and 3.4. Furthermore, as this is not a generic communication model, specific detailed communication factors relevant only to the requirements elicitation process are included. The graphical representation of the model and the taxonomy of requirements elicitation communication factors presented in Section 3.6.2 together describe the requirements elicitation process as seen from a communication perspective.

3.6.1 Graphical Representation

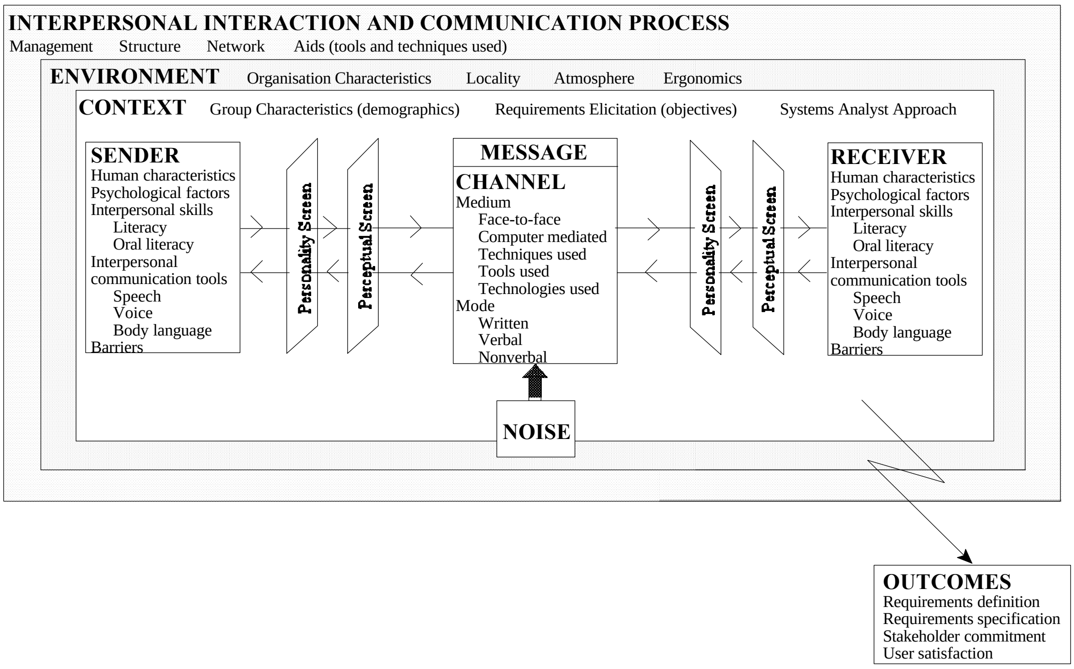


Figure 3.15: Requirements Elicitation Communication Model

Requirements elicitation is shown as a continuous transactional communication process where a *sender* encodes a *message* and sends the message along a *channel* to a *receiver*. The communication is influenced by *human characteristics*, *psychological factors*, *interpersonal skills* (particularly *literacy* and *oral literacy*), *interpersonal communication tools* (particularly *speech*, *voice* and *body language*) and personal communication *barriers* of the sender and receiver. It is further influenced by the *personality* and *perceptual screens* of the sender and receiver. The *medium* of the communication channel may be either *face-to-face* or *computer mediated*, and may be fashioned by any number of specialised *communication techniques*, *tools* or *technologies* chosen by the participants. The *mode* of the communication may be *written*, *verbal* or *nonverbal*.

This transactional communication occurs within a *context* which is described by the *group characteristics* (specifically the demographics of the group), the *requirements elicitation* process itself (fashioned by the objectives of requirements elicitation), and the *systems analyst approach* to the requirements elicitation process.

The requirements elicitation process occurs within an *environment* which is described by the *organisation characteristics*, the *locality* of the participants in the process, the *atmosphere* and the *ergonomics* of the environment. The environment can be manipulated by the participants in the process, although there are restrictions on the extent of this manipulation by elements not involved in the requirements elicitation process. This is indicated by the *interpersonal interaction and communication process* layer which indicates that this influence can occur through process *management*, and that the *structure*, communication *network*, and the *process aids* (specifically the tools and techniques used) all influence the process in a particular way.

The communication channel may be influenced by *noise* which exists in the channel itself, or originates from the environment or the context of the communication process.

The requirements elicitation communication process is based entirely on the premise that specific *outcomes* are sought, these are, a *Software Requirements Specification (SRS)*, *stakeholder commitment*, and *user satisfaction*.

Each of these main elements of the requirements elicitation communication process are described by many factors of communication. These are represented in the form of a taxonomy of communication.

3.6.2 Taxonomy of Requirements Elicitation Communication Factors

The taxonomy is developed out of a careful selection from those factors as presented in, *500 Communication Concepts: English/Afrikaans* (Du Plooy, 1991), *Webster's New World Dictionary of Media and Communications* (Weiner, 1996), *Webster's College Dictionary* (Webster, 1991), and *A Dictionary of Communication and Media Studies* (Watson and Hill, 1993). These authors have taken care to produce factors out of the extensive theoretical research base, from dictionaries of modern language, and only where absolutely necessary, have relied on their own understanding of factors which have not been formally documented elsewhere. Where necessary, further support has been sought from *Specific Elements of Non-Verbal Communication* (Pretorius, 1976) and *Body Language* (Lyle, 1990). The taxonomy represents only those factors which the author believes are relevant to the realm of requirements elicitation as part of the process of information systems development (a miniaturised extract of the taxonomy is shown in **Figure 3.16**)[4]. No discussion relating to each item in the taxonomy is being offered as there are simply too many items to discuss but, where necessary, a definition of items is offered in the **Glossary**. The definition given is chosen from the literature as being the most relevant to the requirements elicitation process. It should be understood that each item does not exist on its own, but rather coexists with other items, where together they contribute to the successful completion of a communication process. However, the importance of this taxonomy should not be underestimated, as each item bears particular significance in the

1	GENERAL TERMINOLOGY RELEVANT TO THE MODEL
1.1	Communication
1.2	Interpersonal interaction
1.3	Interpersonal communication
1.4	Interpersonal interaction and communication structure
1.4.1	Informal
1.4.2	Formal
1.4.2.1	Chaired
1.4.2.2	Facilitated
1.4.3	Continuity
1.4.4	Feedback
1.4.5	Norms
1.4.6	Organised
1.4.7	Rational

Figure 3.16: Extract of the requirements elicitation communication taxonomy

[4] The full taxonomy (in list form) can be found in **Appendix A**. The taxonomy referred to here is a description of the main elements of the requirements elicitation communication process supported by examples where necessary.

communication environment and could significantly influence the success of a requirements elicitation method, and ultimately, the entire requirements elicitation process.

3.6.2.1 Interpersonal Interaction and Communication Process

All requirements elicitation processes are managed by an appropriately skilled person (usually an analyst). Process *management* involves *preparation* for the process itself. This includes *logistical arrangement* (*participant selection*, *participant scheduling, resource sourcing and scheduling*), *participant training*, *team building*, *selecting exercises*, setting up an *agenda*, *minutes*, and *project schedules*, and producing the appropriate *documentation* which represents the discussion of a previous requirements elicitation session.

The *structure* of a requirements elicitation session may be *informal*, or *formal* (*chaired* or *facilitated*). The structure should be *organised* and *rational*, and is usually governed by *norms* which ensure order. Requirements elicitation sessions should show *continuity*, and should allow for *feedback* between participants.

An appropriate communication *network structure* should be adopted, and should reflect the *psychographics* required for a successful requirements elicitation session.

Process aids, including *tools* for *decision making* and *problem solving*, and *techniques* for graphically representing user requirements, should be carefully selected on the basis of the type of system to be developed, and the abilities of the participants to understand them.

3.6.2.2 Environment

The *environment* is a function of the *organisation characteristics* (including the *organisational culture*, *organisational networks*, and *politics*), the *locality* of the participants involved in the requirements elicitation session, the *atmosphere* and *ergonomics* of the physical environment.

3.6.2.3 Context

The *context* of the requirements elicitation process is described by the *group characteristics* (*number* and *authority of participants*), the *requirements elicitation objectives* (which may at any given time be any of: *goal setting and definition*, *expectations clarification and management*, *information elicitation*, *information sharing*, *brainstorming*, *dealing with ambiguity*, *problem solving*, *conflict management*, *negotiation*, *persuasion*, or *decision making*) and the *systems analyst approach* to the process. The systems analyst should have an *awareness of the complexity and size of the organisation*, and general *respect for the organisation* and *for the end users*.

3.6.2.4 Sender/Receiver

The *sender* and *receiver* are characterised by general *human characteristics* (for example: *age*, *culture*, and *race*), by *psychological* (or *mind set*) factors (for example: *attitude*, *commitment*, and *mood*), by their *interpersonal skills* (their *literacy* and *oral literacy*) and the *interpersonal communication tools* which they use (these include *speech*, *voice*, and *body language*), their ability to deal with the *length of the interactions*, and the *barriers* to communication which all or any of these factors may present.

3.6.2.5 Message

The *message*, as defined by Weiner (1996) is, "a communication, a statement, a basic theme, or significance... a group of characters (letters, numbers, and symbols) or a unit of information; a single transmission of data in one direction."

3.6.2.6 Channel

The *channel* is characterised by the *medium* of communication (this includes the communication *techniques* used [for example, *brainstorming*], the *tools* used to aid the communication process [for example, *visual aids*], and the *technologies* used [for example, *paper and pen*], and the *mode* of communication [which may be any of *written*, *verbal* or *nonverbal*]). The channel is affected by *noise* which may be a part of the channel itself, or may come from the communication context or environment.

3.6.2.7 Outcomes

The requirements elicitation process seeks to produce the requirements definition and the requirements specification components of the *Software Requirements Specification (SRS)*. The entire process seeks to ensure *stakeholder commitment* and *user satisfaction*, thereby ensuring the acceptance of the requirements documentation and going some way to ensuring the acceptance of the completed system.

3.7 Conclusion

This chapter has examined, evaluated and compared traditional requirements elicitation methods. This was done by means of an extensive literature survey and a statistical analysis. This was followed by an exploration of existing models of communication which describe the general communication characteristics identified, and which support the key factors for project failure prevention identified in Chapter 2. A requirements elicitation communication model which describes the requirements elicitation communication process was developed on the basis of this knowledge. Finally, a taxonomy of communication terminology which describes the graphical model was developed.

The main strength of the RECM is its inclusion of communication concepts and factors from a variety of linear, relational and convergence models selected specifically for their unique contributions to our understanding of the communication process. Furthermore, the supporting taxonomy of requirements elicitation communication factors provides an extremely detailed and specific reference to low-level communication concepts and factors which are associated with the requirements elicitation process.

A significant weakness of the model is its two-dimensional format and the inclusion of only two participants (sender and receiver) in the requirements elicitation process. Although this is an accepted generic approach to such a representation, the different participants and the roles which they play in the requirements elicitation process may influence the representation of the communication between individual participants. Furthermore, the representation of the *interpersonal interaction and communication process* as a layer beyond the boundary of the environment is misleading until the supporting explanation is read.

The following chapter presents an empirical study designed to examine the principles of the RECM and the relationships of the elements within the model, in the South African context. The empirical study is used as a basis for presenting a modified requirements elicitation communication model which represents the communication aspects of requirements elicitation in South Africa.

Chapter 4
EMPIRICAL STUDY

4.1 Introduction

This chapter presents an empirical study designed to examine the principles of the requirements elicitation communication model (RECM) and the relationships of the elements within the model, in the South African context. The results of this study are used as a basis for presenting a modified RECM which represents the communication aspects of requirements elicitation in South Africa.

The empirical study is designed to achieve two main objectives: i) to determine the actual nature of communication in the requirements elicitation process as observed in industry, and ii) to develop an impression of the requirements of communication technology which may be employed to facilitate communication in the requirements elicitation process. These objectives are achieved by implementing the following process:

- a selection of factors for evaluation;
- the formalisation of a data collection tool;
- the establishment of metrics to measure those factors selected;
- the identification of an appropriate sample from which data could be collected;
- the collection of data;
- the calculation of results from the data; and
- the drawing of conclusions from the results.

The conclusions are drawn into the modified RECM which is presented in the following chapter.

4.2 Method

4.2.1 Respondents

A sample of thirty-two (32) respondents were selected from nineteen (19) companies in several major cities in South Africa. In order to be eligible, respondents were required to:

- be based in South Africa;
- be a member of any company within any industry, and be currently involved in a software development project (of any nature);
- have a background in information technology, and specifically in software development;
- have requirements elicitation experience; and
- be prepared to complete a questionnaire and to be interviewed.

This ensured that participants were aware of South African software development practices, and would thus represent South Africans involved in software development. Representation would be from numerous industries, thus representing a broad base of experience in software development projects where different types of people would be involved. Furthermore, participants would have sufficient experience, knowledge and expertise in order to become fully involved in the study, and to ensure that data collected from them would add sufficient value to the study. [5]

4.2.2 Materials and Equipment

Materials included questionnaire and interview forms. Equipment included a Sanyo microcassette recorder (Talk-Book, TRC-770M) with voice activated system (which significantly increased the recording time per tape).

[5] Experience in distributed requirements elicitation processes was not a requirement. Only one (1) respondent had significant experience in distributed requirements elicitation.

4.2.3 Preparation

Respondents were briefed before each interview. The aim of the briefing was to inform the respondents of the aims and the nature of the study, and the nature of their expected involvement in the study. No discussion regarding previous interviews or expected results was held with the participant during this briefing.

4.2.4 Data Collection Activities

Data collection involved the completion of a questionnaire (see **Appendix B**) which was designed to collect both qualitative and quantitative data. Demographic details relating to each participant were recorded on the questionnaire by the author, and thereafter control of the pen was handed to the respondent. Each question was read aloud by the author, and where necessary, explanations were offered and questions regarding the questionnaire were answered. Where necessary, responses were recorded on the questionnaire form by the respondent. Where responses required extensive writing, they were offered verbally. Verbal responses, which were recorded and later transcribed, were probed and explored by the author with further questions (not found in the questionnaire).

4.2.5 Trial run

A trial run of the data collection was conducted using four (4) ‘dummy’ respondents from the Department of Information Systems at Rhodes University. This was done in order to assess the questionnaire design and to provide the author with some experience in data collection. Some refinements were made to the questionnaire including changes in wording in order to better express a question, and the elimination of redundant questions.

4.3 Data Collection

After consulting Leedy (1997), Melville and Goddard (1996), and Myers and Well (1991), it was decided to use a questionnaire as the primary data collection tool. The questionnaire design was done with the guidance of Fowler (1984), Oppenheim (1966) and Berdie and Anderson (1974). The resultant questionnaire reflects the factors found in the RECM presented in Chapter 3. The questionnaire was completed in an interview situation. Further questions were asked verbally in order to probe issues where appropriate. These questions (and their answers) were recorded.

A questionnaire provides a useful means of assessing expert judgements and identifying trends. It allows for questions to be asked which would result in a rating value (quantitative data), as well as questions which would result in qualitative data to support or enhance the quantitative data. Most of the data required could be gathered using a questionnaire, and a sufficiently high level of information could be gleaned from this data. As explained by Leedy (1997:192-199), a questionnaire is designed to meet a specific research objective which is decided by the researcher. Hence the questionnaire design (semantics and scales) is left to the researcher. To ensure that the right data is collected, it is important that the design is meticulous, and is at least supported by a good statistical reference. To be statistically accurate and to increase the level of confidence in the data collected, the sample responding to the questionnaire needs to be as large as possible (or a statistically representative sample).

4.3.1 Construction of the Questionnaire

Where a binary response was required, a check box was used (see **Table 4.1**). Respondents were simply required to place a mark in the box if their response to the question was positive. A lack of a mark in the box was considered to be a negative response and not a nil response.

Table 4.1: Check box

Factor	Response
1	
2	**T**
3	

Table 4.2: Rating box

Factor	Rating
1	5
2	3
3	1

Where a rating was required, a rating box was used with respondents being asked to place a number (as opposed to a mark) in the box (see **Table 4.2**). Low numbers indicated a high rating while high numbers indicated a low rating. No number in a box implies that the factor was not rated. The range of numbers was limited only by the number of factors which the respondent chose to rate.

To match a value to a response, a 5-point Lickert scale was used. This allowed respondents to 'sit on the fence', yet also to reflect a range of responses on a marginal scale. The scale thus has a lower boundary of 1 and an upper boundary of 5. A 'significant/not significant' boundary of 3.5 was selected. This means that a result of < 3.5 would be considered significant, and a result of **$** 3.5 would be considered not significant. Two types of scale were used, one to rate *importance*, and one to rate *influence* (as shown below). Respondents were asked to rate their answers according to their own experience.

Very important	Important	Undecided	Unimportant	Totally unimportant
1	2	3	4	5

Significant influence	Influence	Undecided	Barely influence	No influence
1	2	3	4	5

The 'significant/not significant' boundary was selected in order to skew the data in cases where a respondent was undecided. This is considered to be a valid action which would result in the encapsulation of factors which might either be marginally important, or have only a slight influence. In assessing the RECM, it was felt that to err slightly in favour of the factor under examination would lead to a more complete, generally applicable conclusion.

Where a question sought to obtain qualitative data, a number of lines were drawn on which the response was written. Alternatively (and this proved to be the most popular option) a verbal response was given. This response was recorded and later transcribed.

4.3.2 Explanation of the Questionnaire

The questionnaire was divided into three sections: i) demographics, ii) methods and techniques, and iii) factors. Section iii) was further divided into fourteen subsections, each representing a different group of factors. The sections were grouped logically for reader-friendliness and ease of response. There were distinct measures within those sections aimed at exploring different aspects of the study area. The metrics (measured as responses to the questions asked) sought to find deeper understanding and clarity about the selected measures.

Each subsection is described below. The description follows the format of question (and related question(s) where appropriate) and then discussion. Headings of the subsections, and questions from the questionnaire are preceded by the corresponding *number* of the heading or question in the questionnaire itself.

4.3.2.1 (1) Demographics section

Demographic information serves to describe the sample group. Data regarding the respondent, the company and industry in which the respondent was employed, and the training and experience of the respondent were captured.

4.3.2.2 (2) Methods and Techniques section

(2.1) What method(s) have you used in order to elicit user requirements?

(2.2) At present, what method(s) do you use in order to elicit user requirements?

(2.3) Rank the method(s) which you have used in terms of their relative success at eliciting user requirements.

(2.4) What, in your opinion, is significant about the method(s) which you ranked the highest (what makes it (them) better than the others)?

Respondents may have experience in a variety of methods, some of which may no longer be used. There may be a trend in terms of a shift in the use of methods. Some methods may be more popular than others, and some methods may be perceived to be better than others. Possible reasons for this may reveal the characteristics of the methods which distinguish them (the methods) from one another. The methods used will influence the nature of the technology needed to support their (the methods) implementation.

The main weakness of this study lies in the structure of the questionnaire. The questionnaire was completed before the RECM (Chapter 3) was completed. The specific terminology which describes this model should ideally have been used in the questionnaire. However, the author believes that this has not jeopardised the results in any way. The questionnaire examines all of the categories of factors in the model in sufficient detail for accurate parallels to be drawn, and assumptions to be made. This is supported in Chapter 6.

Furthermore Chapter 3 discussed, in detail, the requirements elicitation methods which have received extensive coverage in literature. At the time of the development of the questionnaire, this discussion was not complete and it was decided to use terminology common in South African requirements elicitation settings. The result of this decision was that no detailed definitions could be devised for the South African terminology, leaving these methods inadequately described in this thesis. Furthermore, internationally recognised methods which have been fully described, were not included in the questionnaire (see **Table 4.3** for a comparative analysis). The omissions from the questionnaire are *document review*, *participatory design (PD)* and *technical review*. However, respondents were afforded the opportunity to add to the list of methods in the questionnaire and none of these were mentioned by any of the participants (as shown in the Section 4.5).

Table 4.3: Matrix of requirements elicitation methods examined and/or introduced in this study

Method	Questionnaire	Literature review (detail)	Literature review (no detail)	Introduced by respondents
Ad hoc meetings	x	x		
Conference room pilots				x
Current systems analysis				x
Document review		x		
EIP	x		x	
Formal meetings	x	x		
Interview	x	x		
JAD	x	x		
JRP	x	x		
Observation	x	x		
PD		x		
Project Definition				x
Prototyping	x	x		
Questionnaire	x	x		
RAD	x	x		
Technical review		x		
UIA	x		x	
Workshops	x		x	

(2.5 to 2.10) At present, what technique(s) do you use in conjunction with the user requirements elicitation method(s) used?

The techniques chosen for this survey were slightly different in terms of the tools used to implement them, and would thus influence the nature of the technology needed to support their implementation.

(2.11 and 2.12) Have you been involved in a user requirements elicitation process which has been carried out in a virtual environment (distributed or geographically dispersed, where participants are not located at the same place)?
(2.13) If "yes", please describe the environment in terms of the technology used.

Respondents with experience in performing requirements elicitation in a virtual environment may have a different awareness of the communication process and related factors which may render a requirements elicitation process a success or a failure. This may have an impact on the responses to later questions.

4.3.2.3 (3) Factors section

(3.1 to 3.13) There are a variety of factors which contribute to the process of user requirements elicitation. These factors have been grouped into categories. Please indicate the importance of each category to the user requirements elicitation process.

An intuitive feeling about a broad description of factors which may influence communication in the requirements elicitation process may reveal the general sentiment of the respondent regarding the requirements elicitation process. This could then be compared with the result of a more detailed analysis of sub-factors in order to validate the result.

(3.1) How important are the following PROJECT MANAGEMENT factors/activities in terms of their impact on the success of the user requirements elicitation process?

All of the factors listed are project management activities which may be performed by any of the participants in the requirements elicitation process. The overall result of this analysis may be compared with the result from question *(3.1 to 3.13)* above. Furthermore, specific project management activities (relating to the requirements elicitation process) involve some form of communication. Each activity could be analysed, and the result may have significance in terms of the final description of the requirements elicitation communication process, which in turn may influence the nature of the technology needed to support this process in a distributed communication environment. For example, *obtain results approval* involves representing the requirements elicitation process results in some form, and presenting those results to a person (usually the project sponsor) not directly involved in the requirements elicitation process. There are a number of communication scenarios which could develop, for example, the project manager (or the requirements elicitation process facilitator) may record the results in the form of a document, which is then e-mailed to the project sponsor for perusal. Comment may then be passed back to the project manager telephonically.

(3.2.1) How important is it to have a variety of different people involved in the requirements elicitation process?
(3.2.2) Ordinarily, how many people would you expect to find involved in the requirements elicitation process? (Participants were verbally asked to provide a range, indicating the minimum and maximum number of people that may be involved in the requirements elicitation process?)
(3.2.3 to 3.2.14) What types of people would you expect to participate in the user requirements elicitation process?
(3.2.15 to 3.2.25) In what roles would you expect to find participants during the user requirements elicitation process?

An analysis of the level of participation and involvement in the requirements elicitation process would provide a perspective on the number and type of people who would be interacting with one another. It would also provide a perspective on the type of activities which will be performed during the requirements elicitation process. The analysis would contribute to the description of the requirements elicitation communication process as well as the communication technology needed to support it. Furthermore, this analysis may provide a perspective on issues such as scheduling meetings, as, for example, it is generally accepted that *high-level managers* are more difficult to schedule for meetings than *secretaries*.

(3.3) To what extent do the following MIND SET factors influence the success of the requirements elicitation process?

Mind set factors are psychological factors which may influence the interactions of people involved in the requirements elicitation process. The overall result of this analysis may be compared with the result from question *(3.1 to 3.13)*. Furthermore, specific mind set factors may have a significant influence on the process, thus, for example, calling for the adoption of a particular interaction approach by the facilitator. If, for example, a participant's bad *attitude* towards the requirements elicitation process would have a significant influence on the success of the process as a whole, the facilitator may need to train that participant, or adopt specialised motivational techniques in order to change that attitude. This may in turn influence the nature of the technology needed to support this process in a distributed communication environment.

(3.4) To what extent do the following BODY LANGUAGE factors influence the requirements elicitation process?
(3.5) To what extend to the following PERSONAL APPEARANCE factors influence the success of the requirements elicitation process?
(3.6) To what extent do the following SPEECH factors influence the success of the requirements elicitation process?
(3.7) To what extent do the following INTERPERSONAL COMMUNICATION factors influence the success of the requirements elicitation process?
(3.8) To what extent do the following ERGONOMIC factors influence the success of the requirements elicitation process?

The overall result of this analysis may be compared with the result from question *(3.1 to 3.13)*. In the case of each of these questions, specific factors may have had a significant influence on the process, and this may in turn have influenced the nature of the technology needed to support the process in a distributed communication environment. For example, the analysis may reveal that only body language involving visual stimulation resulting from the *head*, *arms* and *hands* is significant. This would influence the nature of the technology chosen to support the process. Or for example, *team building* may have a significant influence on the process, thus requiring the facilitator to set up specific interaction exercises which are not directly geared towards eliciting user requirements.

(3.9) What DECISION-MAKING technique(s) do you use in the user requirements elicitation process?

The techniques chosen for this survey were slightly different in terms of the tools used to implement them. Some of the techniques are characterised by unusual communication scenarios, for example, *de Bono's 6 hats* involves a highly structured communication setting where a high level of control is required by the facilitator. To complicate matters further, props (in the form of different coloured hats) are used (assuming the technique is implemented correctly). The techniques used, will thus influence the nature of the technology needed to support their implementation.

(3.10) Which of the following general forms of DOCUMENTATION do you use / create / read / update during the process of user requirements elicitation?
(3.10.7 to 3.10.15) Which of the following tools do you use to create the documentation?

The documentation used, and the tools used to create the documentation will influence the requirements elicitation communication process and the nature of the technology needed to support their implementation.

(3.11) How important to the success of the requirements elicitation process are the (system modelling) tools which you use during the ANALYSIS PHASE (of the development project)?

During the trial run it became evident that most analysts do not distinguish between requirements elicitation and requirements analysis phases of the development project. Although distinct, these two processes are done together. Thus system modelling tools are used as part of the requirements elicitation process. The question was thus structured for reader-friendliness, to refer to the analysis phase. This is appropriate, as the analysis of this data will only be used to determine the nature of the technology needed to support the important system modelling tools identified.

(3.12) How important to the success of the user requirements elicitation process are the following STANDARDS issues?

The overall result of this analysis may be compared with the result from question *(3.1 to 3.13)* above. Respondents were asked to rate the importance of *quality* in terms of the outcomes of the requirements elicitation process. This would give a perspective on the analysts approach to the requirements elicitation process.

(3.13) How important to the success of the requirements elicitation process is the use of (the following) TECHNOLOGIES?

The technologies listed are mainly communication enabling technologies and thus describe the type of communication process adopted. Furthermore, this measure may reveal more directly, the nature of the technology needed to support the requirements elicitation process.

(3.14) To what extent do the following (OTHER) factors influence the success of the requirements elicitation process?
(3.14.16 to 3.14.20) How important to the success of the requirements elicitation process are the following (OTHER) issues?

Factors listed here could not obviously be categorised, but the analyses of which may (on an individual basis) provide some insights into the nature of the communication process or the technology needed to support it.

4.4 Data Analysis

Decisions regarding the statistical analysis of the data were taken after consultation with Dr. Martin Villet (personal communication), the work of Bakus (1990), and the Statgraphics and Statistica reference manuals.

Demographic details are simply summarised and expressed in graphic terms using histograms and pie charts. Subjective conclusions are then drawn.

5 point Lickert scales are analysed using an Analysis of Variance (ANOVA) or a Multi-factor Analysis of Variance (MANOVA) where appropriate. Software used was either Statgraphics (v7) for small data sets, or Statistica ('99 Edition) for large data sets. Means plot and range tests with a 95% confidence level were performed. Where the F-ratio was significant (p # 0.05), a least significant differences (LSD) test was used to make planned comparisons. Where the F-ratio was not significant ($p > 0.05$), the Bonferroni[6] method was used to make planned comparisons. All such analyses are based on least squares means. The 'significant/not significant' boundary of 3.5 was then compared with the result for each factor.

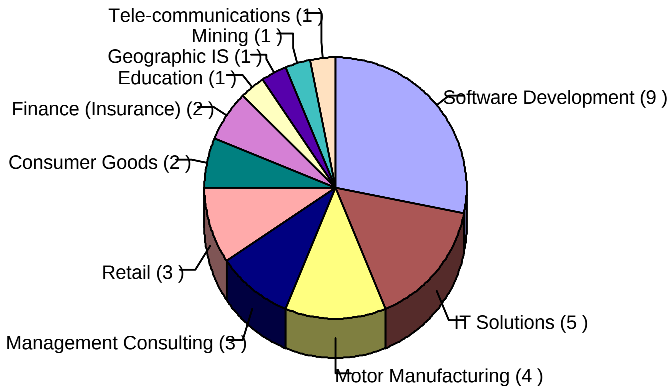
4.5 Results

4.5.1 Demographics

Of the sample of thirty-two (32) respondents, nineteen (19) different companies in eleven (11) different industries were represented as shown in **Figure 4.1**. As shown in **Figure**

[6]The significance levels, as a result of the multiple use of univariate analysis, were adjusted by employing the qualified Bonferroni method, i.e. the p-level of 0.05 and 0.01 divided by the number of univariate analyses computed for each such calculation was determined, and only results with a significance level lass than or equal to the corrected level were regarded as statistically significant. The standard confidence level of 95% was used in all instances of hypothesis testing in this study.

4.2, more than 67% of the sample had more than 10 years of experience in the IT field, and more than 71% had more than 7 years of experience in the process of requirements elicitation. Furthermore, more than 56% have had formal training in requirements elicitation. The training includes University degrees, a component of which was a course in requirements elicitation, short courses run by independent training companies, and in-house training programmes.



Number of respondents: 32
Number of copmanies represented: 19
Number of industries represented: 11

Figure 4.1: Industries represented by the sample group

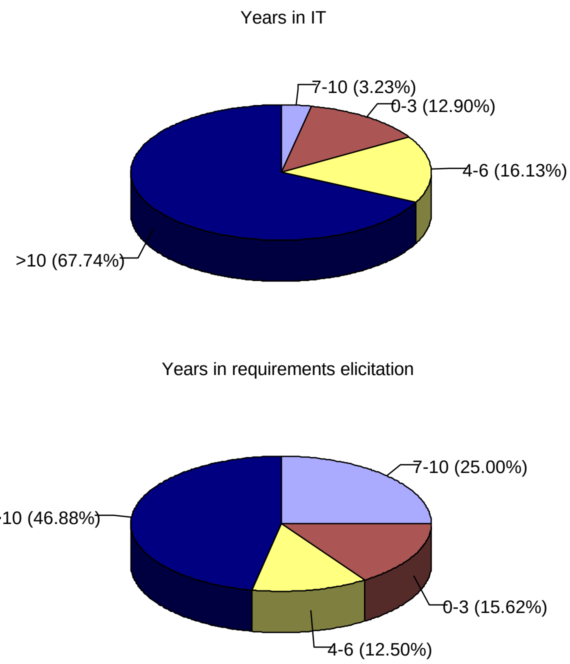


Figure 4.2: Years of experience in IT and requirements elicitation

As shown in **Figures 4.3 and 4.4**, most of the respondents have had experience in both in-house and external projects, and most of those projects have been IS development or software installation projects.

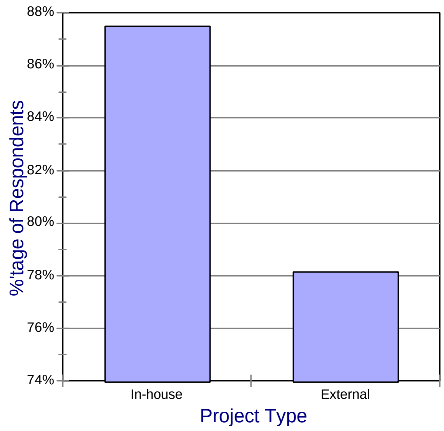


Figure 4.3: General types of projects in which respondents have been involved

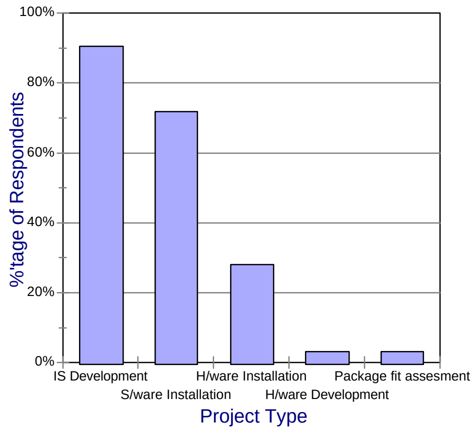


Figure 4.4: Specific types of projects in which respondents have been involved

4.5.2 Methods and Techniques

As shown in **Figure 4.5** (for key of abbreviations, see **Table 4.4**), more than half of the respondents have used and are currently using formal meetings, ad hoc meetings, interviews prototyping, workshops and JAD. An insignificant number of the respondents were using all of the other methods listed. There was a general trend indicating that participants have tried a number of methods which they are no longer using. However, this trend was not significant. There was also no significant change in the use of any particular method. Ranking of the methods was analysed using an ANOVA. A planned comparison was performed (multiple range test). The results were sorted according to the mean and the number of respondents who ranked the method.

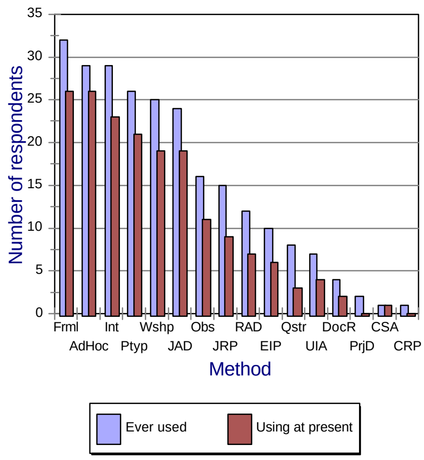


Figure 4.5: Methods used for requirements elicitation

The results are shown in **Table 4.4**. Only those methods which were ranked by more than 50% of the respondents were considered to have a valid ranking.

Table 4.4: Ranking of Methods

Abbr.	Method	Mean of Ranking	Number of responses	Ranking
JAD	JAD	1.95	21	1
Wshp	Workshops	2.15	20	2
Ptyp	Prototyping	2.80	20	3
Frml	Formal meetings	3.81	21	4
AdHoc	Ad hoc meetings	4.14	21	5
Int	Interviews	4.14	21	6
EIP	EIP	3.13	8	Invalid
JRP	JRP	3.30	10	
UIA	UIA	3.60	5	
RAD	RAD	4.29	7	
Obs	Observation	4.44	9	
Qstr	Questionnaire	5.50	6	
DocR	Document review	3.00	1	
CSA	Current system analysis	7.00	1	
CRP	Conference room pilots	10.00	1	
PrjD	Project definition	0.00	0	

General comments regarding the rankings are summarised as follows:

> One respondent stated that interviews, JRP and observation should be used together. It was generally felt that group settings may inhibit some people from expressing their ideas as a result of potential threats posed by other people present in the session. Interviews are used to overcome this scenario if it is problematic.

More specific comments regarding the rankings are shown in **Table 4.5**.

Table 4.5: Specific respondent comments regarding the ranking of methods

JAD	Systematic means of defining user requirements. Involves all members of the project team and allows consensus to be reached. Is facilitated by a skilled person, thus enables good participation and accurate requirements elicitation. Is expensive.
Workshops	Involve a broad audience in a fairly informal setting, thus allowing for consensus to be reached. Allows in-depth discussion. May inhibit honest responses from users. Allows trust to be built between IS professionals and users.
Prototyping	Enables the user to see the system, and thus to validate the requirements definition. Helps to stimulate idea generation where users themselves are not sure of the system requirements.
Formal meetings	Enable the elicitation of specific information, the formal allocation of responsibility, and the formal setting of dates. May stunt creativity.
Interviews	Allow a number of different personal perspectives to be elicited. Encourages absolute honesty from the user. One respondent commented that getting personal opinions is often not very useful.
EIP	Ensures that the project is focussed in the correct area.
JRP	Enables the expression of company vision and strategy.
RAD	Combination of JAD, JRP, and Prototyping enables elicitation of requirements from a variety of different users in a structured environment geared to encouraging participation and creativity.
Observation	Allows effective analysis of the current systems and how they are used. Allows the analyst to question the user ‘on the job’.
Questionnaire	Difficult and time consuming to create. Can be very subjective. Appropriate for large projects with many users who are geographically dispersed. Can be used as a pre-interview technique in order to identify users for involvement in the requirements elicitation process.

The rankings resulting from the statistical analysis of the requirements elicitation methods presented in chapter 3 are compared with the rankings shown in **Table 4.4** above (see **Table 4.6**).

Table 4.6: Results of qualitative data analysis

Rank	Chapter 3 statistical analysis	Empirical study
1	RAD	
2	JRP	
3	JAD	JAD
4	PD	Workshop
5	Technical review	
6	Prototyping	Prototyping
7	Meetings	Meetings (Formal/Ad hoc)
8	Interviews	Interview
9	Questionnaires	
10	Document review	
11	Observation	

These rankings compare favourably and although not all of the method rankings from the questionnaire data were considered valid, those that were valid show the same ranking.

As shown in **Figure 4.6**, a variety of techniques are used to aid the requirements elicitation process. A significant number of respondents were found to use brainstorming, displayed thinking, and team building techniques.

Key:	
B-Storm	Brainstorming
D-Think	Displayed thinking
TeamB	Team building
Ice-B	Ice-breakers
NGT	Nominal group technique
U-Trng	User training
H-kpg	Housekeeping
Doc'n	Documentation

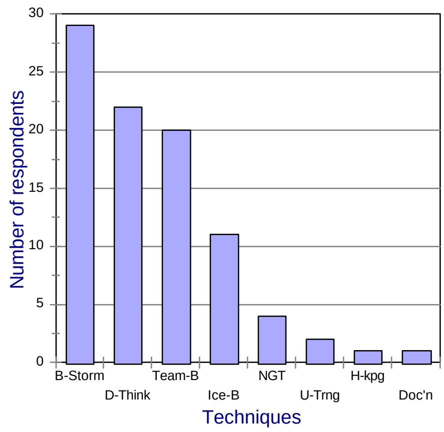


Figure 4.6: Techniques used to aid requirements elicitation

45% of the respondents have been involved in a user requirements elicitation process which has been carried out in a distributed communication environment. Some of these respondents referred to the limited use of e-mail and telephones to clarify issues previously discussed in a face-to-face setting. One of the respondents had used the Internet to facilitate the dissemination of documents regarding the requirements as previously discussed in a face-to-face setting. One of the respondents had used a CASE tool together with telephonic communication. Discussion regarding those documents was then held in either a telephonic or a face-to-face setting. One of the respondents has been involved in teleconferencing, where a 3-way conference call was held between developers where the protocol was mainly a question and answer session on matters regarding requirements. Four of the respondents had been involved in video conferencing sessions geared towards eliciting user requirements. In three of these cases experience in this setting was limited, and in the fourth case a highly sophisticated video conferencing environment is used on a regular basis.

4.5.3 Factors

4.5.3.1 Factor categories

Table 4.7 shows a comparison of means for each category of factors. The initial assessment of the factor categories was done in terms of the overall *importance* of the type of activity to the success of the requirements elicitation process. The results indicate that all categories were either *very important* (0=1) or *important* (0=2) with the exception of *personal appearance*. The result (0=3.1) indicated that respondents were *undecided* about the importance of *personal appearance*. The category rating per factor was the mean (0) of the means of all individual factor ratings for that category. The ratings were done in terms of the importance or the influence of the factor (as indicated). Where the *category rating* was in terms of *importance* and the *category rating per factor* is in terms of *influence*, the overall results are considered comparable. The comparison of this result with the category rating showed that after a detailed assessment of each category, there was no significant change in the assessment of the category in itself. There are two trends which should be noted: i) *mind set* in general was rated as *very important* (Θ=1.29), and would *influence* (as opposed to *significantly influence*) the success of the requirements elicitation process; ii) *personal appearance* would *barely influence* (Θ=3.75) the success of the requirements elicitation process. Category ratings per factor are not applicable (n/a) where data collected did not lend itself to such an analysis, or in the case of *system modelling*, where such an analysis would be inappropriate.

Table 4.7: Comparison of means for each category of factors

Factor Category	**Category rating (Importance) Θ**	**Category rating per factor Θ**
Project Management	1.71	1.78 Importance
Participation	1.13	n/a
Mind set (user and developer)	1.29	2.07 Influence
Body Language	2.52	2.44 Influence
Personal Appearance	3.10	3.75 Influence
Speech	2.32	2.21 Influence
Interpersonal Communication	1.55	1.95 Influence
Ergonomics	2.58	2.38 Influence
Decision-making	1.52	n/a
Documentation	1.65	n/a
System Modelling	2.00	n/a
Standards	2.10	2.03 Importance
Technology	2.68	3.37 Importance

Tables 4.8, 4.9, 4.10 and 4.11 show detailed analysis of individual factors. The factors have been sorted in order of significance or importance, and those factors which fall below the 'significant/not significant' boundary are shaded.

Analysis of the *system modelling* was initially aimed at obtaining an impression of the importance of the different modelling techniques used. However, this is considered to be irrelevant. What is important is to develop an understanding of which modelling techniques are actually used, and which are preferred. Some of the terminology used to describe certain techniques is interchangeable with other terminology. This did not cause any confusion; respondents used the terminology with which they were familiar to rate the technique. Other terminology listed does not actually describe a modelling technique *per se*, but rather a vehicle for developing an understanding of a modelling technique (for example, *time box development* and *object think*).

Table 4.8: Speech, Ergonomics and Standards

Speech		Ergonomics		Standards	
Factor	**Mean**	**Factor**	**Mean**	**Factor**	**Mean**
Pace	1.74	Position of people (spatial relationships)	2.06	Quality	1.29
Stutter	2.06	Venue	2.13	Estimation	1.93
Words used	2.13	Position of tools and technology	2.19	Metrics	2.46
Inflections on words	2.23	Position of furniture	2.39	Function points	2.61
Pronunciation	2.26	Type of furniture	3.13		
Style	2.29				
Enunciation	2.29				
Providing punctuation	2.74				

Table 4.9: Technologies and Other

Technologies		Other	
Factor	**Mean**	**Factor**	**Mean**
Visual Aids	1.48	Organised process	1.27
Electronic mail and messaging	1.55	Facilitator's skill	1.29
Paper and pen	1.84	Facilitation	1.32
Group calendering and scheduling	2.55	Rational process	1.35
Group document handling	3.13	Experience	1.35
Workgroup utilities and development tools	3.81	Job Experience	1.55
Collaborative Internet-based applications	3.97	Industry Knowledge	1.58
Video conferencing	4.06	Follow-up meetings	1.68
Groupware applications and services	4.10	Length of interactions / meetings / sessions	1.74
Electronic meeting systems	4.26	Meeting management	1.77
Groupware frameworks (group support systems)	4.29	Atmosphere of the elicitation environment	2.00
Desktop video and real-time data conferencing	4.35	Tea breaks	2.23
Non real-time data conferencing	4.39	Smoking	2.42
		Eating and drinking	2.65
		Age	3.16
		Gender	4.06

Table 4.10: Project management, Mind set, Body language and Personal appearance

Project management		Mind set		Body language		Personal appearance	
Factor	**Mean**	**Factor**	**Mean**	**Factor**	**Mean**	**Factor**	**Mean**
Scoping	1.19	Attitude	1.19	Hearing / listening	1.19	Clothing style	2.68
Select Participants	1.27	Expectations	1.52	Eye contact	1.71	Clothing colour	2.97
Leadership	1.37	Behaviour	1.90	Facial expressions	1.71	Body piercing	3.06
Obtain results approval	1.42	Values	2.30	Smile	1.94	Face	3.26
Quality control	1.48	Intellect	2.32	Voice (accent, inflections, loudness, pitch, tone)	1.94	Make-up	3.42
Brief project sponsor	1.58	Mood	2.32	Head movements (eg. nodding)	1.97	Body type/shape	3.58
Schedule project	1.68	Memory	2.35	Sight	2.10	Hair style	3.61
Arrange participant schedules	1.71	Aura	2.35	Orientation	2.29	Hands	3.74
Productivity	1.74	Socialisation	2.39	Proximity	2.55	Torso	4.00
Gather materials	1.77			Head position	2.59	Arms	4.03
Educate participants	1.81			Hand position and movements	2.65	Legs	4.10
Time budget	1.87			Posture	2.68	Hair colour	4.13
Obtain resource approval	1.90			Arm position and movements	2.71	Lips	4.16
Financial budget	1.94			Scent / Smell	2.81	Knees	4.26
Schedule, obtain facility	2.00			Body pointing	2.90	Feet	4.26
Review background documentation and models	2.00			Perspiration	3.06	Nose shape/size	4.26
Customise agenda	2.29			Body contact	3.48	Eye colour	4.29
Prepare "script" or notes	2.39			Breathing	3.65		
Assign preparation assignments	2.42						

Table 4.11: Interpersonal communication and System modelling

Interpersonal communication		System modelling	
Factor	**Mean**	**Factor**	**Mean**
Commitment	1.26	Data flow diagram	1.97
Illustrating	1.39	Data Model (Entity-relationship diagram - ERD)	2.10
Group dynamics	1.47	Process decomposition	2.39
Self-confidence	1.48	Entity definitions	2.42
Feedback	1.48	Attribute definitions	2.90
Conflict management	1.52	Dependency analysis	2.94
Explaining	1.55	Activity dependency diagram	2.97
Summarising	1.58	System overview model	2.97
Negotiation	1.61	Process dependency analysis	3.16
Consensus	1.61	Procedure analysis: current systems	3.26
Coaching	1.73	Structure chart	3.32
Inform	1.74	Screen flow	3.35
Synthesising	1.74	Activity hierarchy diagram	3.39
Individual vs Group	1.77	Data Model list	3.55
Roles	1.77	Entity life-cycle analysis	3.58
Communication Channels (networks)	1.81	Process logic analysis	3.68
Team building	1.81	Matrix analysis	3.74
Personality	1.84	Component Modelling	3.87
Language	1.90	Action diagram	4.06
Reflecting	1.97	Procedure action diagram	4.13
Following	2.06	Class diagrams	4.16
Norms	2.10	Information views	4.16
Emphasising	2.13	User view analysis	4.32
Psychology	2.16	System area model	4.32
Culture	2.19	Class Responsibility and Collaboration (CRC) cards	4.48
Informal meetings / socialise	2.35	Use cases	4.52
Pointing	2.39	Time box development	4.61
Orient	2.55	Action block usage	4.61
Flirting	3.13	Work set list	4.65
Race	3.52	Object think	4.77
Nationality	3.58		

4.5.3.2 Participation

It was considered to be *very important* (Θ=1.13) that a variety of people become involved in the requirements elicitation process. This did not refer to the entire project team and user group which will be involved in the systems development project as a whole. However, it did refer to all people who will be involved in the process, but not necessarily limited to those who are specifically associated with the user requirements definition. For example, a secretary was considered to be involved in the process if s/he was tasked with a responsibility which affects the process. The number of people that could be involved is indicated in **Table 4.12**.

Table 4.12: Number of participants in the requirements elicitation process

Minimum	1	Average Minimum	6	Median Minimum	5	Overall Average	11
Maximum	50	Average Maximum	16	Median Maximum	15		

The types and roles of people involved in requirements elicitation are shown in **Figure 4.7.**

Key:	
User	User
Anlst	Analyst
Facttr	Facilitator
MgtM	Management: Middle
MgtU	Management: Upper
MgtL	Management: Lower
Dvlpr	Developer
Admin	Administrator
Prg/Dp	Programmer/Developer
Sec	Secretary
Tech	Technician
PMgr	Project manager
Splst	Specialist
Spsr	Sponsor
Scribe	Scribe
Mgr	Manager
CEO	CEO
Devl's	Devil's advocate

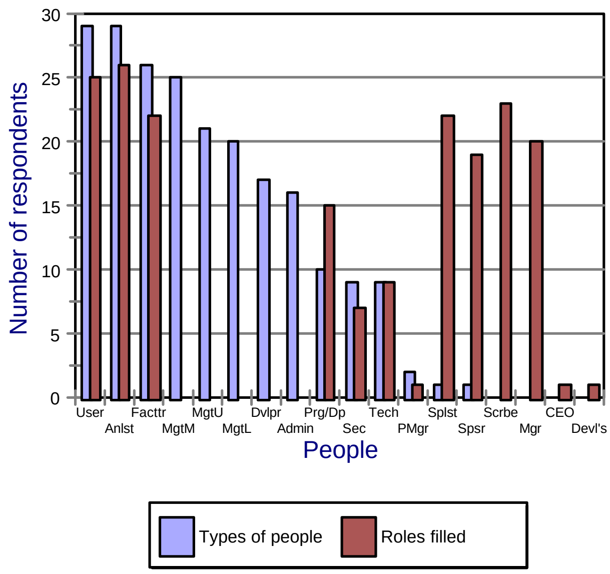


Figure 4.7: Types of people and roles of people involved in requirements elicitation

4.5.3.3 Decision-making techniques

The decision-making techniques used in the user requirements elicitation process are shown in **Figure 4.8**.

Key:	
C-pslv	Collaborative problem solving
Cons	Consensus
Dec/Imp	Decision/Impact analysis
Decmtx	Decision matrix
Dectree	Decision tree
Votg	Voting
de Bono	de Bono’s 6 hats
T-chart	T-chart
F-comp	Forced comparisons
F-field	Force-field analysis

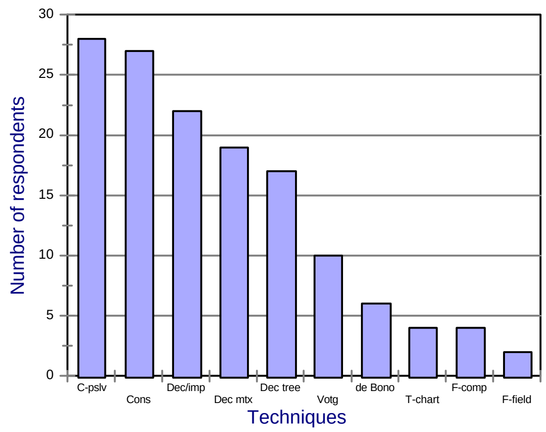


Figure 4.8: Decision-making techniques used during requirements elicitation

4.5.3.4 Documentation

The general forms of documentation which are used in any way (created, read, updated or deleted - *crud*) are shown in **Figure 4.9**.

Key:	
Mnts	Minutes
Agda	Agenda
PSched	Project Schedule
UsrMan	User Manual
HelpFac	Help Facilities
D-Mdls	Data Models
Scope	Scoping
P-type	Protoytping
PrcssDoc	Process Documentation

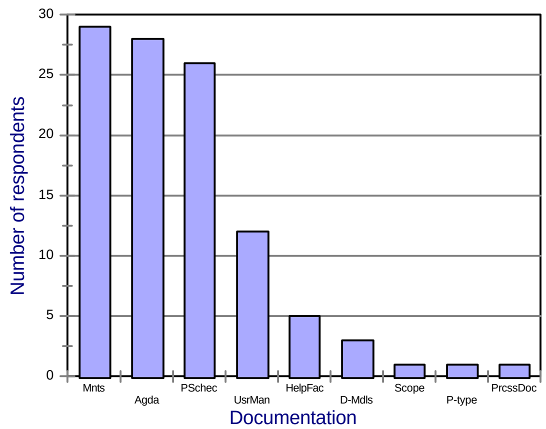


Figure 4.9: Documentation *crud* during requirements elicitation

4.5.3.5 Technologies

Technologies used to *crud* the documentation are shown in **Figure 4.10**.

Key:	
WordP	Word Processor
SSheet	Spreadsheet
Draw	Drawing
PSched	Project Scheduling Tool
HandW	Hand writing
ADT	Automated Design Tool
CASE	Computer Aided Software Engineering Tool
TextEd	Text editor
PBoard	PanaBoard
Proxima	Proxima
PPoint	PowerPoint

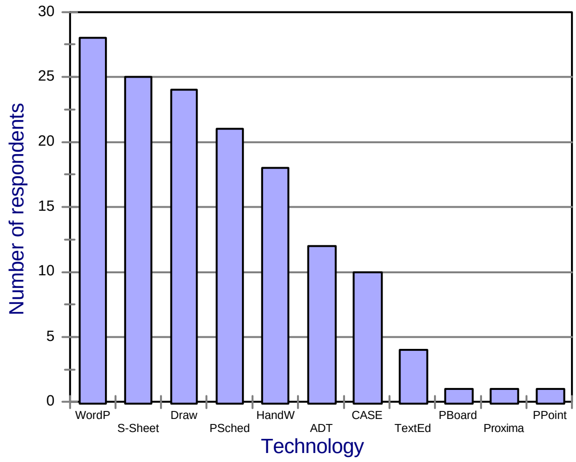


Figure 4.10: Technology used to *crud* the documentation

4.5.4 Comparison of Respondents

In order to compare the perspectives of the one respondent who had significant experience in distributed requirements elicitation with the perspectives of all other respondents, a statistical analysis was performed (this was done as an interesting exercise, with the author recognising that, statistically speaking, the results would not be valid due to their only being one respondent under examination). Two levels of analysis were done; firstly to compare specific factor categories, and secondly to compare all factor categories together. For the first analysis, comparison of data from the respondent in question with data from all other respondents was done as follows: appropriate categories were chosen for comparison. The average of the ratings of the respondent was calculated for each category. The average of the ratings for all other respondents (separately) was calculated for each category. These values were then subjected to a *One-sample t-test* (with a 95% confidence level) where the null hypothesis (H0) is that the respondent is the same as all other respondents. This results in an average rating on the original scale of 1 to 5 and either the acceptance or rejection of the null hypothesis. The results are shown in **Table 4.13**. Where the null hypothesis is rejected, the results are considered to be significantly different.

Table 4.13: Comparison of results of one respondent with all other respondents

Category rating per factor	**Averages**		**One-sample t-test results (95% confidence)**
	Respondent	**Others**	
Project Management	1.26316	1.82708	Reject H0
Standards	1	2.14815	Reject H0
Body Language	3.05556	2.41972	Reject H0
Personal Appearance	4.76471	3.71961	Reject H0
Mind set	2	2.07593	Do not reject H0
Speech	2.12500	2.22083	Do not reject H0
Interpersonal Communication	2.03125	1.95185	Do not reject H0
Ergonomics	2.4	2.38	Do not reject H0
Other	2.06250	1.96208	Do not reject H0

For the second analysis, comparison of data from the respondent in question with data from all other respondents was done as follows. The same categories (as above) were chosen for comparison. The average of the ratings for all other respondents (separately) was calculated for each factor within the factor categories. All factor categories were brought together. These values were then compared with the factor ratings of the respondent in question by means of a *Paired t-test* (with a 95% confidence level) where the null hypothesis (H0) was that the respondent is the same as all other respondents. This results in a comparison of the respondent in question and all other respondents across all factor categories and either the acceptance or rejection of the null hypothesis. In this instance, the null hypothesis was accepted, thus indicating that there is no significant difference between the respondent and all other respondents when viewing all the relevant data together.

4.5.5 General Discussion

After completing the questionnaire, a general discussion in an interview setting was held with the respondent. Two particular areas were explored: i) what did the respondent regard as the definitive mark of a successful requirements elicitation process, and ii) what were the respondent's views on the concept of geographically distributed requirements elicitation.

4.5.5.1 Requirements Elicitation Success

The sentiments expressed by the respondents with regards to the requirements elicitation process are summarised below. Where appropriate, a statement is quoted:

- Clear, unambiguous requirements definition delivered on time and within budget.
- User satisfaction with the deliverables and with the process (trust by users of analysts is a prerequisite for user satisfaction). The users must "buy-in" to the process and the results.
- "The degree of acceptance is a measure of success."
- "User expectations must be met."
- Having the right people, with the right job and communication skills, and a knowledge of the techniques used.
- "Traceability of requirements through the system development life cycle."

4.5.5.2 Geographically Distributed Requirements Elicitation

The sentiments expressed by the respondents are summarised below. Where appropriate, a statement is quoted:

- Even if task completion was guaranteed, and an equally accurate requirements document could be produced, the working environment is about more than getting the job done, human interaction (relationships and social interaction) is important.

- On international projects, overcoming timing problems is possible, but not practical. The users need to "buy-in" to the project and to offer least resistance; this is not achievable where personal interaction is restricted.
- If the technology allowed participants to interact to some extent on both visual and auditory channels, and with the assurance that the tasks could be completed, this environment would be acceptable. "The job is to get requirements and not to view the person."
- Active listening (viewing head nodding and eye contact for example) would not be possible in such an environment. This is too important to allow it to be restricted.
- "Personal touch is critical - lose that and you will meet resistance during the process. A high-tech environment may be too overwhelming for many users. The requirements elicitation process is daunting enough as it is."
- "I would use technology to facilitate one-to-one meetings, but not group meetings." This sentiment was immediately contradicted by the same respondent, "If the technology was sophisticated enough, I would consider using it for formal meetings."
- In an extreme case where virtual reality would enable the facilitator to change someone's appearance in order to overcome prejudices (for example), ethical issues would become important and integrity would be put into question.

4.6 Discussion

4.6.1 Demographics

The minimum sample size considered valid for this study was discussed with academics who have experience in this type of statistical analysis. Twenty (20) respondents is considered to be the minimum representative sample, provided that, demographically, the sample was heterogenous in terms of experience and industries represented. Thirty-two (32) respondents, therefore, make up the sample. The sample of respondents is considered to be statistically representative in terms of the number of respondents, the industries represented, the levels of experience in both the IT field as well as in requirements elicitation, and in terms of the types of projects in which the respondents have been involved. The experiences which some of the respondents have had in requirements elicitation in a distributed environment are not considered to be significant enough to influence significantly the results. This includes (in particular) the one respondent who has had significant experience in distributed requirements elicitation.

4.6.2 Requirement Elicitation Methods

The most popular requirements elicitation methods used are characterised by group participation. Not surprisingly, those methods which are used by more people, were also ranked more highly than those which are more effective at eliciting user requirements. Interviewing was the exception in the sense that it implies a one-to-one communication scenario; this ranking is explained mainly by the greater anonymity which is afforded by this method. Anonymity is seen as important in cases where participation and honesty may be hindered mainly due to political, and authority related reasons. Interviewing was also popular as a method used in the early stages of requirements elicitation where identifying the appropriate users for further requirements elicitation is particularly important. The rankings of the methods were the same when comparing the questionnaire results and the literature study results. This showed that the sentiments expressed by the South African sample group are consistent with those expressed by leading international authors on the subject. It should be noted, however, that the methods ranked as being the best at eliciting user requirements, are not necessarily used most often. For example, JAD is ranked higher than meetings although meetings are used by more people. This can be explained in any one of the following ways: i) the same number of people ranked JAD and meetings, therefore, those people who use meetings and not JAD ranked other methods (not JAD) higher than meetings, ii) JAD is considered to be a better method, but meetings are used as an alternative, or iii) JAD is expensive, and although considered a better method, is thus not used by some analysts. The second reason is made plausible by the sentiment expressed by many of the respondents that the formality of JAD was often too daunting (or simply inappropriate) for many users. Thus, although JAD may be a better method in terms of its ability to elicit user requirements, less formal (less structured) methods (such as workshops or meetings) are used in its place.

Descriptions (which were not evaluated quantitatively) of the methods which ranked the highest (as shown in **Table 4.11**) are presented in **Table 4.14** below. These descriptions were established as part of the statistical analysis of the methods as presented in Chapter 3, **Table 3.4**).

Table 4.14: Descriptive characteristics of highest ranked methods

Factor name/description	**Characteristic**
Method	Structured or unstructured.
Participants	Chosen, not sampled.
Focus	Future, not current system.
Group communication structure	Completely connected or circle with leader.
Communication network	Direct.
Interaction and patterns of interdependence	Reciprocal.

Requirements elicitation is predominantly an investigation of facts, however brainstorming and displayed thinking are techniques used to support the requirements elicitation methods. This implied that requirements elicitation involves a high level of interaction between participants, and that this interaction is structured (in the sense that the communication network is subject to a high level of control by the analyst) and relies on visual stimuli to represent the interactions and store the results of the interactions. Furthermore, team building was also used, implying a need for those interactions to occur in a setting where human interactions are not hindered by communication problems.

Decision making is an important aspect of requirements elicitation, with a variety of decision making techniques being adopted. This was presumed to be due to a need to use different techniques to suit different situations. Collaborative problem-solving and consensus were used most often. These are relatively unstructured techniques as compared with the other popular methods (namely; decision / impact analysis, decision matrix, and decision trees). Voting is a technique which has been given extensive coverage in literature, but is clearly not a popular decision making option in South Africa.

4.6.3 Participation

Allied to the discussion thus far is the fact that there are usually five (5) to fifteen (15) participants involved in requirements elicitation. The overall average number of participants involved, eleven (11), represents a large group of people. The group is diverse in terms of the job descriptions of the participants. This meant that there could be a high degree of influence on the requirements elicitation process from political and power related issues. Due to the expected involvement of management personnel, scheduling requirements elicitation sessions may be a complex task. Scheduling in general is likely to be complex as a result of the large group size. Most sessions will be facilitated by an appointed facilitator. This implies a need for direction and control to come from a trained participant.

4.6.4 Documentation and Technology

Structured documentation (in the form of minutes, agendas and project schedules) was used to assist the smooth set-up, operation, and storage of information of the requirements elicitation sessions. This once again implies a need for structure and control. Specialised technology was used to manipulate this documentation, although specialised CASE tools were not used by a significant number of respondents.

4.6.5 Project Management

Given the large number of people involved in the requirements elicitation process, and given the complexity of the methods used, it is not surprising that project management is important (0=1.78). All of the project management factors examined were either very important or important. From this it can be deduced that there is a strong need for control of project activities and resources in general, and for control of the project in terms of the nature of the requirements elicited (for example, scoping the project (Θ=1.19), and obtaining results approval (Θ=1.42)). The nature of the project management activities implies a great deal of communication between participants in a variety of levels and functions within the organisation and between the user and IS professional organisations. Furthermore, this communication is likely to be characterised by varying degrees of formality. Although extreme, it is possible, for example, that should the communication between the project manager and the project sponsor be ineffective, an entirely feasible and acceptable project could be rejected. Although many of the project management activities examined may seem peripheral to the requirements elicitation process *per se*, it is clear that should any of these activities not be adequately performed, the requirements elicitation process will suffer.

4.6.6 Mind Set

The mind set of the participants will have an influence (Θ=2.07) on the success of the requirements elicitation process. It is thus important for the facilitator to ensure that participants have an appropriate mind set during the requirements elicitation process. Team building (Θ=1.81) is used by facilitators to influence the interactions between participants; this will contribute towards creating a positive mind set. However, the onus lies on the facilitator to ensure that the expectations (Θ=1.52) of the project team are properly managed, and that the behaviour (Θ=1.9) of participants outside of the team building has a positive impact on the team.

Participant selection (Θ=1.27) is a very important project management activity. This is highlighted further by the influence that values (Θ=2.3), socialisation (Θ=2.39), intellect (Θ=2.32), memory (Θ=2.35), and aura (Θ=2.35) have on the requirements elicitation process. Participants should be selected not only for their value in terms of their business and systems knowledge (experience: Θ=1.35, job experience: Θ=1.55, and industry knowledge: Θ=1.58), but also for their ‘fit’ into the profile of the group. This profile is usually decided upon by the facilitator, and may vary depending on the objectives of a particular requirements elicitation session.

4.6.7 Body Language, Personal Appearance, Speech and Ergonomics

The analysis of body language (Θ=2.44), personal appearance (Θ=3.75), speech (Θ=2.21) and ergonomic (Θ=2.38) factors serves to highlight the general importance of all the natural communication tools available to the participants of a requirements elicitation process. The use of the body is important (Θ=2.44), however, the importance declines (although not significantly) from the head towards the feet. It is the use of the body (body language: Θ=2.44), and not the appearance of the body (personal appearance: Θ=3.75; with the exception of the face (Θ=3.26)), which influences the process. It is noteworthy that scent/smell (Θ=2.81) and perspiration (Θ=3.06) are considered to have an influence. It is suggested that the sight of a perspiring participant may lead the facilitator to conclude: i) that the air temperature of the venue is too high (this could cause discomfort and thus losses in concentration), or ii) that the participant is nervous, uneasy or emotionally uncomfortable (this could cause losses in concentration, or inaccuracies in information submitted). An appropriate response from the facilitator would improve the communication setting and thus the overall requirements elicitation results. Perspiration may be detected through smell, but perhaps more importantly, unpleasant or over-powering body odours may cause discomfort and consequent losses in concentration.

The personal appearance (Θ=3.75) of the body itself does not influence the requirements elicitation process. The appearance of the face (Θ=3.26) has an influence, although it is not marked. It is rather the appearance of clothing (style: Θ=2.68 and colour: Θ=2.97), or make-up (Θ=3.42) (these factors alter a persons appearance) which has an influence. These factors are perceived to make a statement, or to project an image which is then associated with the individual wearing them. Participants in the requirements elicitation process are conscious of this, and will be influenced by these factors. It is important to note that detailed impressions (for example, the nose shape/size (Θ=4.26) or the eye colour (Θ=4.29)) are not important.

Not surprisingly, speech (Θ=2.21) in general is important. Not only are factors such as pace (Θ=1.74), pronunciation (Θ=2.26) and enunciation (Θ=2.29) important, but intricate tools which enhance speech are also important. Participants must be orally literate.

Ergonomic factors are often ignored by people in general communication settings. In order to facilitate an effective requirements elicitation process, the venue (Θ=2.13), the furniture (Θ=2.39) and the relationships between people (spatial relationships: Θ=2.06), and between people and furniture (Θ=2.39), tools and technology (Θ=2.19) must be carefully considered. The importance of spacial relationships implies that there is an influence of participants upon one another in respect of their relative positions in a venue, or at a table. This can be manipulated by the facilitator.

4.6.8 Interpersonal Communication

With the exception of race (Θ=3.52), nationality (Θ=3.58) and gender (Θ=4.06), all aspects of interpersonal communication are important. This implies a need for participants to interact in an organised fashion, and to be cognisant of the human relationships in the group. It is noteworthy that the dynamics of the group as potentially influenced by race and nationality will not significantly influence the success of the requirements elicitation process. Cross-cultural communication skills are required in any cross-cultural communication setting. In requirements elicitation in South Africa, it is presumed that cross-cultural communication skills are good. Added to this, gender issues that are common in many aspects of business, barely influence the requirements elicitation process.

4.6.9 Standards

Standards are important in the requirements elicitation process, however, these apply more to the results of the process than the communication process itself. The results (outputs) must be of a good quality (Θ=1.29).

4.6.10 System Modelling

As evidenced in the presentation of the results of the *system modelling* techniques used, South African IS professionals use traditional (as opposed to modern) modelling techniques. The techniques used are generic in nature as opposed to being proprietary (belonging to a specific methodology). There is a good mix of function and data centred techniques, as well as general techniques used to describe requirements in high-level terms.

4.6.11 Communication Technologies

Although most respondents have not been significantly involved in distributed requirements elicitation processes, there are some groupware tools being used namely, electronic mail and messaging, group calendering and scheduling, and group document handling. Paper and pen, and visual aids are used extensively in group sessions to represent user requirements. The groupware technologies are used primarily for scheduling requirements elicitation sessions, and for distributing documentation. E-mail is used as a means for eliciting and discussing user requirements, although this is mainly geared to clarifying previously discussed requirements.

4.6.12 Comparison of Respondents

One respondent in particular (with significant experience in geographically dispersed requirements elicitation) considered project management and standards to be more important, and body language and personal appearance to have less influence than all other participants. It is possible (although not confirmed) that this is due to his experiences with geographically dispersed requirements elicitation. Additional complexities regarding the process (introduced by the nature of distributed working and the technology which supports it) are likely to make management of the process more complex. Thus attention to project management issues will be more important to the success of the requirements elicitation process. The more complex nature of the process may call for more attention to standards issues. It is possible that this results from increases in the need for control brought about by the increase in the diversity (geographical) of the participants in the process.

Body language and personal appearance can be juxtaposed with mind set, speech and interpersonal communication (and with many of the factors in the *other* factor category), where body language and personal appearance refer to 'external' communication elements. Although body language is well known to make a significantly large contribution to the success of human communication, it is often seen as a support to the spoken word (speech). Body language is not easily conveyed using communication technologies (particularly video conferencing as used by the respondent in question). It is possible (although not confirmed) that the respondent feels (as a result of his experience) that these two factors have a less significant influence.

No study has been conducted to determine whether or not the respondents attitude changed as a result of his experiences with geographically dispersed requirements elicitation.

When viewed in general terms, only four (4) of the five (5) categories examined showed a significant difference between this respondent in question and all others. Furthermore, the results show that the respondent in question was at most 1.14815 (and at average 0.00034) points different from all other respondents. Referring back to the scales used to rate the factors, the respondent in question was never on a different side of the significant/not significant boundary, and only had what can be considered to be a marginally different grade of importance or influence as compared with other respondents.

Due to the subjective nature of this analysis, it was decided that a difference would only be considered significant where the values in question fell on different sides of the 3.5 'significant/not significant' boundary and where this difference spaned at least two ratings on the scale. For example, the result would be significant if the values were 1.5 and 3.6. They would not be significant if they were 1.5 and 3.2. There is no significant difference between the assessment of the respondent in question and all other respondents. This conclusion is supported by the result of the Paired t-test which showed that overall, the respondent in question and all other respondents are not significantly different.

4.6.13 Requirements Elicitation Success

No matter what methods, tools and techniques are used to elicit user requirements, the objectives always remain the same, they are:

- clear, unambiguous requirements definition;
- on-time and within-budget delivery;
- user satisfaction; and
- user ‘buy-in’.

These objectives are achieved within an environment of good communication between users and analysts, where trust is a cornerstone of their interaction.

4.6.14 Geographically Distributed Requirements Elicitation

Opinions are divided regarding the plausibility of geographically distributed requirements elicitation. Most of the respondents felt that this setting would be inappropriate, mainly due to the perceived loss of personal interaction between participants. Task completion is considered to be less important than interpersonal interaction. This is mainly due to a fear that user satisfaction and thus ultimately user acceptance of the requirements document would be negatively affected.

Some respondents indicated that they would be prepared to use such an environment in certain circumstances and given a certain minimum technological requirement. These respondents would, however, be cautious about using the technology to significantly influence the nature of the communication process in terms of the representation of the images of the participants.

4.7 Conclusion

This chapter has presented an empirical study designed to examine the principles of the RECM and the relationships of the elements within the model, in the South African context.

The empirical study was designed to achieve two main objectives: i) to determine the actual nature of communication in the requirements elicitation process, and ii) to develop an impression of the requirements of communication technology which may be employed to facilitate communication in the requirements elicitation process. Based on the results of the empirical study, the requirements elicitation process, as it is carried out in South Africa, can be described as follows:

Requirements elicitation is an organised and rational process of the investigation of requirements for the development of an information system. The investigation predominantly involves extensive and complex communication between a large group of stakeholders. The objective of requirements elicitation is to clearly and unambiguously define information system requirements as expressed by the users of the system. These requirements are represented in high quality requirements definition and specification documents. The process of requirements elicitation is as important as the documents which result from it. User ‘buy-in’ (with respect to the process and the final documentation) will result from relationships based on trust between users and analysts. User satisfaction is measured by on-time and within-budget delivery, and by the degree of user acceptance. Good requirements definition will result in the traceability of the requirements through the systems development life cycle.

Requirements elicitation methods used are either structured or unstructured (this is at the preference of the analyst). These methods can loosely be described as formal or ad hoc meetings. Interviews are used extensively during the process of participant selection, and are also used where individual perspectives are sought without bias resulting from political or power reasons. Prototyping is used in combination with other methods, predominantly as a means of stimulating idea generation, and of validating previously elicited requirements definitions. The focus of the requirements elicitation effort is on the future system needs as opposed to the current system. Participants are specifically chosen, and will be involved in complex, direct communication scenarios where reciprocal interaction will be encouraged, but will be controlled by a facilitator.

Visual representation (such as displayed thinking and system modelling), problem solving, and decision making techniques are used during the requirements elicitation process. User training with respect to the requirements elicitation process is carried out where system modelling techniques are used. These techniques complement the requirements elicitation method, aiding communication, memory, documentation, problem solving and decision making.

Control of the requirements elicitation process includes all project management type activities which will ultimately ensure that requirements elicitation proceeds smoothly and according to a set plan. These activities also ensure that the appropriate stakeholders are informed of, or involved in, the process. The stakeholders include a mix of representatives from the function area for which the system requirements are being specified, and from appropriate management levels. Support staff are also involved in the process where appropriate, either to assist in the operations of the requirements elicitation process, or to offer expert advice.

Good (positive and constructive) interpersonal interaction and communication are a critical part of the requirements elicitation process. This is facilitated by careful planning, and process management. Participant selection, attention to important ergonomic factors, and selection of appropriate system modelling techniques and supporting technologies are all important for planning. Process management includes managing the interactions of the participants with one another and with their environment (for example, manipulating spatial relationships), and managing the participants themselves. Participants have a responsibility to express themselves in a manner which will enhance the communication process. Good communication skills are very important and particular attention should be given to speech and body language. Participants should also be aware that their personal appearance does influence the communication process.

Traditional system modelling techniques are used. Models and supporting notes are recorded in a visually appealing manner using large display technologies such as white boards. Documentation is sometimes distributed using groupware technology, although the main application of groupware technology is for aiding in project management activities.

This general description of requirements elicitation as it is performed in South Africa, serves to present the essence of the revised RECM as described in detail in the next chapter. This description highlights elements of the requirements elicitation communication process which were absent from, or inappropriately included in the RECM presented in Chapter 3.

From a technology perspective, at a high level the requirements elicitation process, as described above, needs to be supported. More specifically, written, verbal and nonverbal modes of communication need to be supported (in particular, agendas, minutes, project schedules, memos, discussions, queries, models, requirements definitions and specifications, speech, voice, body language and scent).

This summary of the findings contributes to the development of the modified RECM presented in Chapter 6 and the discussion regarding the GDRE technology infrastructure in Chapters 7 and 8.

Chapter 5
MODIFIED REQUIREMENTS ELICITATION COMMUNICATION MODEL

5.1 Introduction

The aim of this chapter is to modify the requirements elicitation communication model (RECM) presented in Chapter 3 in the light of the findings of the empirical study detailed in Chapter 4.

The original model is revisited, with particular attention given to those elements showing the most significant modifications. The main components are explored and explained with the aid of a series of context diagrams, and low-level modifications are detailed in a *revised* taxonomy of requirements elicitation communication factors. A modified RECM is then presented.

The RECM forms an important part of the model of *geographically distributed requirements elicitation* (GDRE) which is developed in the next chapter.

5.2 The *Requirements Elicitation Communication Model* Revisited

On the basis of the empirical study, the RECM developed in Chapter 3 is subject to some changes. The changes are predominantly at the lower levels of detail as shown in the *taxonomy of requirements elicitation communication factors* in Chapter 3, Section 3.6.2 and in Appendix A (these changes are reflected in the *revised taxonomy of requirements elicitation communication factors* presented in **Appendix C**). However, there are some significant structural changes too.

Motivation for the changes is presented in the discussion relating to the results of the empirical study (Chapter 4). At a low level, all communication factors found in the shaded areas of Tables 4.8 to 4.11 (Chapter 4) have been excluded from the model. These are the factors statistically considered not significant to the success of the requirements elicitation process. Additional factors have been added to the model on the basis of the results of the empirical study. These are introduced and discussed in this chapter and linked to the results of the empirical study.

The revised RECM is explained in detail in this section. Each major component of the model is introduced, discussed and presented graphically as a stepping stone to the presentation of the final model.

5.2.1 The Communication Network

Although the requirements elicitation method chosen has an influence on the nature of the communication process, the requirements elicitation communication process can most accurately be described as a complex set of interactions between a group of participants. This is motivated by the finding that, on average, a requirements elicitation process involves eleven (11) participants (Chapter 4, Section 4.5.3.2). Furthermore, the methods most often used, and the methods ranked the highest in terms of the effectiveness at eliciting user requirements (Chapter 4, Section 4.5.2) are predominantly characterised by group participation (Chapter 3, Section 3.3.3). The interaction network is best described by the *circle with leader* (Frost *et al*, 1993:158) communication network as discussed in Chapter 3. It is implicit in this network structure that the communication channels between the leader and other participants, and the communication channels between other participants, are different. The *leader* (in this case, the *analyst* who is responsible for the requirements elicitation process) may assume a variety of different roles which include an element of power, or control over the communication processes among all participants. There is no conceptual change in terms of the direction of the relationships, or the relationship network structure, however, as shown in **Figure 5.1**, a minor adjustment to the Frost *et al* (1993) model highlights the leader and the special powers of the leader's relationships. The relationships among all participants are influenced by the nature of the participants themselves, and the communication skills which those participants possess.

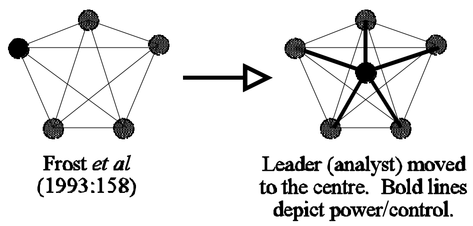


Figure 5.1: Adapted circle with leader communication network

The revised RECM is based on this modified description of the *circle with leader* communication network. For the purposes of simplicity, focus is drawn to three people in the network - the leader (analyst) and two other participants (see **Figure 5.2**). It should be noted that the relationships are bidirectional - this characteristic is specifically shown in order to stress the nature of the interaction. As discussed in Chapter 3, it is also implicit that communication between two participants may be initiated at any point, that it is not linear or chronological, and that the process is infinite.

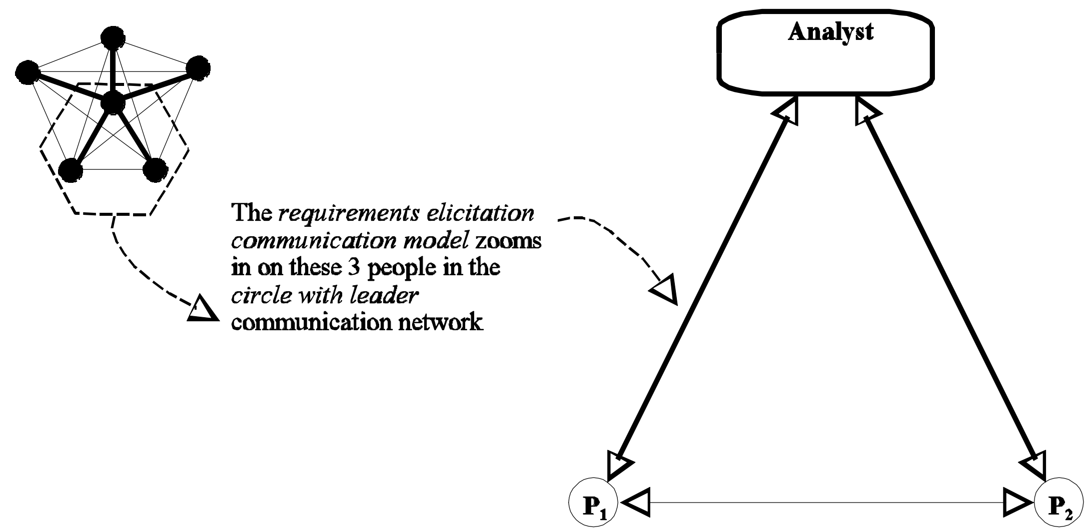


Figure 5.2: Context diagram 5.1

5.2.2 Participants

As depicted in **Figure 5.3**, all participants in the process are possessed of *human characteristics* (such as *personality*, *age*, *experience* and *personal appearance*), and they are subject to *psychological factors* (such as *perceptions* of other elements involved in the process). *Personality* and *perceptual screens* (as discussed in Chapter 3) are depicted in the form of solid and dashed lines respectively. These screens transect all relationships in the network. Participants have *interpersonal skills* (*literacy* and *oral literacy*), and *interpersonal communication tools* (*speech*, *voice*, and *body language*) with which they implement those skills. Any of these factors may constitute a *barrier* to the communication process if they conflict in a negative manner with the communication needs of other participants, or if they inhibit the participants' communication. This reflects no major change in the original model, and minor changes at low levels are shown in **Appendix C**. However, on the basis of the findings presented in Chapter 4, Section 4.5.3.2, and the discussion in Chapter 4, Section 4.6.3, emphasis regarding the roles of the participants (in particular the analyst) is shifted.

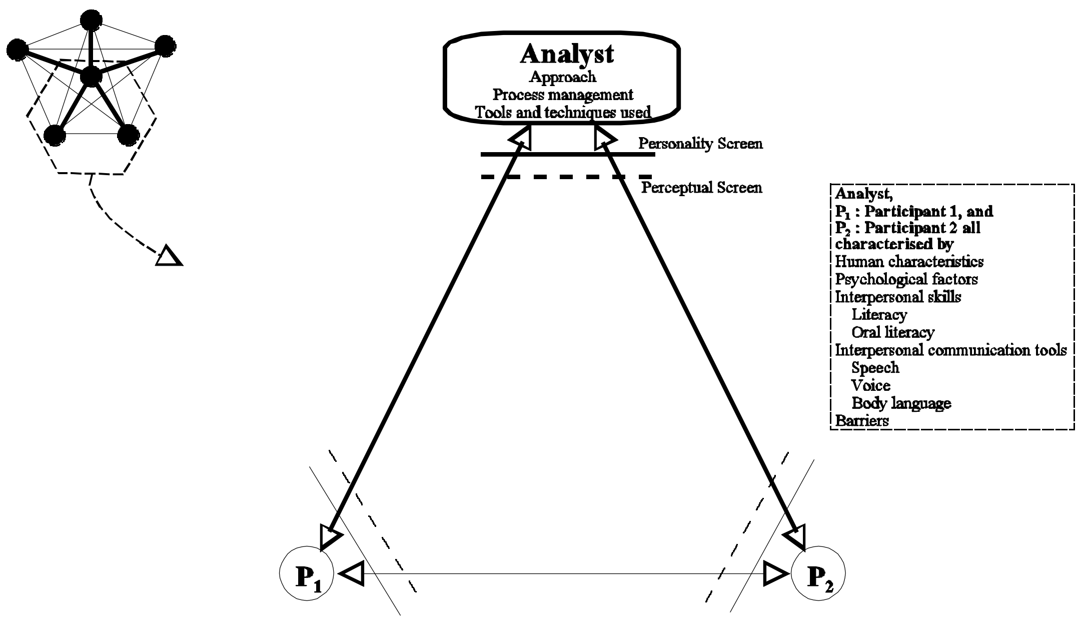


Figure 5.3: Context diagram 5.2

The analyst who is responsible for ‘leading’ the process has a particularly significant opportunity to impact the communication process. As discussed in detail below, the analyst fills the roles of a *process manager* and a *facilitator*. The analyst’s *approach* is governed by the personal characteristics of the analyst, specifically with regard to the analysts views of the environment, the process itself, and the participants in the process.

In the role of process manager, the analyst is responsible for *planning*, *implementing* and *controlling* the process. Activities are mainly related to resource management. The process manager acts as an interface, identifying and extracting resources from the environment into the requirements elicitation process. *Process management* activities will involve interactions between people who are both directly and indirectly involved in the requirements elicitation process. For example, a secretary may be contacted with respect to venue scheduling. Later, participants may be contacted with information regarding the location of the venue. Process management includes *logistical arrangement (participant selection*, *participant scheduling*, *resource sourcing and scheduling*), *participant training*, *team building*, *selecting exercises*, setting up an *agenda*, *minutes*, and *project schedules*, and producing and distributing the appropriate *documentation* which represents the discussion of a previous requirements elicitation session.

As a facilitator, the analyst is responsible for protecting the process from disruptions in the environment, and from disruptions from within the process itself. Interactions and communication need to be managed by the facilitator, with a view to ensuring that the maximum benefit is gained from those interactions. The facilitator is responsible for establishing and managing relationships among all participants and for ensuring that the efforts of participants in the process remain focussed (*scope*), are recorded in a suitable manner (enhancing *understanding* and *memory*), and are contributing towards attaining the required *outcomes* of the process.

The analyst will use a variety of *tools and techniques* to assist in the management and facilitation of the process. *Decision making* and *problem solving* tools, and techniques for graphically representing user requirements are particularly relevant to the requirements elicitation process.

This change in emphasis prompts a further change in the structure of the RECM. In the original model (Chapter 3), factors described above as being in the realm of, or under the control of the analyst (*approach*, *process management* and *tools and techniques used*) were considered simply to be part of the context, or to be features of, or in the nature of the *interpersonal interaction and communication process* as characterised by the requirements elicitation process. Visually, the result is that the *interpersonal interaction and communication process* layer falls away (see **Figure 5.4**).

5.2.3 Environment, Requirements Elicitation Environment, and Context

Figure 5.4 shows the *environment*, the *requirements elicitation environment* and the communication *context* in which the communication process occurs. Unlike the original model, this reflects a distinction between the environment in terms of external influences, and the environment in terms of the influences implicit in the immediate surroundings and structure of the requirements elicitation process. This distinction is made in order to improve a weakness in the logic of the original model design rather than as a direct result of findings in the empirical study.

The *environment* with which the analyst interacts, and which is the environment surrounding the requirements elicitation process as a whole, is characterised by the elements and relationships which exist in it. Of particular impact on the requirements elicitation process are the *organisation characteristics* which include the *organisational culture*, *organisational networks*, and *politics*.

The *requirements elicitation environment* is characterised by the *locality* of the participants, the *atmosphere* of the meeting room, and the *ergonomics* of the room and the furniture within it.

The context of the communication setting is requirements elicitation. The context of the requirements elicitation process is described by the *group characteristics* (*number* and *authority* of participants), the *requirements elicitation method(s)* used (specifically with reference to the communication specifications implicit in the method), and the requirements elicitation objectives at any given time (*goal setting and definition*, *expectations clarification and management*, *information elicitation*, *information sharing*, *brainstorming*, *dealing with ambiguity*, *problem solving*, *conflict management*, *negotiation*, *persuasion*, or *decision making*). Unlike the original model, attention is drawn specifically to the requirements elicitation method(s) as being definitive of the requirements elicitation communication context. The results of the empirical study (Chapter 3, Section 4.5.2) revealed that the specific method(s) used not only influence the context as a result of their objectives, but their specific characteristics in terms of (amongst others) participation, focus, communication structure and related patterns of interaction and interdependence (Chapter 3, Section 4.6.2), influence the context of the requirements elicitation process.

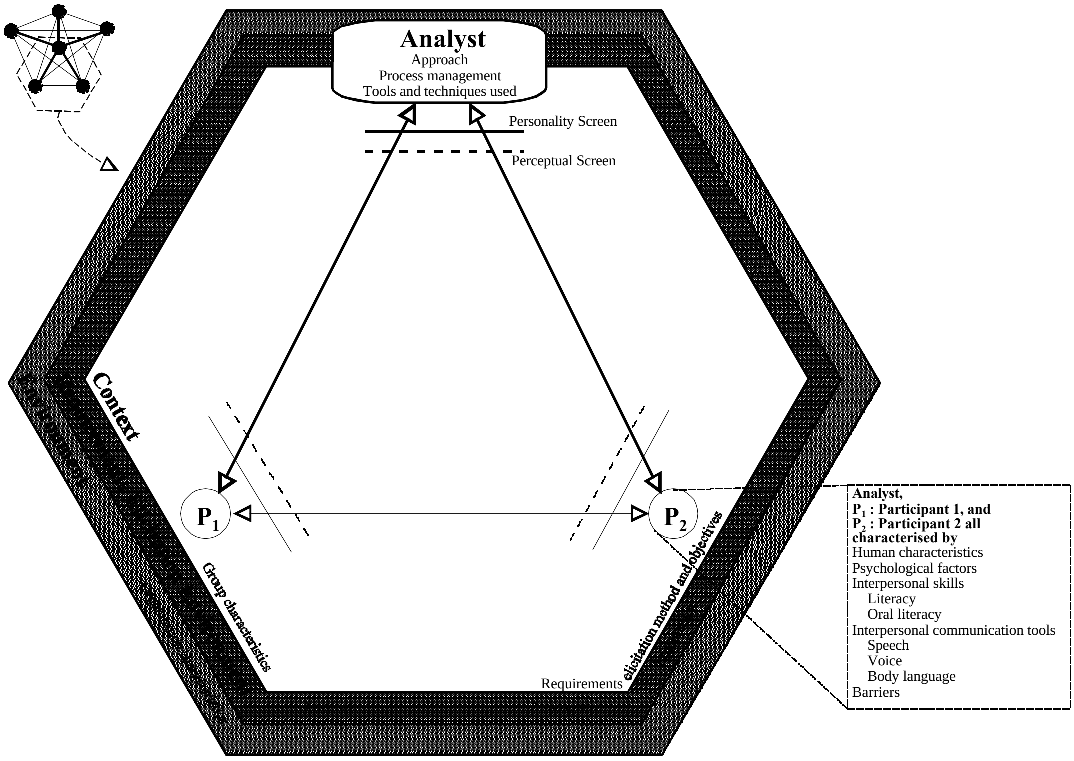


Figure 5.4: Context diagram 5.3

5.2.4 Message and Channel

*Message*s in the form of “a communication, a statement, a basic theme, or significance... a group of characters (letters, numbers, and symbols) or a unit of information; a single transmission of data in one direction” (Weiner, 1996) are sent between participants. Ultimately, the aim of the requirements elicitation process is to formulate messages which represent user requirements, to ensure that all relevant participants have received and understood the message, and to ensure that the messages are then properly documented. Due to the general sentiment found in the empirical study regarding the need to have effective communications during a requirements elicitation process, resulting in unambiguous expressions of the user requirements, stronger emphasis is placed on the message resulting in common understanding among all participants.

Figure 5.5 shows the relationships between the participants and the *message*, the *channel*, and *noise*.

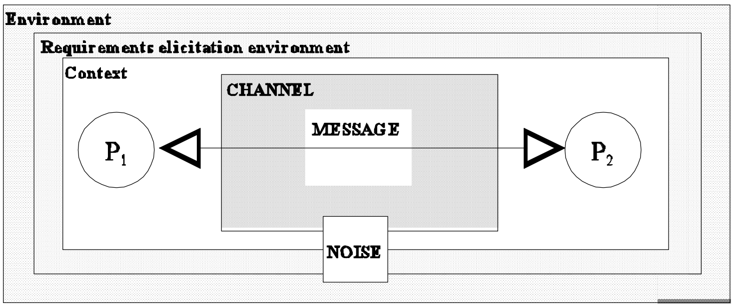


Figure 5.5: Context diagram 5.4

Figure 5.6 shows these same relationships but in the more complicated setting of the three (3) participant communication scenario. As shown in **Figure 5.6**, messages are sent along a *channel* which is characterised by the *medium* of communication. The nature of the medium is either *face-to-face* or *computer mediated*, and includes the communication *techniques* used (for example, *brainstorming*), the *tools* used (for example, *visual aids*), and the *technologies* used (for example, *paper and pen*). The *mode* of communication may be any of the *written*, *verbal* and/or *nonverbal* modes. The channel is affected by *noise* which may be part of the channel itself, or may come from the communication context or environment.

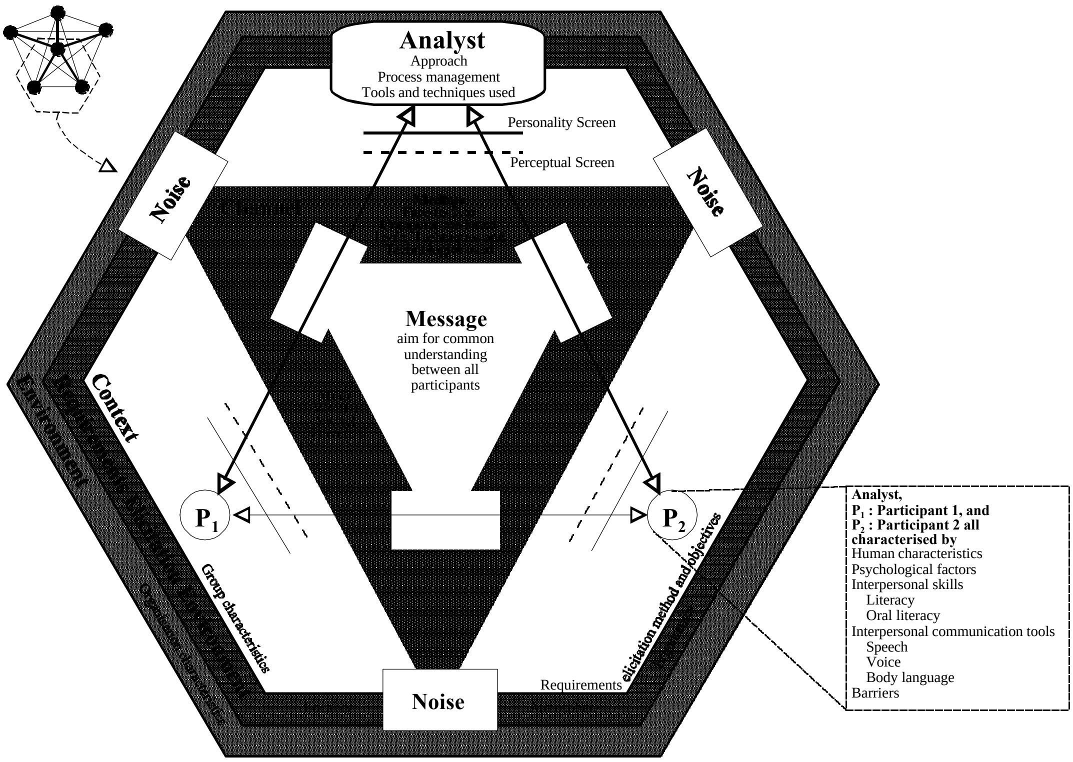


Figure 5.6: Context diagram 5.5

5.2.5 Outcomes

The requirements elicitation process aims to achieve very specific objectives, these are documented in the form of *requirements definition* and *requirements specification* documents. These documents are a record of the communications which have occurred during the requirements elicitation process and should be written in an unambiguous, meaningful manner which can be understood by the participants of the requirements elicitation process and by the system designers. During the process of requirements elicitation, these documents are reviewed by the participants in order to validate the requirements described in them. These documents are also used by designers to produce prototypes which are fed back in to the requirements elicitation process for review by the users. This serves to assist in the requirements validation process. Measurement of requirements elicitation process success is not only based on the accuracy of the documentation resulting from it, but also on the cost effectiveness of the process. Pressure is placed on the requirements elicitation process as a result of time and budgetary constraints (in the modified model, this is shown specifically in order to emphasise the significance of this pressure). There is a constant tension between quality, cost and time. The requirements elicitation process relies on *stakeholder commitment*, *user satisfaction* and ultimately *user acceptance*. Unlike the original model, *user acceptance* is included as a specific outcome. The findings shown in Chapter 4, Section 4.5.5.1 and as discussed in Chapter 4, Section 4.6.13 support this. Arising from the results and discussion relating to requirements elicitation success and interviewee sentiments regarding the concept of geographically distributed requirements elicitation (Chapter 4, Sections 4.5.5.1, 4.5.5.2, 4.6.13 and 4.6.14), the following addition is made to the model: the desired outcomes described above can be achieved in the face of the tension between quality, cost and time by developing *trust*ing relationships between analysts and users. Trust leads to *buy-in* to both the process and the results. *Outcomes* are included in the model shown in the next section.

5.3 Requirements Elicitation Communication Model

The RECM shown in **Figure 5.7** combines all of the factors discussed above. Visually, the model appears to be quite different from the RECM presented in Chapter 3, but this is only as a result of the addition of a third person in the model. It is important to note that with the inclusion of additional participants, the communication process becomes more complex. Increases in complexity occur dramatically with the introduction of additional participants; relationships among participants are direct, and it is these relationships, together with the diverse characteristics of the participants, which result in increased complexity.

Section 5.3 of this chapter is a revised taxonomy of requirements elicitation communication factors. The full taxonomy (in list form) can be found in **Appendix C**.

The revised RECM and the accompanying taxonomy describe the communication process of requirements elicitation.

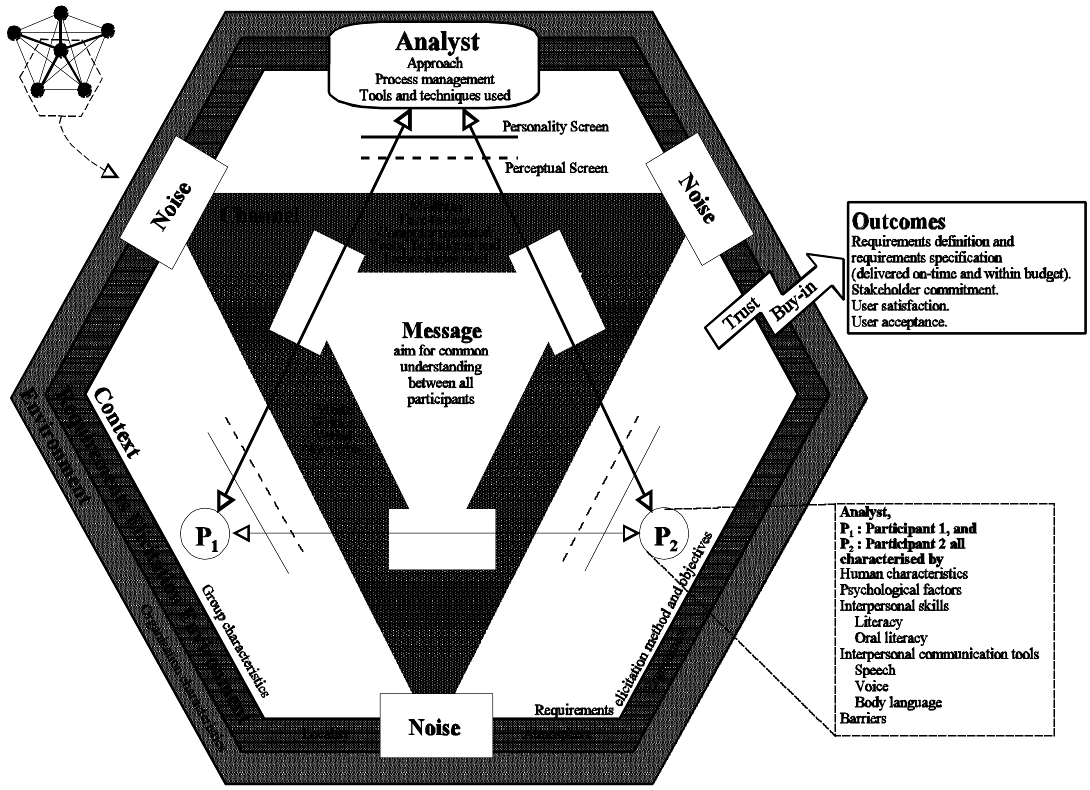


Figure 5.7: Requirements Elicitation Communication Model

5.4 Conclusion

Based on the findings of the empirical study detailed in Chapter 4, this chapter has presented a modified version of the RECM presented in Chapter 3. The modifications are predominantly at the lower levels of detail, but some structural changes are also effected. The modified model is described in detail and this description represents a revised taxonomy of communication in requirements elicitation.

Specifically (and in summary), the circle with leader communication network was modified to show a difference in the relationship between the analyst and other participants, and between other participants. The analyst was represented as a significantly different participant, with specific powers of leadership and facilitation over the requirements elicitation process as a whole. These powers resulted in a direct change in the original RECM where the *interpersonal interaction and communication process* layer was removed and the factors within it shifted to the analyst and to the context layer. The requirements elicitation environment was classified as being distinct from the general environment, thus drawing a distinction between those environmental factors which can be controlled by the requirements elicitation process (or elements within it) and those which cannot. Lastly, greater emphasis was placed on the outcomes of the requirements elicitation process being developed on the basis of user trust resulting in user buy-in before those outcomes could be truly considered as achieved.

The RECM forms an important part of the model of GDRE which is developed in the next chapter.

Chapter 6
GEOGRAPHICALLY DISTRIBUTED REQUIREMENTS ELICITATION

6.1 Introduction

This research has examined the requirements elicitation process in detail. The requirements elicitation communication process is modelled on the basis of an extensive literature survey and an empirical study. Important principles of information systems project management are introduced and discussed in Chapter 2. From a communications perspective, Chapter 3 examines the requirements elicitation process, and draws on the principles of project management in order to build the requirements elicitation communication model (RECM). Chapters 4 and 5 examine, empirically, this model from a South African IT industry perspective and modify the model to reflect this perspective. This section draws on all of this previous work in order to explain the process of requirements elicitation in a distributed environment. This explanation is presented in the form of a *model of geographically distributed requirements elicitation* (GDRE).

The model is built in a step-by-step process with detailed explanations presented where appropriate. Finally, a three-phase model of GDRE is presented. The model reflects the phases of the McLeod *et al* (1996) project life-cycle (PLC), taking into account appropriate principles from Dewdney's (1998) model of project management in a virtual environment. The model also reflects the suggested solutions to the problems associated with globally dispersed software development (GDSD) as discussed in Chapter 2.

Furthermore (and most significantly), the model reflects the RECM in a manner that both expresses GDRE in a manner which supports the appropriate communication processes, and expressly requires the implementation of said model. Within the framework of the RECM, three specific requirements elicitation methods are suggested for implementation in the model of GDRE. Arguments for these suggestions are based on the findings of the empirical study and are motivated as being the methods best suited to eliciting user requirements in a distributed environment.

This chapter concludes *Part II: building a model of geographically distributed requirements elicitation*. *Part III: Investigating technology for the implementation of the model of GDRE* follows.

6.2 A Model of GDRE

6.2.1 The Phases of GDRE

A complex process is more easily explained and understood when its many tasks are grouped into logically related phases. GDRE is divided into three phases: *planning*, *implementation* and *termination*.

Planning is the first phase and consists of activities relating to the preparation and set up of the process. During the planning phase, general project information developed during the project initiation and planning phases is used as input. The major participants in this phase are the analyst (leader), other analysts who will be involved in the implementation phase, the project manager and administrative support staff.

The implementation phase is the requirements elicitation process itself, and includes activities such as virtual team building which are designed to support the requirements elicitation process. The implementation phase largely involves a structured group session approach including representatives from both the IS professional and user groups. As there are likely to be numerous requirements elicitation sessions, the implementation phase will cycle back to the planning phase whenever necessary.

The termination phase marks the end of the requirements elicitation process. Documentation is 'signed-off' and the process is wrapped up. The aim of the termination phase is to ensure that not only are the tasks of requirements elicitation completed, but that the participants are satisfied with the process. The phases fit together as shown in **Figure 6.1**.

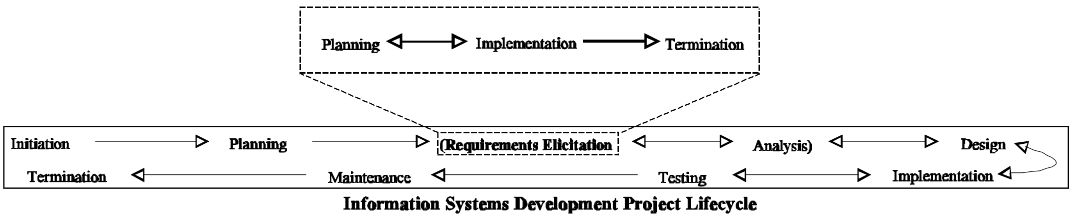


Figure 6.1: Context diagram 6.1

6.2.1.1 Planning

The planning phase is defined and described mainly on the basis of information presented in Chapter 2. Of particular relevance are the discussions relating to project management, and GDSD (specifically the solutions to problems associated with previously studied GDSD projects).

There are numerous activities which need to be performed before the implementation phase can commence. Inputs from the initiation and planning phases of the project as a whole either influence or are used to guide some of the activities of the planning phase. These activities are described in 14 steps and these should all be completed. They are:

Step 1: Establish boundaries and scope

Step 2: Select the requirements elicitation method(s)

Step 3: Identify and customise the activities (tasks)

Step 4:	Select the tools and techniques
Step 5:	Determine the skills needed
Step 6:	Assess the organisation size and complexity
Step 7:	Select the technology to support all predicted formal and informal information flows, configuration management and defect tracking
Step 8:	Estimate effort and durations
Step 9:	Select participants (use interviewing)
Step 10:	Establish participant locality
Step 11:	Schedule participants
Step 12:	Source and schedule other resources
Step 13:	Set up and test a process-centred technological infrastructure
Step 14:	Provide project plans to all participants

These steps are explained as follows:

Step 1: Establish boundaries and scope

Although the boundaries and scope of the project as a whole will have been established during the project planning phase, it is important to re-examine these and to establish the boundaries and scope of the GDRE phase of the project. The analyst should gain an understanding of both the business area in which the problem exists, and the people and technology in that business area. Each GDRE session should be defined in terms of specific objectives. Project complexities should be considered, and major decisions which may face the participants should be determined as likely outcomes of a particular session.

Step2: Select the requirements elicitation method(s)

Although there are many advantages associated with the use of communication technologies, their maturity has not yet developed to the point where complex and intricate informal communication processes can be effectively supported. This is mainly due to the inaccessibility and lack of pervasiveness of the technology. Traditional ad hoc ‘corridor meetings’ cannot take place where participants are not co-located. Even calling an ad-hoc meeting to be facilitated by video-conferencing technology cannot be done without the expenditure of extra effort. Project management issues such as venue and technology booking become obstacles to the communication process. Furthermore, desktop communication technologies (the pervasiveness of which is increasing) do not have the appropriate qualities to facilitate many of the communication aspects of the requirements elicitation process. For example, the camera is usually zoomed to pick up facial features and head movements, thus excluding the transmission of other body language. Or, where the camera is zoomed to include the torso for example, the picture quality and size is too poor for transmission of important facial expressions. Furthermore, the facilitation of interaction and communication processes is particularly complex in a computer-mediated environment. Some technologies have addressed the concepts of turn-taking and mouse-control for example; however, the solutions are not satisfactory for the requirements elicitation communication processes. The choice of communication technologies to support the requirements elicitation process is extremely important. The minimum specifications of the technology are that it is able to facilitate the communication processes described by the RECM (choice of communication technology will be discussed in detail in chapter 7). It is for these reasons that the choice of requirements elicitation methods used in GDRE is to some extent dependent upon the technological constraints. However, the author believes that the technology should not drive the process. The author recognises that there is a trade-off but believes that carefully chosen methods implemented properly will yield excellent results.

Mason *et al* (1987:88) state that, “the correct mix of methods will depend on the exact circumstances and on what the analyst is trying to achieve.” This statement is indeed true; however the author believes that a mix of *interviews*, *structured workshops* and *prototyping* will yield the best results.

The author believes that structured methods will be easier to implement for group sessions. The strict control of communication processes, and the pre-defined tools and techniques used will make their technological implementation much easier. The structured methods include JRP, JAD and RAD. As revealed in the empirical study, in South Africa the formal implementation of JAD is moulded to suit company needs. Workshops are operated on similar principles to JAD; however, they do not adhere strictly to the JAD process in terms of the phases of JAD (August, 1991) and particularly in terms of the tools and techniques used in JAD. Conceptually, JRP is run like JAD but with an emphasis on strategy issues. RAD prescribes the use of JRP, JAD and prototyping. Structured workshops allow the group session approach principles encompassed in JRP and JAD but with flexibility in terms of the process itself (phases) and the tools and techniques used. Thus, for the bulk of the requirements elicitation process, structured workshops (the exact implementation of which is left to the analyst, but should be predefined at least in terms of process, tools and techniques) should be used.

Where group sessions are not appropriate for reasons of confidentiality or participant numbers, interviews are recommended. As compared with questionnaires, although interviews might be more difficult to implement, set-up is significantly less complex. Furthermore, set-up costs are significantly lower and information richness is significantly higher. Interviews can also be conducted using the same technology as that which is put in place for the structured workshops. Interviews can also be used in the participant selection process.

Prototyping can be compared with technical review on the basis of requirements validation. It is compelling to use technical review as opposed to prototyping mainly because the technological implementation is the same as for structured workshops. However, the quality of the results of prototyping is considered to be significantly better. Prototyping is recognised internationally as a highly effective means of both requirements elicitation and requirements validation. In the GDRE environment, the author believes that requirements validation is significantly more important, particularly because the communication environment is unfamiliar and could lead to ambiguity and misunderstandings. In a distributed environment, prototyping could be implemented as an interactive means of testing requirements, and the technological implementation of this scenario is already reasonably mature.

Step 3: Identify and customise the activities (tasks)

The specific objectives identified in step 1 (establish boundaries and scope) should be defined in terms of specific activities which will need to be completed. These activities should be identified and expressed in terms of achievable *actions* (operations) which can be performed given the requirements elicitation method(s) chosen.

Step 4: Select the tools and techniques

Activities are usually completed with the aid of specialised *tools* and techniques. These tools and techniques are selected on the basis of their ability to support the activity given the requirements elicitation method(s) chosen. Tools include, amongst others, visual display tools such as whiteboards, and paper and pens. Techniques include, amongst others, specialised decision making and problem solving techniques.

Step 5: Determine the skills needed

Participants will later be selected on the basis of their skills and knowledge. Participants are likely to change during the implementation process, depending on the objectives of a particular session. The skills needed should be matched with the activities identified and customised in step 3.

Step 6: Assess the organisation size and complexity

As discussed in Chapter 2, the organisation size and complexity has an influence on the requirements elicitation process. The author believes that this influence will be greater in a GDRE environment due mainly to the impact which size and complexity will have on the selection and implementation of the technological infrastructure (discussed in step 7) to support the process. It will also have an influence on participant selection, and on participant locality (discussed in steps 9 and 10).

Step 7: Select the technology to support all predicted formal and informal information flows, configuration management and defect tracking

Selecting the appropriate technology to support the process is the most important aspect of the planning phase and this is discussed in detail in chapter 7. Poor technology selection could result in the failure of the requirements elicitation process. The technology should support all predicted formal and informal information flows, configuration management and defect tracking.

Step 8: Estimate effort and durations

The requirements elicitation process duration estimations should be done within the boundaries of the general project duration estimations. Although there is a high degree of uncertainty associated with requirements elicitation process durations, specialised project management techniques should be used to perform these estimations (see McLeod *et al*, 1996 for details). Estimations will help with both resource scheduling activities and cost management.

Step 9: Select participants (using interviewing)

Participant selection should be done on the basis of the skills required for the completion of an activity, job experience, industry knowledge, knowledge with respect to the business area in which the problem exists, and personal characteristics. Participants may change during or between sessions depending on the objectives of the session and the associated activities. When selecting user representatives, many of these requirements can be ascertained on the basis of a reference from a manager in the business area concerned. However, this may be ineffective given the potential knowledge gap of the manager with regard to the requirements elicitation process. The author believes that in order to select the right users up front, the analyst should perform this task personally. Furthermore, this should be done on a personal basis where there is a direct communication link between analyst and potential participant. Interviewing is thus recommended as the method for performing this selection activity. Interviewing can be done in either a face-to-face or a computer mediated setting (or both depending on the locality of the participants).

Participants may include any of the following types of people: user, analyst, facilitator, manager (all levels), project manager, programmer/developer, secretary, technician, specialist, sponsor, and scribe. For group sessions, it is important that the number of participants is carefully considered. Schermerhorn *et al* (1994) and Wagner *et al* (1995) discuss group size with respect to group effectiveness. Their conclusions are the same: it is difficult to pinpoint the ideal group size, but as a group becomes larger, its effectiveness declines. Schermerhorn *et al* (1994) suggest that a group with five (5) to seven (7) members is ideal. According to August (1991:37) the "best of (JAD) session leaders cannot possibly manage more than 15 participants effectively."

According to Schermerhorn *et al* (1994), although the resources available increase with an increase in group size, the communication/coordination requirements also increase. Complexity in a communication scenario increases with additional participants, and it is usually the number of participants involved in a communication scenario which determines the communication method adopted. For example, for small groups of participants (two [2] to seven [7]) an informal meeting may be effective. As the group size increases, the formality of the meeting increases. This is due to the need for control of the communication processes in the meeting. There is thus a pressure (based on participant numbers) placed on the requirements elicitation method chosen. It may be necessary at this stage to revisit the decision taken in step 2 regarding the choice of requirements elicitation method.

Step 10: Establish participant locality

The locality of the participants will be determined by the normal workplace of the participant, or the workplace of the participant during the scheduled period for the project in question. GDRE will enable participants to be located at their normal workplace, or at the workplace of another project (depending on their circumstances). The locality will introduce possible complications such as time zone differences, and technological infrastructure availability.

Step 11: Schedule participants

With a knowledge of the participants and their locality, specific requirements elicitation activities should be scheduled. Where participants exist in different time zones, this activity becomes more complicated. However, depending on the nature of the project, as explained by Gorton *et al* (1996:652) this factor can be used as an advantage to the process. Time zone differences may allow different teams to work on different aspects of the project on a "24-hour" basis.

Step 12: Source and schedule other resources

Resources such as money, materials, equipment, technology and information should be sourced and scheduled to enter the process at appropriate times. Certain resources may need to be purchased or leased. Resource availability may influence the GDRE schedule (for example, if necessary technology already owned by the organisation is not available for a specified time period). However, due to the complexity of scheduling participants for GDRE, it may be advisable to purchase or lease additional resources.

Step 13: Set up and test a process-centred technological infrastructure

As discussed in Chapter 2, Section 2.4, a process-centred environment must support *activities* (executed by people or tools assuming *roles*) made up of *actions*, and consuming *resources* in order to produce a *product*. GDRE adopts a process-centred approach to task completion and thus calls for a technological infrastructure to support this. The technology should be set up and tested, ensuring that this approach is appropriately supported.

Step 14: Provide project plans to all participants

Participants should be informed of the project plan. Important and relevant details regarding schedules, venues and technology infrastructure should be provided. This will allow participants to prepare adequately for their involvement in the implementation phase.

Extremely large systems development projects

Steps 1 to 14 apply specifically to systems development projects which can (and will) be completed by one project team (although the team members may change). It is possible for extremely large systems development projects to be completed by more than one project team. This may involve setting up more than one team to complete the requirements elicitation process. In this event, the author suggests approaching the project from a project management perspective as discussed by Dewdney (1998) and as represented in **Figure 2.3**. There are, however, three significant steps which should be taken when planning for a multi-team requirements elicitation process:

- Significantly disparate product features should be identified. Different teams could then be tasked with defining the requirements for those disparate features.
- Cross-functional teams with an appropriate mix of skills (as discussed above) should be set up.
- A group collaboration environment should be set up. Not only should the collaboration technology be set up as described in step13, but different teams should be able to collaborate where necessary. This might involve the adoption of additional technological infrastructures.

6.2.1.2 Implementation

The implementation phase is defined by the primary objective of requirements elicitation, to investigate, to elicit and to define user requirements. There are no specific steps to follow during this phase, however, there are some principles which are defined. These principles are founded upon the plans made during the planning phase, with a specific focus on achieving the objectives of GDRE taking into account the reliance on communications technology.

6.2.1.2.1 Adopt a process-centred approach to task completion

As discussed in Chapter 2, Section 2.4, Doppke *et al* (1998) suggest adopting a process-centred technological environment to support software process modelling and execution within virtual environments. As shown in **Figure 6.2**, this approach can be described as follows: *resources* are allocated to *activities* (tasks) which may consist of *sub-activities*. Activities are carried out by *agents* (humans/machines) which are cast in *roles* and use *tools* to perform *actions* (operations), many of which constitute *transactions*. Transactions are performed to produce *artifacts* (which are made up of *sub-artifacts*) which collectively constitute the end *product* (which is made up of *sub-products*).

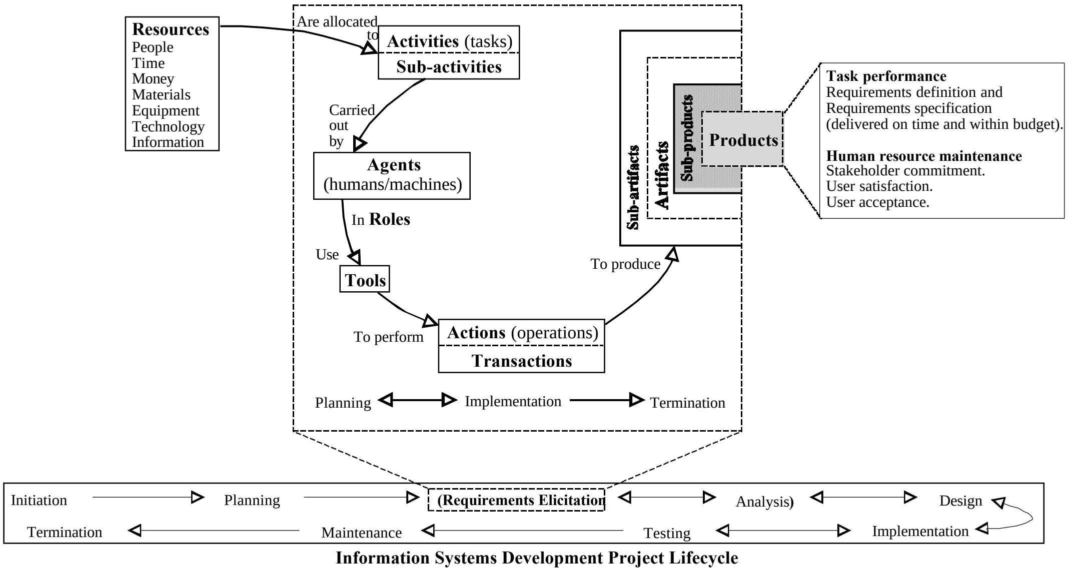


Figure 6.2: Context diagram 6.2

Many of these terms have already been introduced during the discussion of the planning phase. The author believes that the logic of Doppke *et al* (1998) of software process modelling requiring a process-centred technological infrastructure for implementation in a virtual environment can be applied to requirements elicitation. Consequently, requirements elicitation (in the traditional sense) can be described as process-centred. In order to facilitate the selection of technological infrastructures to facilitate the process, it is particularly convenient to view GDRE specifically as a process-centred process.

Resources include people, time, money, materials, equipment, technology and information. All of these have been discussed to some extent thus far. Information, however, requires specific discussion at this point. Information as referred to in this instance includes information specifically held by the participants in the process, and which is particularly relevant to the requirements definition. Users, for example, are included in the process as it is believed that they have the potential to elicit information gathered by them as a result of their experience in the job and in the industry. Analysts, however, may also acquire information that is specifically relevant to the requirements definition through the methods of document review and observation. These methods may be used if necessary as a means of gathering information. However, for the purposes of GDRE, their results should be seen only as information in-put into the process.

Activities (tasks), once completed, will result in the achievement of objectives which in themselves may be a tangible product. For example, where an objective is requirements definition, the activities may include (amongst others) defining the problem in terms of the general business area in which it exists, and expressing the problem by way of a pre-defined modelling technique. These activities may have *sub-activities*, the collective completion of which will constitute the completion of the activity as a whole.

Activities are carried out by *agents (humans/machines)* which have been chosen as a result of steps 7 and 10 of the planning phase. The agents (humans) fulfill *roles* which include: user, analyst, facilitator, programmer/developer, secretary, technician, project manager, specialist, sponsor, scribe, manager, CEO and devil's advocate. The agents (machines) fulfill roles which include (amongst others): communication enabler, requirements modeller and project scheduler.

The agents use *tools* (as discussed in step 4 of the planning phase) to assist in performing *actions (operations)*. Actions, for example, may be the drawing of a model on a whiteboard. A number of actions constitute *transactions* which can be described (using this example) as communication processes between participants (as described by the RECM).

These transactions produce *sub-artifacts* (a model), a collection of which constitute an *artifact* (a collection of models which are prescribed by a methodology (such as Information Engineering)).

A collection of artifacts constitute a *sub-product* (for example, the expression of the problem by way of a pre-defined modelling technique) a collection of which constitute a *product* (for example, the requirements definition).

Schermerhorn *et al* (1994:275-298) explain that an effective group is one that achieves high levels of both *task performance* and *human resource maintenance* over time. In respect of task performance, an effective group achieves its performance goals in terms of time taken, cost and quality. With respect to human resource maintenance, an effective group is one whose members are sufficiently satisfied with their tasks, accomplishments, and interpersonal relationships such that they would be prepared to work together on an on-going basis. Schermerhorn *et al* (1994) and Wagner *et al* (1995) elaborate on these concepts. GDRE is essentially a group process and thus this philosophy for effective groups is applicable. The product of the process-centred approach to GDRE is thus explained in these terms.

Task performance includes *requirements definition* and *requirements specification, delivered on time and within budget*. Human resource maintenance includes stakeholder commitment, user satisfaction and user acceptance. These sub-products are collectively achieved once the planning, implementation and termination phases of GDRE have been completed.

6.2.1.2.2 Implement the *requirements elicitation communication model*

GDRE relies on communication as a means of achieving its objectives. The principles encapsulated by the RECM should be implemented as a means of maximising the effectiveness of the GDRE process. The model relies on the effective completion of the planning phase. Furthermore, it reflects the process-centred approach to task completion, where agents (participants) fulfil roles and use tools to complete communication transactions (see **Figure 6.3**) with the purpose of producing outcomes (which are reflected as the products as discussed above).

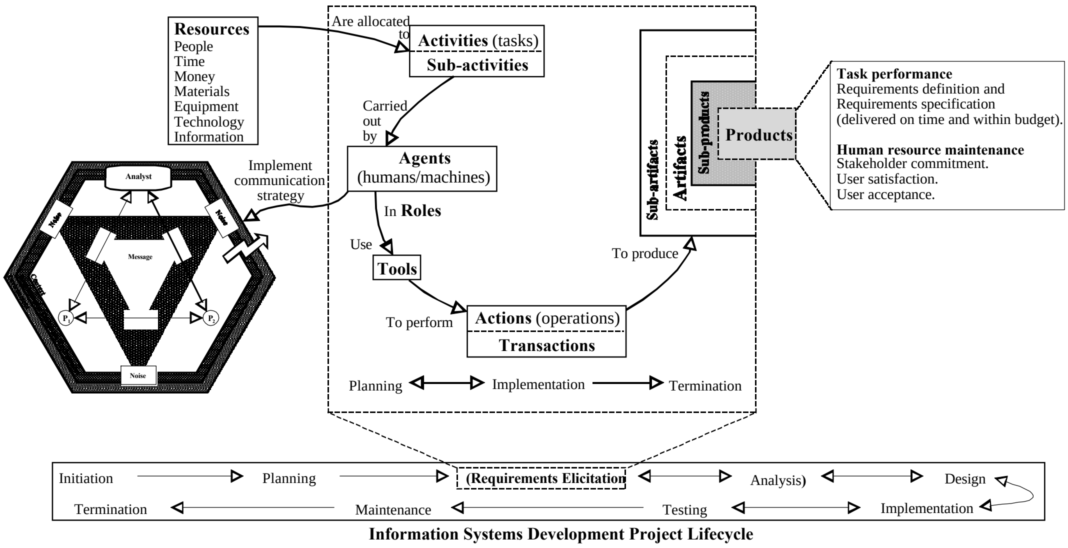


Figure 6.3: Context diagram 6.3

6.2.1.2.3 Implement human resources management strategies designed for distributed working environments

Achieving the human resource maintenance objectives in GDRE is significantly more complex than achieving them in a traditional requirements elicitation environment. This is predominantly due to the environment being foreign to participants in terms of its communication and interpersonal interaction factors. Numerous studies have been done on teams, teamwork and team building, and with the advent of collaboration technologies these studies have extended into the area of distributed (or virtual) teams. Notable are the works of Carmel (1999b), Cantu (1998), Chidambaram and Jones (1993), Dix, Finlay, Abowd and Beale (1998), George, Easton, Nunamaker and Northcraft (1990), Gould (1998), Hebeler (1995), Kimball (numerous studies), Kostner (1996), McLaughlin (1996), Metes (1997), Ocker, Hiltz, Turoff and Fjermerstad (1996), Siegel, Dubrovsky, Kiesler and McGuire (1986), Valacich, Wheeler, Mennecke and Wachter (1995), and Yoo (1998). These authors have explored a wide range of team related aspects, underlining the complexity and importance of the issues involved. No matter what environment (direct or indirect) a team is operating in, the team-related human aspects of communication and interaction remain, and must be attended to.

Harpur (1998)[7], in a study entitled *An Integrated Model of Non-Verbal Facilitation in Virtual Joint Application Development,* examined communication in JAD, and in particular the communication aspects of JAD facilitation. Principles of facilitation were then contextualised in a virtual environment and were adapted for practical implementation in this environment.

Stead (1998)[8], in a study entitled *Maintaining Effective Group Dynamics in Virtual Joint Application Development,* developed a model of virtual team building. This model provides a framework of team building in a distributed environment and includes a discussion on the practical implementation of the framework with example team building exercises.

Aristotelous (1999)[9], in a study entitled *Towards a Model for Maintaining Social Satisfaction in a Virtual Systems Development Team,* explains that as social beings, humans have social needs which must be met in order for them to be motivated towards

[7, 8, 9] Information Systems Honours research project supervised by Nicholas Vat.

accomplishing their goals. In a distributed environment, social needs can be met using the *model for maintaining social satisfaction in virtual systems development teams*. The most significant contribution of Aristotelous (1999) is that virtual teams should operate in both face-to-face and computer-mediated settings at different times and depending on the needs of the team. Aristotelous (1999:98) specifically suggests a ‘first face-to-face meeting’ with the aim of laying ‘the foundation for trust and friendships.’ Thereafter, ‘milestone face-to-face meetings’ should be woven with ‘computer mediated communication’ for the purposes of meeting human resource needs and specific task completion.

6.2.1.2.4 Manage the technological infrastructure

As GDRE relies heavily on the technological infrastructure which supports it, this infrastructure should be managed. Management activities include ensuring that the infrastructure is available at the right times, that it remains stable, and that it is indeed adequately supporting the communication and interaction scenarios relevant to the successful completion of the requirements elicitation process. These management activities will require the technical expertise of a network manager as well as an expert in the use of the specific communication technologies chosen. This is discussed in more detail in Chapter 7.

Extremely large systems development projects

For extremely large systems development projects (as discussed previously) there are three additional principles which should be applied during the implementation phase:

- Group collaboration should be encouraged. Although teams would be working on significantly disparate aspects of the project, it would still be necessary for them to collaborate on issues of linkage between systems, and on requirements specification techniques. The different requirements specification documents would need to be drawn together at some point in the SRS and adherence to specific standards or forms would make this document more meaningful and more accurate.

- Consensus decision making should be encouraged. Reaching consensus during the requirements elicitation process is the preferred means of decision-making. This should be encouraged in GDRE as consensus increases the chances of achieving the human resource maintenance objectives.
- Requirements documents with all teams should be formally inspected. In order to ensure the integrity and validity of the requirements definition, all requirements documents should be inspected by the analyst (leader). The analyst should look for inconsistency, duplication or repetition, ambiguity and adherence to the agreed standards.

6.2.1.3 Termination

The termination phase signals the end of the GDRE process. Three important objectives should be met during this phase: i) to learn from the experience; ii) to sign off the documentation; and iii) to disband the group(s). These objectives can be achieved through the application of the following 6 step process:

Step 1: Report

Step 2: Evaluate the process

Step 3: With a view to using the knowledge in future projects, review what has been learnt

Step 4: Celebrate a job well done

Step 5: Sign off the documentation

Step 6: Re-allocate resources to other projects, or other phases of the current project

These steps are explained as follows:

Step 1: Report

McLeod *et al* (1996:136, 219) emphasise the importance of reporting. Appropriate people should be identified and presented with a report of the project progress. These people are usually those not directly involved in the day-to-day activities of the requirements elicitation process and may require different information at different intervals. *Some reporting may be required during the implementation phase of GDRE.*

Step 2: Evaluate the process

The process should be evaluated in terms of the achievement of the objectives of task performance and human resource maintenance. A formal evaluation should be scheduled as part of the GDRE process and preferably in the form of a group session.

Step 3: With a view to using the knowledge in future projects, review what has been learnt

The results of evaluation should feed into a discussion regarding the future implementation of projects in a similar environment. This should be documented, and will ensure that the knowledge acquired in the project will not be lost, and previous mistakes or problems will not be re-encountered.

Step 4: Celebrate a job well done

MacLachlan (1996:6) suggests that a celebration is an important part of project termination. The current author believes that this is a particularly important aspect of GDRE and should be conducted in a face-to-face setting.

Step 5: Sign off the documentation

As with any requirements elicitation process, the requirements documentation often represents a legal document which is binding to both user and developer organisations.

Step 6: Reallocate resources to other projects, or other phases of the current project
Resource management ends once the resources have been reallocated to other projects, or to other phases of the current project. This step signals the absolute end to the GDRE process.

6.2.2 Summary of the *model of GDRE*

The model of GDRE is summarised in **Table 6.1**. This representation shows the three phases of GDRE, and includes all the steps and the principles discussed above.

Table 6.1: Model of Geographically Distributed Requirements Elicitation

Geographically Distributed Requirements Elicitation		
Planning ø	**Implementation** ÷	**Termination**
1. Establish boundaries and scope. 2. Select the requirements elicitation method(s); choose from interviews, structured workshops, and prototyping. 3. Identify and customise the activities (tasks). 4. Select the tools and techniques. 5. Determine the skills needed. 6. Assess the organisation size and complexity. 7. Select the technology to support all predicted formal and informal information flows, configuration management and defect tracking. 8. Estimate effort and durations. 9. Select participants (using interviewing). 10. Establish participant locality. 11. Schedule participants. 12. Source and schedule other resources. 13. Set up and test a process-centred technological infrastructure. 14. Provide project plans to all participants.	• Adopt a process-centred approach to task completion. • Implement the *requirements elicitation communication model*. • Implement human resources management strategies designed for distributed working environments. • Manage the technological infrastructure.	1. Report. 2. Evaluate the process. 3. With a view to using the knowledge in future projects, review what has been learnt. 4. Celebrate a job well done. 5. Sign off the documentation. 6. Reallocate resources to other projects, or other phases of the current project.
In addition, for extremely large systems development projects: • Identify significantly disparate product features. • Setup cross-functional teams. • Setup a group collaboration environment.	In addition, for extremely large systems development projects: • Encourage group collaboration. • Encourage consensus decision making. • Formally inspect all requirements documents with all teams.	

6.3 Conclusion

This chapter proposes a model of GDRE which reflects the RECM presented in the previous chapter, and the solutions to and control measures for the project management issues presented in Chapter 2. Briefly, these issues relate to the planning, scheduling, leading and controlling of people and other resources involved in the process, as well as the required quality of the results of the process and the commitment of the users to those results. The model also takes account of the concepts of distributed communication and experiences presented in the literature to date regarding globally dispersed software development projects. The model of GDRE is presented as a 3-phase model describing the *initiation*, *implementation* and *termination* of the process of requirements elicitation carried out in a distributed environment.

The model reflects the phases of the McLeod *et al* (1996) project life-cycle (PLC), taking into account appropriate principles from Dewdney's (1998) model of project management in a virtual environment. Initiation, feasibility study, planning, task execution (specified by the requirements elicitation method[s] used), reporting and termination are all viewed to some extent in the realm of distributed communication, distributed work groups and the associated complexities.

The model also reflects the suggested solutions to the problems associated with globally dispersed software development (GDSD) as discussed in Chapter 2. The most significant reflection is the adoption of a process-centred approach to GDRE.

Furthermore (and most significantly), the model reflects the RECM in a manner which both expresses GDRE in a manner which supports the appropriate communication processes, and expressly requires the implementation of said model. Within the framework of the RECM, interviews, structured workshops and prototyping are specifically suggested as requirements elicitation methods for implementation in the model of GDRE. Arguments for these suggestions are based on the findings of the empirical study and are motivated as those methods best suited to eliciting user requirements in a distributed environment: *interviews* for private, one-to-one communications; *structured workshops* for controlled group sessions; and *prototyping* for requirements validation.

This chapter concludes *Part II: building a model of geographically distributed requirements elicitation*. *Part III: Investigating technology for the implementation of the model of GDRE* follows. Chapter 7 investigates the subject of communication technology, identifying and defining specific communication technologies and communication technology classification schemes, and it examines methods for the evaluation of those communication technologies.

PART III

INVESTIGATING TECHNOLOGY FOR THE IMPLEMENTATION OF THE MODEL OF GDRE

The aim of Part III is to define a framework for the selection of technology which will facilitate the implementation of the model of GDRE. Literature regarding existing communication technologies is explored. Specific types of communication technologies are examined, and technology classification schemes are presented. Methods for evaluating specific technologies are then examined. The model of GDRE is revisited, with the specific intention of identifying the communication processes *per se* and the GDRE process support functions which the technology will need to facilitate. Issues relating to managing the technology in the GDRE process are discussed, and a framework for evaluating the impact of the technology on GDRE group processes and a model for evaluating the costs of GDRE are presented.

Chapter 7
COMMUNICATION TECHNOLOGY

7.1 Introduction

Part II culminated in the development of a model of geographically distributed requirements elicitation. The implementation of this model is dependent upon the technology which is employed to support it. This chapter investigates the subject of communication technology.

With a view to aiding the process of designing an appropriate technological infrastructure to support GDRE, the concept of *groupware* is explored in detail. Specific communication technologies are identified and defined, and communication technology classification schemes are investigated. This is followed by an examination of methods for the evaluation of those communication technologies. Specifically, the *Denver Model for Groupware Design*, the *Arizona Groupware Grid*, the *Collaborative Framework*, the *EWG/IVC Services Taxonomy* and a conceptual framework for studying the impact of technology on groups are examined.

The following chapter investigates issues relating to the management of the technology, the impact of the technology on the GDRE processes, and the cost of implementing the technology.

7.2 Groupware

7.2.1 What is groupware?

The term 'groupware' was coined by Peter and Trudy Johnson-Lenz in 1978. They defined it as a system "of intentional group processes plus supporting software." Groupware has been defined in a variety of different ways, but the most commonly used (besides that of Johnson-Lenz), and those definitions offered by industry leaders are (as cited in Coleman (1997a:2)): "A co-evolving human-tool system" (Doug Englebart, 1988), "Computer-mediated collaboration that increases the productivity or functionality of person-to-person processes" (David Coleman, 1992).

Coleman (1997a:1) explains that "groupware supports the efforts of teams and other paradigms that require people to work together, even though they may not actually be together, in either time or space." Furthermore, groupware should do this with minimum interference. Supporting Coleman's definition, Nunamaker *et al* (1995:3) state that groupware is "any technology specifically used to make groups more productive." Coleman (1997a:15) and Nunamaker *et al* (1995:3) suggest that groupware offers the following advantages (this is a selected list relevant to requirements elicitation): i) better cost control, ii) better information access, iii) improved communication, iv) structured and focussed problem solving, v) aligning personal and group goals, vi) increased productivity, vii) better customer service, viii) fewer meetings, ix) integration of geographically disparate teams, x) increased competitiveness through faster time to market, xi) better coordination globally, and xii) leveraging professional expertise. In summary, groupware uses technology to provide solutions to business processes (in this case, requirements elicitation).

The Denver Model for Groupware Design (Salvador, Scholtz and Larson, 1996) as shown in **Figure 7.1** provides further insights into groupware and its capabilities. The particular relevance of this model to this project is the *Design* (sub)*Model* which describes the actual functional design of the system, with particular reference to the people, artifacts, tasks and activities, interactive situations, and interactive social protocols which the groupware technology will support.

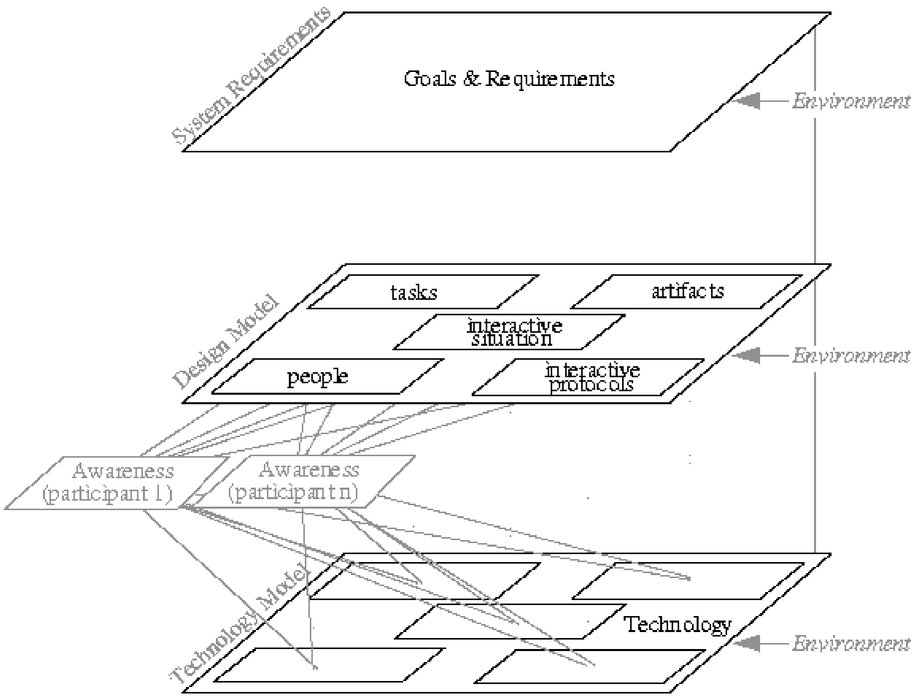


Figure 7.1: The Denver Model for Groupware Design

- *People:* for example, names, appearance, voice, addresses, phone numbers, primary language, signature, culture, business, interests.
- *Artifacts:* objects produced or consumed during the interaction, for example, text, sound, temporal image, static image and computational elements.
- *Tasks (and activities):* representing four levels: i) goals refer to the high-level work goals that guide all behaviours in the workplace and to a large extent can determine culture and specific characteristics of products that might work well in that environment; ii) tasks represent the high level representation of the type of work that occurs in that environment; iii) activities represent the basic communication interaction units, which in combination will accomplish a task, for example; monitoring, orchestrating, gathering information and resources, generating ideas, evaluating ideas/information, organising ideas/information, share/teach ideas/information, discuss and come to agreement, plan a project, and

produce a project; and iv) operations are the basic interface manipulation unit to manipulate audio, video and data during the communication act.

- *Interactive situations:* the relationship of participants to themselves, time and space.
- *Interactive (social) protocols:* the allowable sequence of exchanges of signals and information that determine and identify resolutions and conflicts.

There are specific types of groupware which have been developed, and which attempt, in some way, to account for the requirements as identified in the Denver Model for Groupware. Coleman (1997a:2-9) developed a taxonomy of groupware (as shown in **Appendix D**) which has been combined here in **Table 7.1** with work presented by Nunamaker *et al* (1995:3) and by Ramarapu, Simkin and Raisinghani (1999:159) (adapted from Johansen (1989:1-31)).

Table 7.1: Groupware technologies

FUNCTIONAL CATEGORY and DESCRIPTION	Coleman	Nunamaker	Ramarapu
Collaborative - Internet-based Applications and Products: use the Internet as the input and output while still using traditional groupware on the LAN.	T		
Comprehensive Support Systems: this is a move towards putting users "inside" their computing environments.			T
Computer Supported Collaborative Work (CSCW): systems that are essentially cooperative in the sense that they are team based. A cooperative system is "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." (Ramage, 1997)		T	
Conversational Structuring: develops a structure for team conversations that is similar to the task and style of the team participants themselves.			T
Desktop Video and Real-time Data Conferencing (Synchronous) / Group Conferencing / Video Conferencing: emphasis on real time, plus store documents and/or allow others to see and work on the same document simultaneously, whether on each others' screens or on a shared whiteboard.	T	T	T

FUNCTIONAL CATEGORY and DESCRIPTION	Coleman	Nunamaker	Ramarapu
Electronic Voting: usually a feature of a GSS; allows participants to place an electronic vote regarding a particular issue.		T	
Electronic Meeting Systems (EMS): real-time conferencing systems (local and remote) as well as collaborative presentation systems).	T	T	T
Electronic Mail and Messaging: includes messaging infrastructures and e-mail systems.	T	T	T
Electronic Brainstorming: usually a feature of a GSS; allows participants to electronically submit ideas into a pool of ideas.		T	
Facilitation Services: electronic support for the facilitator which supports the activities of a work team.			T
Group Calendaring and Scheduling: products for calendar, meeting, and resource coordination.	T	T	
Group Document Handling: group editing, shared screen editing work, group document/image management and document databases.	T	T	
Group Development Tools: according to Dr. Robert Briggs (pers. comm., 21 September 1999) there are two classes of group development tools: i) those used by groups to do development, and ii) those used to develop group tools. In the first class would be tools like CoReview and Activity Modeler, both developed by university of Arizona to be used by groups to support the development of software. CoReview allows a team of programmers to review and comment on computer code, to flag and discuss errors, etc. The programmers may work synchronously or asynchronously, they may work face-to-face or distributed. Activity Modeler allows a team to work together to define existing and future business processes. It is used for requirements definition. In the second class would be the Lotus Notes programming language, which lets a programmer develop a collaborative application.		T	
Groupware Applications: vertical applications that use collaborative technologies to either enhance processes or support collaboration in a specific work environment.	T	T	
Groupware Frameworks / Group Support Systems (GSS) / Group Decision Support Systems (GDSS): focuses on products that help integrate “islands of collaboration” to realise seamless integration across computer platforms, operating systems, e-mail systems, and network architectures.	T	T	T
Groupware Services/ Coordination Software / Group Memory / Team Database: services to support collaboration.	T	T	T

FUNCTIONAL CATEGORY and DESCRIPTION	Coleman	Nunamaker	Ramarapu
Non Real-time Data Conferencing / Electronic Conferencing (Asynchronous): like a bulletin board, where a conversation takes place over time; messages are left and answered later. Messages may be public or private.	T	T	
On-line resources: ability of computer programs to function, in some sense, as team "members" (a concept that relies heavily on artificial intelligence).			T
Presentation Support Software: even if the meetings have no electronic aids, software can make the process of preparing presentations much easier.			T
Project Management: project scheduling tools which communicate information about, tasks, resources, time and project finances.		T	T
Shared Drawing: electronic whiteboards which allow concurrent drawing.		T	
Spontaneous Interaction: allows "drop-in" encounters over electronic media, much like what currently happens in hallways or around coffee pots.			T
Text Filtering: the team uses the filter to search out information and people that will help move its task forward. Person-to-person messages are also filtered to insulate the team members from low-priority interruptions.			T
Workflow: workflow process diagramming and analysis tools, workflow enactment engines, electronic forms routing products.	T	T	
Workgroup Utilities and Development Tools: utilities to support, group working, remote access to someone else's computer, and specific tools for workgroup application development.	T		

7.2.2 How is groupware classified?

Groupware itself can be classified into different groups. DeSanctis and Gallupe (1987) developed the time/space categorisation shown in **Table 7.2**. The matrix is divided according to the time and space of users using the technology. Groupware is then classified as either *co-located* or *remote*, where the interaction is between users who are either in the same place or in different places respectively. The temporal subdivision describes the groupware as either *synchronous* or *asynchronous*, where the interaction occurs either in real-time or at different times respectively.

Table 7.2: Time/space matrix

	co-located	remote
synchronous	face-to-face interaction (face-to-face meetings)	synchronous distributed interaction (telephone, audio-conferencing, video-conferencing)
asynchronous	asynchronous interaction (planing/operations rooms, post-it notes)	asynchronous distributed interaction (fax, voice mail, e-mail, computer conferencing, newsgroups, web)

This model has proven to be inadequate for classifying technology such as a shared whiteboard, where the whiteboard is shared between two different locations. Designed for many people to write on at the same time in a different place, a participant could write on the board, but not be sure of exactly when the person(s) at another location will see what is being drawn. As a result a modified time/space matrix was developed (**Table 7.3**).

Table 7.3: Modified time/space matrix

<table>
<tr><th></th><th>co-located</th><th>remote</th></tr>
<tr><td rowspan="2">concurrent synchronised</td><td>meeting rooms</td><td>video conferences</td></tr>
<tr><td colspan="2">shared work surfaces and editors</td></tr>
<tr><td>mixed</td><td colspan="2">co-authoring systems, shared calendars</td></tr>
<tr><td>serial</td><td colspan="2">argumentation tools</td></tr>
<tr><td>unsynchronised</td><td colspan="2">e-mail, electronic conferences</td></tr>
</table>

A further variant of the DeSanctis and Gallupe (1987) model attempts to explain the categories of groupware in even greater detail (**Table 7.4**).

Table 7.4: A 3x3 matrix of groupware options

		time		
		same	different but predictable	different and unpredictable
place	same	meeting facilitation	work shifts	team rooms
	different but predictable	teleconferencing video-conferencing desktop	electronic mail	cooperative writing
	different and unpredictable	interactive multicast seminars	computer bulletin boards	workflow

The space/time dependence classification as shown in **Table 7.5** (Ramarapu *et al*, 1999:164) bears many similarities to the classifications shown previously, but there is a particular focus on *attending meetings* and *sending messages*.

Table 7.5: Space/time dependence

	space/time dependance		
	space and time dependent	time dependent	space and time independent
attending meetings	face-to-face meetings, video conferencing	audio conferencing, real-time electronic conferencing	computer conferencing
sending messages		telephone chatting	FAX, e-mail, voice-mail

Dix (1994) developed a *framework for CSCW artifacts* (as described in the Denver Model for Groupware Design) which provides further insights into the classification of groupware (see **Figure 7.2**). The people/artifact framework shows two participants (P), the artifact (A) and the interactions between them.

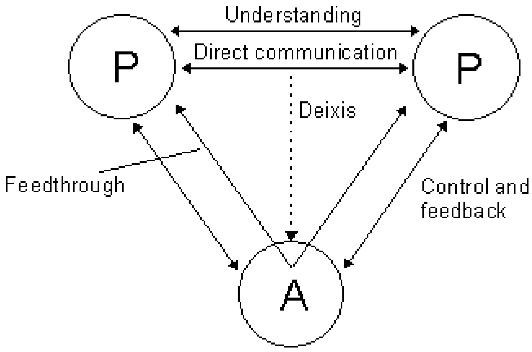


Figure 7.2: People/artifact framework (Dix, 1994)

Participants must be able to communicate with one another at all times. Direct lines of communication between participants indicate this direct communication, and these are supported by *computer-mediated communication* (e-mail, bulletin boards, structured messaging systems, video conferences). Where the purpose of the communication is not simply to transfer information, but also to deliver understanding, the groupware supporting this is known as *meeting* and *decision support systems* (argumentation tools, meeting rooms, shared work surfaces). Where communication between participants occurs via an artifact, the type of groupware is known as *shared applications* and *artifacts* (shared PC's, shared editors, co-authoring systems, shared diaries).

Dyson (1990) explains that groupware can be classified in terms of its locus of control or its 'centre', and describes three (3) classifications: i) user-centred, where the system (which is built by the user) sees the user as the 'centre', and everything else as the outside world; ii) work (or object)-centred, where the work itself is seen as the 'centre', and the system 'follows the work around'; and iii) process-centred, which ensures that the work is completed, "treating it as a complex, possibly nested transaction".

Whitehead (1999) classified groupware in terms of its contribution to the user. The *contributional classification* answers the question, "How does the groupware enhance human capabilities?" The pyramid layout (as shown in **Figure 7.3**) is based on work presented by Briggs in 'Getting a Grip on Groupware'.

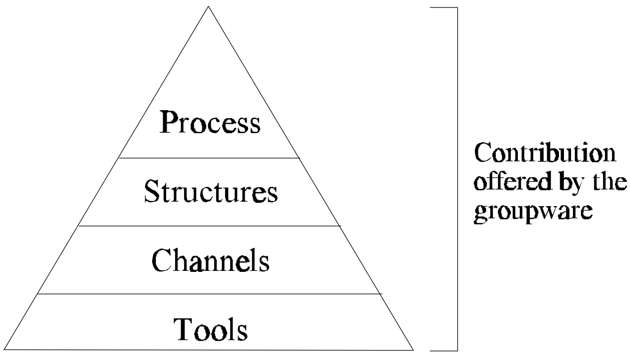


Figure 7.3: Contributional classification of groupware

There are four (4) levels of technology which are described as follows:

- *Tools*: this type of technology merely provides assistance to its users. It augments human information handling abilities (for example, shared documents).
- *Channels*: allow transfer of information between users (for example, e-mail and database access).
- *Structures*: have the ability to add additional meaning or information. They arrange information differently (for example, text conferencing, outlining tools).
- *Process*: allows decision making and dissemination of roles and activities (for example, GSS).

There are other classification schemes which aim to categorise commercial products by the way in which they are used, and how they achieve solutions to business problems (for example, the Arizona Groupware Grid (which is discussed in section 7.4.1.2 below)).

Finally, with a view to ensuring a full understanding of groupware and its place within the organisation setting, Coleman (1997a) has classified groupware within the IT architecture (as shown in **Table 7.6**). Within the general IT architecture of an organisation, groupware lies on a network infrastructure and interfaces with many different types of application within an organisation.

Table 7.6: Groupware within the IT architecture (Coleman, 1997:20)

<table>
<tr><td rowspan="4">Database or infobase
Object repository or knowledge base
Document and image repository</td><td colspan="4">ENTERPRISE-WARE
Cross-vendor support Standards
Integrated Networks Local/remote servers
Executive Information Systems</td></tr>
<tr><td colspan="4">GROUPWARE
Group decision support systems Desktop video and audio conferencing
Group application development environment Workflow</td></tr>
<tr><td>Group-enabled applications</td><td colspan="2">E-mail/messaging</td><td>Calendaring/scheduling</td></tr>
<tr><td colspan="2">Personal productivity application</td><td colspan="2">Network operating systems</td></tr>
<tr><td colspan="5">Operating systems</td></tr>
<tr><td colspan="5">Hardware infrastructure: cables, multiplexers, modems, ATM, Frame relay, ISDN</td></tr>
</table>

7.3 Other Communication Technologies

There are numerous other technologies which are used to support communication processes, and which are not listed in the groupware taxonomy. These technologies have been identified by the author and are presented in **Table 7.7** below.

There are many other types of technology which in some way enable human communication. For example, one could argue that a printer enables the printing of documents for distribution to participants. Indeed, a printer does enable communication in some way, however, only those technologies which are directly involved in the communication process (either as a means for the representation or presentation of a message) have been listed here as having particular relevance to the requirements elicitation process.

Table 7.7: Other Communication Technologies

TECHNOLOGY TYPE and DESCRIPTION
Computer Aided Software Engineering (CASE) tool: according to Rader *et al* (1993), "any tool found to be useful in support of a software project." This would make most technology a CASE tool. Oman (1990) is more specific, "a true CASE tool must, by definition, be a tool for engineering software".
Paper and Pen: although rudimentary, 'paper and pen' is a common technology used to aid the communication process. Electronic note pads with electronic pens are available, essentially substituting paper and 'hard copy' documents with electronic versions.
Slide/Data Projector: allows information to be displayed in a large format easily visible to a group of people.
Spreadsheet: allows the presentation of data or information wherever numbers and calculations are involved.
Telephone: allows verbal dialogue between people. Traditionally between 2 people only, but conference telephones allow conversation involving many people.
Word Processor: used to create and edit documents where text, tables or graphics are involved.

7.4 Evaluating Communication Technologies

In order to select appropriate communication technologies to support GDRE, it will be necessary to evaluate existing communication technologies in terms of their ability to facilitate the communication processes identified in Chapter 5. This section introduces some models for evaluating groupware, and discusses the evaluation of other communication enabling technologies.

7.4.1 Evaluating Groupware

Each category of groupware indicated in the taxonomy presented in **Table 7.2** consists of a variety of software products, each with its own capabilities (see **Appendix D**). Furthermore, this software is installed and run on a hardware platform, the minimum specification of which will lend a particular atmosphere to the implementation of the software, and which may be quite distinct from the maximum implementation. For example, images in video conferencing may be displayed in windows on a 14" computer monitor, or they may be projected into life size images on a wall. In each case, it is likely that the camera receiving and transmitting the image may be zoomed to different degrees, revealing different levels of detail of the image, and thus influencing the receiver's perception of the image. Ultimately this could influence the communication process. For example, it may be desirable for a systems analyst to see the facial expressions of a user in order to determine their feelings about a particular issue. Although the software may support image processing, the hardware may not support the requisite zoom levels or image quality in order to produce the desired image. Thus, the systems analyst may not be able to accurately determine the users feelings about the given situation.

This disparity makes it virtually impossible to evaluate groupware *per se.* In fact, it is only really possible to evaluate specific groupware software products, given a predefined hardware platform. However, from a functional perspective, some authors have attempted to describe methods for evaluating groupware. These are briefly described below.

7.4.1.1 The Denver Model for Groupware Design

In their discussion on the *Denver Model for Groupware Design* (as shown in **Figure 7.1**), Salvador *et al* (1996) explain that when evaluating groupware, all of the relevant factors (from the *design model*: people, artifacts, tasks and activities, interactive situations, and interactive social protocols) which the groupware technology will support need to be considered. It should be noted, however, that this is not likely to be a simple task. Multiple users, their interactions with the software, hardware and one another, the influence which groupware is likely to have on group dynamics, as well as the type and/or quality of the output will all play a role in assessing the groupware.

7.4.1.2 The Arizona Groupware Grid

Nunamaker *et al* (1995:3) describe the Arizona Groupware Grid as a model for analysing and comparing groupware technologies. This model attempts to address issues relating to team productivity in different environments, and how technology can be used to improve productivity. It provides a framework for evaluating the potential contributions to productivity enhancement of different groupware packages.

As explained by Nunamaker *et al* (1995), group work can be viewed in three levels. The *individual level* (uncoordinated effort toward a goal), the *coordination level* (coordinated but independent effort), and the *group dynamics level* (concerted effort toward a goal). Technology which makes the individual more productive appears at the individual level (for example, word processors and spreadsheets). Individual productivity may not improve group productivity if it is not coordinated. Technology to improve coordination falls into the coordination level (for example, team schedulers and project management tools). In instances where individuals actually work together to complete a specific task, productivity can be improved through the use of technology which falls into the group dynamics level (for example, electronic meeting tools).

The horizontal axis of the groupware grid is derived from the Focus Theory of group productivity (Briggs, 1994) which asserts that "regardless of the goal, group members accomplish their tasks by exchanging and thinking about information". Briggs explains that there are three processes in which group members must engage to become productive: *communication*, *thought*, and *information access*, but points out that attention can only be devoted to one of these processes at a time. It is suggested that there is thus an 'attention cost', where the other two processes receive no attention, and that this cost can be reduced by technology.

As explained by Nunamaker *et al* (1995:5), the communication process involves "choosing a set of words, behaviours, and images and presenting them through a medium (eg. paper, telephone, computer) to convey information to other team members." Where communication is constrained or highly demanding of attention, technology could improve the communication process, thus making a group more productive. Likewise, technology could improve both the thought and the information access processes, thus making groups more productive.

These factors are presented as shown in **Table 7.8**. Each cell contains examples of the kind of support available for a particular process at a particular level.

Table 7.8: Arizona Groupware Grid (Nunamaker *et al* (1995:6), and Briggs and Nunamaker (1997:67))

	Productivity Processes		
	Communication	**Thought**	**Information Access**
Group Dynamics Level	Anonymity Parallel contribution Synchronous communication	Structured and focussed processes	Session transcripts Automatic concept classification
Coordination Level	Asynchronous communication	Team scheduling Automated workflow Project Management	Shared data stores
Individual Level	Presentation Graphics Preparing stimuli	Spreadsheets Simulation Outlining tools	Information filtering Local data stores

The Arizona Groupware Grid crosses the three productivity processes with the three levels of technology support for groupware, thus giving a grid onto which the contributions of a single tool or an entire groupware environment can be mapped. According to Nunamaker *et al* (1995:7), it is thus possible to "compare the potential for productivity of different environments by comparing their respective grids."

7.4.1.3 The Collaborative Framework

The methodology for evaluation of collaboration systems is described in detail by Cugini, Damianos, Hirschman, Kozierok, Kurtz, Laskowski and Scholtz (1997). The framework builds on an earlier framework devised by Pinsonneault and Kraemer in 1989 (Pinsonneault and Kraemer, 1993) to analyse the impact of technology on group process while controlling for the effect of other contextual variables. Cugini *et al* (1997) have merged the work of Pinsonneault *et al* (1989) and McGrath (1984) into an expanded framework which enables the classification of tasks which groups perform. The relevance of this framework to the present study is the possibility of identifying and classifying tasks relating to requirements elicitation, and the subsequent matching of technology to enable the completion of those tasks. Some work has been done in this area by Beauvais (1999), who specified a particular hardware platform and particular groupware, classified requirements elicitation tasks, and performed experimental work to evaluate the success of those tasks given the technological environment.

More relevant is the work presented by Cugini *et al* (1997) on the actual evaluation of the technology in terms of its specific characteristics. Firstly, Cugini *et al* (1997) defined four levels of applicability in which technological solutions could be classified, and a top-down and bottom-up view which an evaluator could have of these levels (as shown in **Table 7.9**).

Table 7.9: Evaluation Questions (Cugini *et al*, 1997:36)

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 systems 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 system with the 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.

In addition, Cugini *et al* (1997) explore, in more detail, the parameters for social protocols and the group characteristics as mentioned in **Table 7.9**. This exploration provides insight into the exact nature of human interaction and the factors which need to be considered when evaluating technology to support this interaction. The insights are summarised in **Tables 7.10 and 7.11**.

Table 7.10: Parameters for Social Protocol (Cugini *et al*, 1997:37)

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 only if chair], informal turn-taking, or free-for-all
Hierarchy support	Voting, contributing-restricted, contributing-free access, observing only
Communication needs	
Communication	Private ° public, 1 way ° ç way
Dependency (interaction)	Loose ° tight
Level of security needed	None ° 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 7.11: Group Characteristics (Cugini *et al*, 1997:38)

Dimension	Values
Time	
Spontaneity of collaborations	Planned, spontaneous
Duration of sessions	Number of hours ° days
Time frame for collaborative sessions	Synchronous, asynchronous
Location	Same for all ° different for all
Group type	
Number of participants	Number
Stage of development	Newly formed ° working group
Homogeneity	Gender diversity, peer diversity, computer experience diversity, cultural diversity
Length of time group will exist	Limited ° long term
Computer requirements	
Hardware, software requirements	Platforms, resources available (time, money)
Training	Walk-up and use ° formal classes
Computer expertise	Novice ° expert

7.4.1.4 EWG/IVC Services Taxonomy

In 1997, the DARPA Intelligent Collaboration and Visualisation Program headed by Dr Jean Scholtz prepared a draft of what was called the EWG/IVC Services Taxonomy (Scholtz, 1997). This taxonomy is based on the premise that human problems can be mapped with technological solutions. The taxonomy, which can be found in full in **Appendix E**, suggests that it would be necessary firstly to define a set of problems which is amenable to group solution (and to classify those problems in terms of their functional requirements). Secondly, it would be necessary to classify collaborative tools in terms of the functional solutions which they offer, and then to map the problem to the appropriate tools. The taxonomy classifies a set of typical collaborative activities (known as *Services*) into domains in which functional characteristics can be identified.

7.4.2 Evaluating Other Communication Technologies

The same principles apply as for the evaluation of groupware, and any of the methods discussed above can be used. Ramarapu *et al* (1999:167-169) have developed a conceptual framework for studying the impact of technology (in general) on groups. This framework is applicable to groupware, and to other communication technologies. The framework (as shown in **Figure 7.4**) is based on the work of McGrath and Hollingshead (1994) and Hackman (1969), and views the groupware paradigm as the interaction of four basic sets of variables.

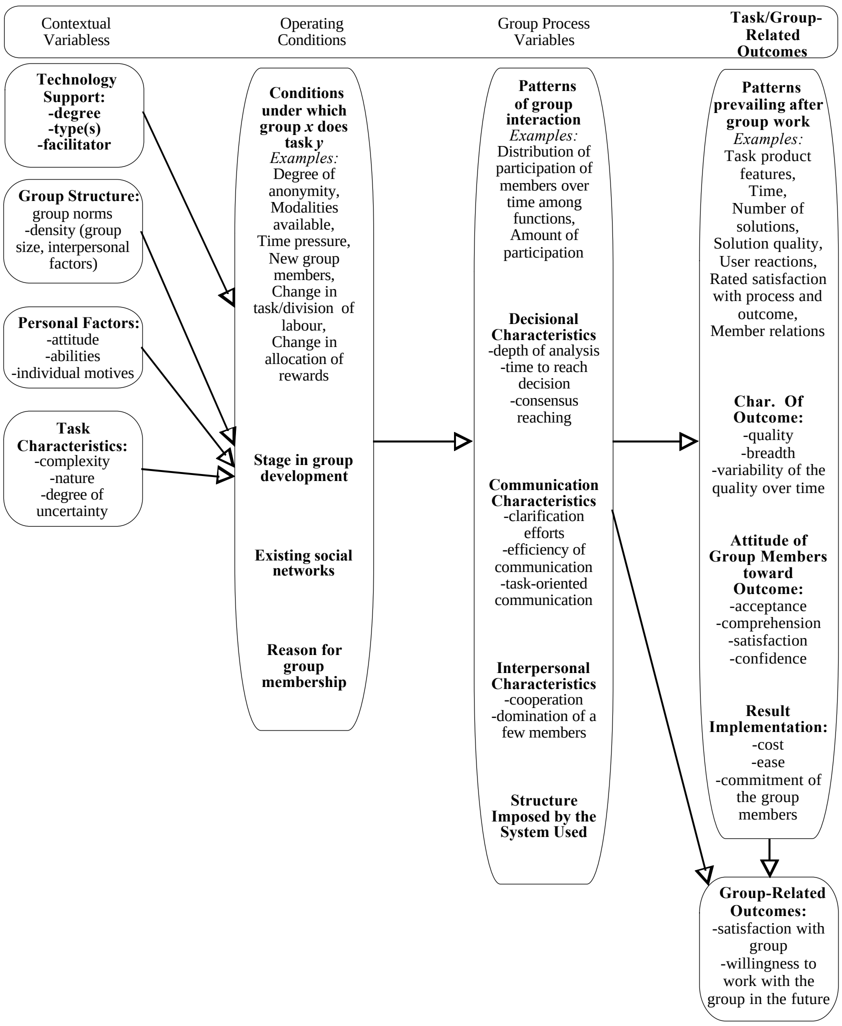


Figure 7.4: Conceptual framework for studying the impact of technology on groups (Ramarapu *et al*, 1999:167)

The *contextual variables* (technological support, group structure, personal factors, and task characteristics), *operating conditions* (prevailing conditions under which a given group implements its tasks), *group process variables* (define ongoing group activity), and *task/group related outcomes* (provide outcome measures of group performance).

Ramarapu *et al* (1999) suggest that these variables typically form the criteria for evaluating the effectiveness of the communication system. The communication and interpersonal interaction factors which are found in this framework, point to specific aspects of communication which are of concern in this research.

7.5 Conclusion

This chapter has investigated the subject of communication technology. With a view to aiding the process of designing an appropriate technological infrastructure to support GDRE, specific communication technologies were identified and defined, and communication technology classification schemes were investigated. *Groupware* describes a variety of technologies which support distributed working, however, other technologies (such as CASE tools) are used to support communication processes and may be used during the GDRE process. Ramarapu *et al*'s (1999) *space/time dependence* classification scheme (**Table 7.5**) focuses on attending meetings and sending messages and is suited to identifying groupware to support interviewing and structured workshops. However, due to the wide variety of communication processes in requirements elicitation, there is no particular classification scheme which is entirely suitable. Discussion on classification schemes was thus followed by an examination of methods for the evaluation of specific communication technologies. The Denver Model for Groupware Design, The Arizona Groupware Grid, the Collaborative Framework, the EWG/IVC Services Taxonomy, and the Conceptual Framework for Studying the Impact of Technology on Groups were all identified as having valuable contributions regarding this evaluation process.

The following chapter investigates issues relating to the management of the technology, the impact of the technology on the GDRE processes, and the cost of implementing the technology.

Chapter 8
ISSUES IN THE SELECTION OF A GDRE TECHNOLOGY INFRASTRUCTURE

8.1 Introduction

The previous chapter examined communication technologies, communication technology classification schemes, and methods for evaluating specific technologies.

This chapter revisits the model of GDRE (specifically the communication processes which make up GDRE). Based on the finding presented in Chapter 7 regarding the classification and evaluation of communications technology, there is some discussion relating to the identification of appropriate technology to support GDRE. A conclusion is drawn regarding the minimum technology requirements: no attempt is made to evaluate existing communication technologies or to match specific communication technologies with the GDRE process. Issues relating to the management of the technology, the impact of the technology on the GDRE group processes, and the cost of implementing the technology are discussed.

The following chapter concludes the research.

8.2 Key Elements of the Model of GDRE

8.2.1 Communication Scenarios

General communication scenarios are described by the requirements elicitation objectives shown in Section 4.3 of the *revised taxonomy of communication in requirements elicitation* (**Appendix C**). The requirements elicitation methods suggested in the *model of geographically distributed requirements elicitation* represent formal information flows: they are interviews, structured workshops and prototyping. Interviews imply one-to-one communications, whereas structured workshops and prototyping imply group communication. These formal information flows imply synchronous communication. Group communication should reflect the *circle with leader* communication network. This implies a need for structure. It is implicit in structured workshops (at least) that the communication process will be facilitated. However, side conversations should also be supported. Formal information flows will occur primarily during the implementation and termination phases of GDRE. Informal information flows include ad hoc communications in the forms of telephone conversations, e-mails, voice mails, faxes, and file sharing. These will occur in both group and one-to-one settings, and will most often be asynchronous. Informal information flows will occur primarily during the planning phase of GDRE, but will also occur during the implementation and termination phases.

Modes of communication are described as written, verbal and nonverbal. In particular, written communication will take the forms of agendas, minutes, project schedules, memos, discussions, queries, models, and requirements definitions and specifications. Of particular importance in verbal communication is speech and voice (detailed in Sections 5.4.1 and 5.4.2 of the revised taxonomy of communication in requirements elicitation), while in nonverbal communication body language and scent are important (detailed in Sections 5.4.3 and 5.4.4 of the revised taxonomy of communication in requirements elicitation).

8.2.2 GDRE Process Support Functions

The technological infrastructure refers not only to the communication technologies, but also the technologies which constitute the environment in which the participants of GDRE will be situated. GDRE process support functions include document handling, configuration management, and defect tracking. Dewdney (1998) suggests using a data repository with version and access control to integrate (merge and correct errors) work from different teams. Environmental issues include atmosphere and ergonomics (which may be partially facilitated by 'reference' technology).

8.3 Identifying the Appropriate Technology

8.3.1 Classification and Evaluation

Given the numerous communication scenarios and support functions, classifying a single type of technology to support GDRE is not possible. GDRE will require a *mix* of a variety of different classifications of technology. Using the 3x3 matrix of groupware options shown in **Table 7.4**, it is possible to imagine the GDRE process involving interactions which happen in each of the nine (9) time/place scenarios. It is also possible to imagine a need for all possible technology classifications described in the people/artifact framework shown in **Figure 7.2**. Dyson's (1990) classifications introduced are more general, and the classification of process-centred technology is the most appropriate for GDRE . The technological infrastructure should account for the complex nature of GDRE (the 'work'), viewing it as a set of different processes (transactions) aimed at collectively achieving an objective. All of the layers of the contributional classification describe technologies which will be required in a GDRE process.

As GDRE is not purely task driven, simply evaluating task completion, as examined by Cugini *et al* (1997) using the collaborative framework for evaluating collaborative systems, is not entirely appropriate. However, examining the four (4) levels of applicability (as shown in **Table 7.9**) with respect to the communication scenarios in question (as opposed to the tasks for completion) will focus attention on the relevant types of groupware which need to be evaluated. Furthermore, Cugini *et al* (1997) provide some relevant insights into more specific qualities which the technology should have with respect to the facilitation (or representation) of social protocol and group characteristics (as shown in **Tables 7.10 and 7.11**). In a sense, determining whether or not the technology enables rules of order (for example, with respect to meeting conduct) is classifying the technology at that micro level.

At this point, it is important to note that the exact scenarios which will prevail are determined not by GDRE itself, but by the chosen approach for the implementation of GDRE, and the nature of the systems development project as a whole. The implication is that the communication technologies will have to be chosen on the advent of each new GDRE. It is for this reason that in each case of GDRE process planning, the Denver Model for Groupware Design (discussed in chapter 3) should be applied. This model, in particular the *design* (sub)*model*, can be equated with the process centred approach adopted by GDRE. This is seen particularly with respect to its description of elements which should be considered during the groupware design process (interactive situations, tasks, people, artifacts, and interactive protocols). The Denver Model for Groupware Design provides an excellent guide of the issues relating to groupware and its (collective) design to support a process. Adopting this approach will provide a groupware (communications technology) *mix* which will facilitate GDRE.

Allied to the application of the Denver Model for Groupware Design is the use of the Arizona Groupware Grid (as described in chapter 3) for analysing and comparing specific groupware technologies which will make up the *mix* of communication technologies. The Arizona Groupware Grid should be used to compare the potential for productivity of different technological environments, and this is enabled through the view of technology in terms of human productivity processes and goal orientation.

It is possible to use the functional categorisation of groupware technologies (as shown in **Table 7.2**) to eliminate those categories of technologies which will definitely not be used in GDRE. They are: group development tools and workgroup utilities and development tools. This leaves a wide range of different groupware technologies which are likely to be used in GDRE.

8.3.2 The Minimum Technology Requirements

In order to support appropriately the communication scenarios presented above, the communication technologies chosen will be required to exhibit certain minimum qualities. Shipalana (1997)[10], in a study entitled *Towards a Model of Dispersed JAD,* concluded that JAD could only be effectively conducted in a distributed environment with virtual reality technology as the enabler. Shipalana (1997) argues that the communication processes are simply too complex for other communication technologies to facilitate. Shipalana (1997) adds that there are additional advantages to be gained from conducting JAD in such an environment, making it a compelling option for further investigation. The current author believes that the re-creation of traditional requirements elicitation communication settings in a virtual world is the objective which technology development should have in order to fully and most appropriately implement GDRE. This would have communication advantages particularly with regard to participant familiarity with the communication scenario, and could indeed offer the potential to improve the traditional requirements elicitation communication scenario. However, this solution is not feasible at present, and there are likely to be compromise positions which will yield sufficiently accurate results to render GDRE feasible.

For the purposes of this work, it is only appropriate to state that the technology should be of a minimum quality which will at the very least render the process of GDRE feasible in terms of its implementation and the outcomes which such implementation will produce. Numerous considerations will need to be taken into account, the essence is the ability of

[10]Information Systems Honours research project supervised by Nicholas Vat.

the technology to convey (reflect) the physical and psychological characteristics of the communication environment and the elements within it. Specific considerations include those of Cugini *et al* (**Tables 7.10** and **7.11**), as well as issues such as the speed of the network links, the quality of the image produced (for example, with respect to colour, zoom and depth of field) and the sense of spatial relationships conveyed.

8.4 Managing the Technology

As mentioned previously, technology will need to be managed by a suitably qualified person(s). A *technology manager* amounts to an additional participant (or role) in the process of requirements elicitation. The author foresees another role being necessary, that of *communication flow manager*. The communication flow manager is the person responsible for controlling the communication flows between participants with respect to the technology enabling those flows. For example, where shared drawing tools are used, and mouse control becomes an issue between participants, the communication flow manager will control the passing of mouse control between participants. This role could be filled by the analyst or the technology manager, but depending on the complexity of the tasks associated with this role, it may be necessary to include another participant in the process.

There are also *meeting facilitation agents* which are designed to fulfill some of the tasks associated with communication flow management. This area of technology development is a developing one and is not yet mature enough to eliminate the need for human intervention. Significant work in the realm of artificial intelligence (AI) appears to be an appropriate approach to solving this problem. For example, Chen, Houston, Yen and Nunamaker (1996) present an artificial intelligence approach to creating software agents to assist in the meeting idea convergence process.

8.5 Evaluating the Impact of the Technology on the GDRE Group Processes

As a quality control mechanism, the author recommends conducting a study on the impact of the technology on the requirements elicitation process. The conceptual framework for studying the impact of technology on groups (Ramarapu *et al*, 1997) shows a comprehensive classification of issues (variables, conditions and outcomes) which need to be measured.

8.6 Evaluating the Technology Cost of Implementing GDRE

Field[11] (1999), in a study entitled *Towards a Model of Geographically Dispersed Requirements Elicitation: Reducing Travel Related Costs,* analysed the travel related costs associated with the requirements elicitation process. Field determined that the requirements elicitation travel related costs (TC) are a function of the direct travel costs (T) such as the cost of renting a car, the accommodation costs (A) such as hotel charges, the productivity costs (P) such as the potential working time lost while travelling, and the technology costs (E) such as the networks and e-mail facilities. This is represented by the formula (Field, 1999:82): **TC = T + A + P + E**

Field (1999:102) states that, "each of these costs can be divided further and an associated monetary value applied... (and that)... depending on the environment in which the project takes place, these costs will be greater or smaller." A case study was conducted for the purposes of comparing the costs of the requirements elicitation process of a project in two different communication scenarios: i) traditional face-to-face requirements elicitation, and ii) geographically distributed requirements elicitation.

[11]Information Systems Honours research project supervised by Nicholas Vat.

Field (1999) concludes that travel related costs associated with requirements elicitation can be reduced by adopting GDRE. Field (1999:127) states that "it is cheaper to implement technology as a vehicle for distributed requirements elicitation than to incur travel costs."

Although these conclusions are based on a different model of GDRE than that presented in this research, the current author believes that the methodology adopted by Field (1999) for calculating these costs provides valuable insights into the cost centres and their relationships. These insights are appropriate for consideration when evaluating the technology cost of implementing GDRE.

There are other costs (besides those related to travel) which will need to be evaluated. For example, likely additional costs relating to more complex project management activities, or the costs related to the termination phase of GDRE. These costs would be added to the function representing the total cost of requirements elicitation.

8.7 Conclusion

This chapter has revisited the model of GDRE (specifically the communication processes which make up GDRE) in order to identify the classifications of technology which will support these processes. No specific classification of technology was identified, and it was concluded that there is no single classification which will adequately support GDRE. As a result, suggestions were made regarding the considerations which need to be taken when evaluating and selecting technology which will comprise the GDRE technology infrastructure. Issues relating to the management of the technology, the impact of the technology on the GDRE group processes, and the cost of implementing the technology were also discussed.

The following chapter concludes the research.

PART IV

CONCLUSION AND APPENDICES

The aim of Part IV is to conclude the thesis, to present ideas for future research arising from it, and to present the Appendices.

Chapter 9
CONCLUSION

1 Introduction

This research has addressed the problem of conducting requirements elicitation in a distributed environment. The knowledge and processes required to solve this problem adequately are not well established. With a focus on requirements elicitation as a communication process, a model of geographically distributed requirements elicitation was developed. This model is supported by an investigation of the associated implementation technology.

2 Contribution of the Thesis

Within the realm of a systems development project, this study has explored information systems requirements elicitation as an aspect of the requirements analysis phase of the SDLC. Reasons for systems development project failure are often linked to poor requirements analysis, and more specifically, poor requirements elicitation. These reasons were explored, and possible solutions were investigated. The reasons were established as being poorly established specifications and design, and lack of stakeholder "buy-in" or commitment. These reasons refer to two aspects of the requirements elicitation process: i) the management of activities, and ii) the management of people.

Requirements elicitation is identified as being in essence, a communication process. The field of human communication was studied in detail. This provided a foundation for the expression of requirements elicitation as a communication process. Traditional requirements elicitation methods represent the nature of the communication processes encompassed in a requirements elicitation process. These methods were examined in detail, and communication issues were isolated and the methods compared. It was found that, on the basis of a variety of communication characteristics, each requirements elicitation method is distinct. For example, interviews traditionally represent a wheel group communication structure, while JAD represents a circle with leader communication structure. It was also found that communication characteristics such as this are used by analysts in the process of determining which requirements elicitation methods to use in a given situation. For example, where the situation calls for one-to-one communication between analyst and user, interviewing is the requirements elicitation method of choice. This confirms that requirements elicitation methods have different characteristics. The empirical study (in particular, section 4.5.2) sought to determine whether or not requirements elicitation methods could be ranked, thus giving a comparative perspective regarding the effectiveness of those methods. The results clearly show that this could be done, and qualitative data regarding this ranking process further supported the communication characteristics as the basis on which comparisons are done (see **Table 4.5**). Thus the first hypothesis (Chapter 1), *different information systems requirements elicitation methods (some which are more effective than others) have different characteristics*, was accepted. The empirical study results referred to above later resulted in the inclusion of interviews, structured workshops and prototyping as the requirements elicitation methods of choice in the model of GDRE.

In order to express the knowledge gained from the investigation to this point, a requirements elicitation communication model (RECM) was developed. This model is based on general human communication principles and also takes into account, and solves for, those issues relating to project failure. The model is based on principles and discussions found in the literature and reflects the requirements elicitation process as described by international authors and researchers.

An empirical study was conducted in order to evaluate the model, and to develop an understanding of the technological requirements to implement such a model in a distributed work environment. The empirical study, which was carried out in South Africa, led to the modification of the RECM. The RECM thus carries a distinctly South African flavour, and no attempt was made to compare this with other countries. It was found that the less structured requirements elicitation methods are favoured, and that traditional structured requirements elicitation methods are moulded to suit particular analyst needs. A great deal of importance is placed on direct inter-personal interaction and social issues relating to human communication are considered to have a significant influence on the success of the requirements elicitation process. It was found that the RECM needed some modification. Most significantly, the revised model showed structural changes after it was found that the analyst (leader) has a significant impact on the nature of most communication processes within the requirements elicitation process. The model ultimately expresses requirements elicitation communication processes in terms of the environment(s) in which they occur, the communication transactions themselves, and the outcomes of those communication processes. In addition, the model describes influential requirements elicitation process management activities (such as planning the specific requirements elicitation tasks, and scheduling the participants) without which the communication processes are not likely to achieve their objectives.

Knowledge acquired in the investigation of both project failure and the requirements elicitation communication process was combined with an investigation of distributed communication and globally dispersed software development. This was then used in the development of a model of geographically distributed requirements elicitation (GDRE). The obvious differentiation of GDRE from face-to-face requirements elicitation is in the indirect versus direct communication channels which exist between the participants. Distributed communication requires that some form of technology act as the carrier of communication signals between communicating parties. As discussed in Section 3.4, the ultimate aim of distributed communication enabling technologies is to enable the normal face-to-face communication channels, the premise being that to restrict the use of any of a human beings natural communication tools and techniques, would hinder communication. Today however, it is generally accepted that by and large, such technologies restrict a person's ability to use his/her available communication tools and techniques for communication. For example, a significant proportion of communication success is attributed to nonverbal communication. To date, communication technologies are not able to replicate natural body odours, thus restricting a nonverbal communication tool. Thus the second hypothesis (Chapter 1), *geographically distributed communication has distinct characteristics which restrict communication*, was accepted.

As previously indicated, interviews, structured workshops and prototyping are existing requirements elicitation methods which are included as part of the GDRE process. These methods are quite distinct, and each offers important advantages with regard to eliciting user requirements in particular situations. To re-iterate the statement of Mason *et al* (1987:88), "the correct mix of methods will depend on the exact circumstances and on what the analyst is trying to achieve." It was not necessary to develop a new requirements elicitation method, thus the third hypothesis (Chapter 1), *the critical success factors of different requirements elicitation methods can be isolated and re-amalgamated to form a new requirements elicitation method*, is neither accepted nor rejected.

The differentiation between direct and indirect communication calls for more stringent planning and control of a geographically distributed requirements elicitation process, and a greater emphasis on managing human relationships within the process. The model of GDRE adopts principles from general project management and reflects the principles and structure of the RECM. GDRE consists of three phases: *planning*, *implementation* and *termination*. Planning is chiefly concerned with the set up of the requirements elicitation environment and choosing participants suitable for the requirements elicitation methods chosen. GDRE implementation should adopt a process-centred approach to task completion and should adopt the RECM. This phase also requires special management attention to be given to human resource and technological needs. Termination is primarily concerned with learning from the process, effectively dealing with human resource needs and ending the requirements elicitation phase of the SDLC. The model of GDRE presents a structured, step-by-step approach which can be followed by the person responsible for the requirements elicitation phase of a systems development project.

The empirical study was carried out in South Africa, and thus the model of GDRE reflects the sentiments expressed by South Africans. No comparative study was done to determine the applicability of the model in other countries, and this is left as an important area for future study. However, a geographically distributed information systems requirements elicitation method was developed, and thus the fourth hypothesis, *a geographically distributed information systems requirements elicitation method can be developed for South African companies*, is accepted.

Finally, an investigation of communication technologies was performed. Communication technologies which are designed to support collaborative work in a distributed environment (groupware) and other communication technologies were examined. Technology evaluation schemes were explored, and issues (such as hardware quality, or task completion) were raised regarding the appropriate evaluation criteria which should be adopted (given the technology capabilities and the desired collaborative work support which is required). This was then linked to the model of GDRE, thereby providing some perspectives on an appropriate technology infrastructure for the implementation of GDRE. It was concluded that a mix of technologies would need to be chosen to suit each individual implementation plan for GDRE. This mix may include, for example, an electronic meeting system with top-of-the-range hardware supporting life-size imaging and reference capabilities, and a CASE tool (amongst others). It was found that, due to the complex nature of the requirements elicitation process there is, at present, no single communication technology available which will effectively support GDRE, and minimum support would be required for specific communication processes and GDRE process support functions. In essence, it is possible to complete a requirements elicitation process using a mix of communication technologies. Some guidelines were presented regarding the evaluation of said technologies. In essence the technology manager should begin by consulting the analyst regarding the requirements elicitation method(s) to be adopted in the GDRE process. Armed with a knowledge of the communication processes associated with these method(s), and the process management issues associated with GDRE, he/she should identify specific software and the requisite hardware to support the process. The Denver Model for Groupware Design can be used for guidance on issues relating to groupware and its (collective) design to support a process, and then the Arizona Groupware Grid can be used to analyse and compare specific groupware technologies. Allied to the technology selection are other considerations regarding technology management (the issue of a technology manager versus a communication flow manager was discussed) and cost evaluation (Field’s (1999) model of GDRE cost assessment was suggested as appropriate for comparing the cost of GDRE and traditional face-to-face requirements elicitation). Ultimately, cost evaluation is important as GDRE sets out to reduce the costs of traditional face-to-face requirements elicitation.

The model of GDRE provides a basis from which information systems analysts can work when choosing to adopt a distributed working approach to requirements elicitation. Furthermore, it defines important aspects of requirements elicitation in general, for example the principles of the RECM apply to all requirements elicitation settings. These aspects have been explored in detail and the knowledge generated during this study is directly applicable to requirements elicitation in general. Lastly, the underlying principles of the model of GDRE could be applied to other distributed working settings. Concepts are common in other distributed working environments and many of the planning, implementation and termination issues are valid in other settings.

3 Future Research

Practical issues relating to the *implementation phase* of the model of GDRE need to be explored. Five areas for future research arise from this:
Firstly, in order to *adopt a process-centred approach to task completion*, at least the following questions require an answer: What are the tasks relevant in GDRE? What are the possible approaches to completing these tasks? What is the best approach? What are the relevant aspects (resources, activities, agents, tools actions artifacts and products) of the process described by that approach? How can these aspects be implemented in a geographically distributed requirements elicitation environment?

Secondly, the RECM stipulates *what* needs to be done, future research should focus on *how* it should be done. This would contribute to the successful *implement*ation of *the requirements elicitation communication model (RECM)*. For example, the RECM suggests that the requirements elicitation environment should exude a certain atmosphere. How can that atmosphere be appropriately created and replicated?

Thirdly, before one can *implement human resources management strategies designed for distributed working environments*, important strategies need to be identified, and their specific implementation needs to be explored. Of particular relevance would be strategies relating to teamwork.

Fourthly, *manag*ing *the technological infrastructure* implies the management of two aspects of the technological infrastructure: 1) the infrastructure itself, and 2) the use of the infrastructure. This project would require the researcher to identify relevant technology management issues, examine what needs to be done in order to ensure that the infrastructure is properly used and managed (available, stable, and supports the communication processes), examine approaches to improve the communication process support offered by communication technologies, explain how the communication processes can be appropriately implemented or supported.

Lastly, *for extremely large systems development projects*, complex issues relating to geographically distributed teamwork should be explored. Specifically, issues relating to group collaboration, consensus decision making and document inspection should be identified. Alternative solutions to these issues should then be identified and explored, the best solutions chosen, and their implementation explained.

Much work needs to be done in the area of the GDRE technology infrastructure. In the first instance, specific technologies which could facilitate much of the GDRE process needs should be identified. An assessment should be undertaken of the technological ability to facilitate GDRE. Gaps in the technological environment will need to be filled through further technology development.

It is suggested that future work should include testing of the model of GDRE. This would best be done in a real world business setting. In the first instance, it may be appropriate to limit the testing to a geographical distribution with no significant time-zone differences or cultural diversity. Later, significant time-zone differences and greater cultural diversity could be introduced in the testing process.

An interesting study would be to compare the South African scenario as reflected in the modified RECM with other countries. Significant differences in the approach of other countries could lead to the modification of the model of GDRE to suit different nations.

A study should be conducted to determine whether or not there are attitude changes (specifically regarding communication elements such as the importance of body language in the requirements elicitation process) in participants who move from traditional requirements elicitation processes to GDRE processes. Findings in this study may require greater or lesser emphasis being placed on certain communication elements. This would affect the nature of the model of GDRE, and more specifically, the minimum requirements of the technology to support it.

Finally, the ultimate aim of GDRE is to reduce the costs (both financial and productivity) of traditional requirements elicitation processes in an increasingly global market place. A study should be undertaken to determine the actual costs of implementing GDRE. A feasibility study could then be conducted, comparing the costs of traditional requirements elicitation approaches to those of GDRE.

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Glossary

Action block usage:
See chapter 4.

Action diagram:
See chapter 4.

Action language:
Not used exclusively as signals. Reusch and Kees (1956) (as quoted in Pretorius (1976))

Activity dependency diagram:
See chapter 4.

Activity hierarchy diagram:
See chapter 4.

Adaptors:
Displacement activities and other gestures which reveal emotional reactions. Ekman, P and W Friesen (as quoted in Lyle (1990)), and Du Plooy (1991)

Age:
"The length of time during which a being has existed." Webster (1991)

Agenda:
"A list, plan, outline, or the like, of things to be done, matters to be acted or voted on." Webster (1991)

Appearance:
The outward look or aspect of a person.

Arms:
Appearance particularly relevant to...

Atmosphere:
"Tone or mood, ambience; sound and visual effects to create a mood." Weiner (1996)

Attitude:
"An individual's predisposition to behave or react in a certain way towards persons, objects, institutions, events and/or issues." Du Plooy (1991)

Attribute definitions:
See chapter 4.

Aura:
"An atmosphere or quality that seems to emanate from a person or thing." Weiner (1996)

Authority of participants:

Automated Design:
See chapter 4.

Awareness of the complexity and size of the organisation:
See chapter 2.

Barriers:
"Anything which interferes with, or distorts the meaning of the message; or hinders the interpretation of a message exactly as was intended by the communicator." Du Plooy (1991)

Behaviour:
"The manner of conducting oneself." Webster (1991)

Bias:
"A bent or prejudice." Weiner (1996) This exists very much "in the eye of the beholder." Watson *et al* (1993)

Body contact:

Body pointing:

Body:
Appearance particularly relevant to...

Brainstorming:
"Dynamic small-group communication to stimulate the emergence of new ideas, approaches and/or solutions - not their evaluation." Du Plooy (1991)

Breathing:
Deep, shallow, heavy, fast, slow, loud, soft, etc.

CASE:
See chapter 4.

Chaired:
Run by "the presiding officer of a meeting, committee, etc., or the head of a board or department." Webster (1991)

Channel:
Auditory, visual, haptic, olfactory, taste.

Character:
"The distinguishing moral qualities and personality traits of a person..." Du Plooy (1991)

Chronemics:
"In nonverbal communication: The use of time, the meaning of which may differ depending on the context and culture or subculture." Du Plooy (1991)

Class Responsibility and Collaboration (CRC) cards:
See chapter 4.

Class diagrams:
See chapter 4.

Clothing:
Style and colour.

Collaborative problem solving:
A group of people involved in the process of resolving any question or matter involving doubt, uncertainty, or difficulty.

Collaborative Internet-based applications:
See chapter 7.

Commitment:
"The state of being committed." Webster (1991)

Communication networks:
"In organisational communication: Formal networks, the official channels through which information is exchanged. Informal networks, the exchange of information between two or more people on a personal level." Du Plooy (1991)

Communication:
"An interpersonal and/or social interaction between at least one communicator and at least one recipient, which implies:
a message, a medium, a context in which the process of sharing of meaning occurs, an intentional purpose to express, to interpret, to provide and/or to receive feedback." See chapter 2. Du Plooy (1991)

Communication Techniques used:

Component Modelling:
See chapter 4.

Conflict:
"An opposition of actions, desired, ideas or goals." Du Plooy (1991)

Conflict management:
To manage a controversy or quarrel.

Consensus:
Example: requires a specific communication environment.

Context:
"...the entire situation, background, or environment relevant to a specific action." Weiner (1996)

Continuity:
"En even, logical succession of events." Du Plooy (1991)

Culture:
"A way of life which includes knowledge, belief, art, morals, laws, customs and any other capabilities or habits acquired by an individual as a member of a society or group." Du Plooy (1991)

Data Model (Entity-relationship diagram - ERD):
See chapter 4.

Data flow diagram:
See chapter 4.

Data Model list:
See chapter 4.

de Bono's 6 hats:
Example: requires a specific communication environment.

Dealing with ambiguity:
See chapter 2.

Decision tree:
Example: requires a specific communication environment.

Decision matrix:
Example: requires a specific communication environment.

Decision making:
The process of deciding.

Decision / impact analysis:
Example: requires a specific communication environment.

Decision making:
The process of deciding. See chapter 2.

Demographics:
"The profile of an actual or intended group of recipients according to sex, age, nationality, occupation, marital status, educational level, income and/or residential area." Du Plooy (1991)

Dependency analysis:
See chapter 4x.

Desktop video and real-time data conferencing:
See chapter 7.

Displayed thinking:
To show or exhibit ones thoughts.

Displays:
Obvious gestures displaying emotion, such as clenching an angry fist, or sinking your head in your hands in despair. Ekman, P and W Friesen (as quoted in Lyle (1990)), and Du Plooy (1991)

Documentation:
That which is given forth as a result of the communication process. See chapter 2.

Drawing:
See chapter 4.

Education level:

Electronic meeting systems:
See chapter 7.

Electronic mail and messaging:
See chapter 7.

Emblems:
Gestures which are substitutes for words, such as sign-language. Ekman, P and W Friesen (as quoted in Lyle (1990)), and Du Plooy (1991)

Entity definitions:
See chapter 4.

Entity life-cycle analysis:
See chapter 4.

Enunciation:
"The pronunciation and articulation of words and other communicative sounds; an aspect of vocal delivery." Watson *et al* (1993)

Environment:
"The aggregate of surrounding things, conditions, or influences; surroundings; milieu." Webster (1991)

Ergonomics:

Ethics:
"Systems of value-judgments concerning degrees of right and wrong, goodness and badness in communicative behaviour." Du Plooy (1991)

Ethos:
The recipient's interpretation of the persuader's credibility and determined in terms of his/her seeming expertness, trustworthiness and goodwill." Du Plooy (1991)

Expectations clarification and management:
See chapter 2.

Expectations:
"People come to have a collection of ideas about what is expected of them in terms of their behaviour in certain social situations and, in turn, of what they should expect concerning the behaviour of others and of their treatment in society generally." Watson *et al* (1993)

Experience:
Job and general life experience.

Eye contact:
"The practice of looking a person in the eyes." Weiner (1996)

Eyes:
Appearance particularly relevant to...

Face:
Appearance particularly relevant to...

Facial expressions:
"Facial expressions... are constantly changing in response to inner and outer stimuli. And when we look at someone's face we are quickly able to tell whether the person is interested, bored, cheerful or downcast. In turn, we consciously or unconsciously use our own facial signals to convey a wide range of emotions and give emphasis to what we are saying." Lyle (1990)

Facilitated:
Run by a professional with specific skill in managing group communication.

Feedback:
"A message which the communicator perceives as being expressed by a recipient in response or reply to his/her message. Can be direct or indirect: immediate or delayed." Du Plooy (1991)

Feet:
Appearance particularly relevant to...

Flow:
The movement along of the speech, as in a stream.

Force field analysis:
Example: requires a specific communication environment.

Forced choice-paired comparison:
Example: requires a specific communication environment.

Formal:
"Of or pertaining to language use typical of impersonal and official situations, characterised by adherence to traditional standards of correctness, often complex vocabulary and syntax, and the avoidance of contractions and colloquial expressions." Webster (1991)

Gender:
Sex.

Gestures:
"Any action that sends a visual signal to an onlooker." Watson *et al* (1993)

Goal setting and definition:
See chapter 2.

Grammar:
"The part of the study of language that deals with forms and structure of words and their customary arrangement in phrases and sentences." Weiner (1996)

Graphics:
"Any kind of visual presentation (including title cards, charts, graphs) as distinct from alphabetical or numerical characters." Du Plooy (1991)

Group calendering and scheduling:
See chapter 7.

Group document handling:
See chapter 7.

Groupware frameworks (group support systems):
See chapter 7.

Groupware applications and services:
See chapter 7.

Hair:
Appearance particularly relevant to...

Hand writing:
See chapter 7.

Hands:
Appearance particularly relevant to...

Haptics:
"The use of touch and touching, the meaning of which may differ depending on the context and culture or subculture." Du Plooy (1991)

Help facilities:

Ice breaker:
"Something that eases tension or relieves formality." Webster (1991)

Illustrators:
Emphatic, expansive movements which amplify the spoken work, it was this big. Ekman, P and W Friesen (as quoted in Lyle (1990)), and Du Plooy (1991)

Income:
Financial.

Informal:
"Without formality or ceremony; casual." Webster (1991)

Information elicitation:
Drawing or bringing out information.

Information views:
See chapter 4.

Information exchange:
To give and receive information reciprocally.

Intellect:
"The faculty of the mind by which one knows or understands, as distinguished from that by which one feels or wills; capacity for thinking and acquiring knowledge." Webster (1991)

Interaction structure:

Interpersonal communication:
"Face-to-Face communication between at least two people participating directly with on another. A deliberate transactional activity involving verbal and nonverbal communication." Du Plooy (1991)

Interpersonal interaction:
See chapter 2.

Kinesics:
"Body language, or the use of facial expressions; gestures (movements of head, shoulders, trunk, arms, hands, legs and feet); and posture (whilst sitting, standing or walking). May accompany verbal speech or occur in the absence of speech." Du Plooy (1991)

Knees:
Appearance particularly relevant to...

Language:
"A body of words, symbols, signs, and systems for communicating among people of the same group or nation." Weiner (1996)

Legs:
Appearance particularly relevant to...

Length of interactions:

Lips:
Appearance particularly relevant to...

Literacy:
The ability to read and write.

Locality:
Face-to-face or dispersed.

Marital status:

Matrix analysis:
See chapter 4.

Medium:
The mass media, other communication media, formal (internal) organisational networks, external structures, agents, dealers and (informal) interpersonal paths through which information is exchanged." Du Plooy (1991)

Memory:
"The mental capacity or faculty of retaining or recalling facts, events, impressions, or previous experiences." Webster (1991)

Message:
"A communication, a statement, a basic theme, or significance... a group of characters (letters, numbers, and symbols) or a unit of information; a single transmission of data in one direction." Weiner (1996)

Mind set:
Situation (possibly temporary), not necessarily the normal character displays of an individual.

Minutes:
"The official record of the proceedings at a meeting of a society, committee, or other group." Webster (1991)

Mood:
"Emotional state." Weiner (1996)

Motivation:
"Any stimulation or inducement which arouses, maintains and/or channels a recipient's behaviour toward a specified goal." Du Plooy (1991)

Movements indicative of character:
Including the use of open and closed body language. Ekman, P and W Friesen (as quoted in Lyle (1990)), and Du Plooy (1991)

Nationality:
"The status of belonging to a particular nation... national quality or character." Webster (1991)

Negotiation:
"Mutual discussion and arrangement of the terms of a transaction or agreement." Webster (1991)

Noise:
"An interference that distorts and renders a message difficult or impossible to interpret." Du Plooy (1991)

Nominal group technique:

Non real-time data conferencing:
See chapter x.

Nonverbal / Body language:
Pertaining to actions.

Norms:
Unwritten rules which govern behaviour in a particular setting.

Nose:
Appearance particularly relevant to...

Number of participants:

Object think:
See chapter 4.

Object language:
All intentional and non- intentional displays of material things. Reusch and Kees (1956) (as quoted in Pretorius (1976))

Objectives:
"Something that ones efforts or actions are intended to attain or accomplish; purpose; goal." Webster (1991)

Occupation:
"A person's usual or principal work." Webster (1991)

Oral literacy:
"The ability to communicate verbally, by talking and listening." Du Plooy (1991)

Organisational culture:
"Norms, reminiscences, heroes, stories, rites, rules, rituals and/or values underlying the communication, organising and work procedures which are peculiar to an organisation and which are shared by its employees." Du Plooy (1991)

Organisational networks:
"Series of overlapping and interrelated formal and informal structures or patterns through which information is conveyed in a n organisation. Types of networks are influenced by friendship, authority, status, task expertise and/or the type of information exchanged." Du Plooy (1991)

Organised:
"Having an organisation or structure for directing widespread activities." Webster (1991)

Orientation:
"...the angle at which people sit or stand in relation to one another." Watson *et al* (1993)

Outcomes of the Requirements Elicitation Process:
See chapter 5.

Pace:
"...tempo, overall speed, intensity, and rhythm." Weiner (1996)

Paper and pen:
See chapter 7.

Paralinguistics:
"A branch of nonverbal communication which pertains to variations in sounds (e.g. rhythm, pitch, tempo, accents, intensity); pauses; silences; hesitations and sounds such as eh and hm. These nonverbal acoustic aspects can complement, contradict, emphasise, regulate and/or substitute, spoken words or their meanings." Du Plooy (1991)

Participant training:
See chapter 2.

Participant selection:
See chapter 2.

Participant scheduling:
See chapter 2.

Personality:
"Characteristics, traits, attitudes, and habits of a person." Watson *et al* (1993)

Perspiration:
Could reflect nervousness.

Persuasion:
"The presentation of evidence that emphasises the consequences to those recipients who adopt (or fail to adopt) a given belief." Du Plooy (1991)

Pitch:
"The relative position of a tone in a scale." Weiner (1996)

Politics:
"Political principles or opinions." Webster (1991)

Position of tools and technology:

Posture:
Appearance particularly relevant to...

Power:
"The probability that one actor within a social relationship will be in a position to carry out his own will despite resistance, regardless of the basis on which this probability rests." Watson *et al* (1993)

Preparation:
See chapter 2.

Problem solving:
The process of resolving any question or matter involving doubt, uncertainty, or difficulty. See chapter 2.

Procedure analysis: current systems:
See chapter 4.

Procedure action diagram:
See chapter 4.

Process:
"A systematic series of actions directed to some end." Webster (1991)

Process decomposition:
See chapter 4.

Process logic analysis:
See chapter 4.

Process dependency analysis:
See chapter 4.

Project scheduling:
See chapter 4.

Project schedules:

Prompting:
"Influencing a respondent's answer, e.g. by providing a list of anticipated answers." Du Plooy (1991)

Pronunciation:
"The act or manner of speaking words, especially with reference to the production of sounds and the placing of syllable stress, intonation (voice modulation), and other factors." Weiner (1996)

Proxemics (spatial relations):
"The adjustment of interpersonal distance or space between individuals. Four territories can be demarcated: (1) intimate, most private space (e.g. near a loved one); (2) personal (e.g. informal meeting with friends); (3) social (e.g. a formal interview); and (4) public, accessible to everyone."
Proxemic determinants:
"Three factors which influence the adjustment of space between individuals:
(1) human characteristics (sex, age, ethnicity, culture, status, familiarity, attraction, personality); (2) environmental characteristics (amount of space available, arrangement of furniture); and (3) interactional characteristics (formality, familiarity with the environment, the purpose of the interaction)." Du Plooy (1991)

Proximity:
Closeness.

Psychographics:
"A quantitative classification of an actual or intended group of recipients (audience, market or respondents), based on their activities, interests and opinions." Du Plooy (1991)

Race:
"A group of persons related by common descent or heredity." Webster (1991)

Rational:
"Based on or agreeable to reason." Webster (1991)

Regulators:
Non-verbal ways of indicating whether we wish to speak, or listen, or want to change our role during conversation, these include headnods, gaze behaviour and postural changes. Ekman, P and W Friesen (as quoted in Lyle (1990)), and Du Plooy (1991)

Requirements specifications:
See chapter 2.

Residential area:

Resource sourcing and scheduling:
See chapter 2.

Respect for the organisation:
See chapter 2.

Respect for the end-user:
See chapter 2.

Ritual gestures:
Such as those used in religious contexts. Ekman, P and W Friesen (as quoted in Lyle (1990)), and Du Plooy (1991)

Role:
"A social role consists of the expected behaviour associated with a particular social position." Watson *et al* (1993)

Scent:
Pleasant, unpleasant, etc.

Screen flow:
See chapter 4.

Setup:
This involves communication, but is geared towards improving the communication processes which will be employed to achieve the communication agenda.

Sexuality:
Sexual character; Hetero/Homo-sexual etc.

Sign language:
Used exclusively as signals. Reusch and Kees (1956) (as quoted in Pretorius (1976))

Smile:
Pleasant, unpleasant, etc.

Socialisation:
"The shaping of human behaviour through experience in and knowledge of certain social situations:
the process by which individuals are made aware of the expectations others have of their behaviour; by which they acquire the norms, mores, values and beliefs of a social group or society; and by which the culture of a social group or society is transmitted." Watson *et al* (1993)

Speech:
"The art or manner of speaking." Weiner (1996)

Spreadsheet:
See chapter 7.

Stakeholder commitment:
See chapter 2.

Status:
"...the social evaluation of an individual or group, the degree of prestige or honour that society accords him, her or it." Watson *et al* (1993)

Structure:
Wheel, Y, Circle, Completely Connected, Wheel with Facilitator, etc...

Structure chart:
See chapter 4.

Style:
"Standards of grammar... that are considered to be generally acceptable and desirable." Weiner (1996)

System area model:
See chapter 4.

System overview model:
See chapter 4.

Systems analyst approach:
See chapter 2.

T-chart:
Example: requires a specific communication environment.

Team building:

Technologies used:

Text editor:
See chapter 7.

Time box development:
See chapter 4.

Tone:
"A vocal... sound or its quality, pitch, or modulation." Weiner (1996)

Tone:
"A manner of speaking or writing that expresses a particular meaning, feeling, or attitude." Weiner (1996)

Tools used:

Torso:
Appearance particularly relevant to...

Type and Position of furniture:

Use of enabling technology:
See chapter 2.

Use cases:
See chapter 4.

User satisfaction:
See chapter 2.

User Requirements Elicitation Techniques used:

User view analysis:
See chapter 4.

User manuals:

Values:
"Each society, social group or individual has certain ideas, beliefs, ways of behaving, upon which is placed a value. A collection of these values... may amount to a value system." Watson *et al* (1993)

Venue:
"The scene or locale of any action or event." Webster (1991)

Verbal:
"Pertaining to words, in contrast to actions." Weiner (1996)

Video conferencing:
See chapter 7.

Visual Aids:
"Films, slides, posters, charts, and other devices or material involving sight." Weiner (1996)

Voice:
"Sound made through the mouth, or a sound like a vocal utterance." Weiner (1996)

Volume:
"The amplitude or loudness of sound." Weiner (1996)

Voting:
Example: requires a specific communication environment.

Word processor:
See chapter 7.

Words used:

Work set list:
See chapter 4.

Workgroup utilities and development tools:
See chapter 7.

Written:
"Communication "inscribed on a surface." Weiner (1996)

Appendix A
Requirements Elicitation Communication Taxonomy

This taxonomy is a list of terminology relevant to communication in the requirements elicitation process. The list is organised in sections which represent specific areas of the 'requirements elicitation communication model' presented in chapter 3. All terminology which appears in this list is defined and/or explained in the Glossary.

1 INTERPERSONAL INTERACTION AND COMMUNICATION PROCESS
1.1 Communication
1.2 Interpersonal interaction
1.3 Interpersonal communication

1.4 Process Management
1.4.1 Preparation
1.4.1.1 Logistical arrangement
1.4.1.1.1 Participant selection
1.4.1.1.2 Participant scheduling
1.4.1.1.3 Resource sourcing and scheduling
1.4.1.2 Participant training
1.4.1.3 Team building
1.4.1.4 Select exercises
1.4.1.5 Agenda
1.4.1.6 Minutes
1.4.1.7 Project Schedules
1.4.2 Documentation

1.5 Structure
1.5.1 Informal
1.5.2 Formal
1.5.2.1 Chaired
1.5.2.2 Facilitated
1.5.3 Continuity
1.5.4 Feedback
1.5.5 Norms
1.5.6 Organised
1.5.7 Rational

1.6 Network
1.6.1 Psychographics
1.6.2 Structure

1.7 Process Aids
1.7.1 Tools used
1.7.1.1 Decision making
1.7.1.1.1 Consensus
1.7.1.1.2 de Bono's 6 hats
1.7.1.1.3 Decision / impact analysis
1.7.1.1.4 Decision matrix
1.7.1.1.5 Decision tree
1.7.1.1.6 Force field analysis
1.7.1.1.7 Forced choice-paired comparison
1.7.1.1.8 T-chart
1.7.1.1.9 Voting
1.7.2 Techniques used
1.7.2.1 Action block usage
1.7.2.2 Action diagram
1.7.2.3 Activity dependency diagram
1.7.2.4 Activity hierarchy diagram
1.7.2.5 Attribute definitions
1.7.2.6 Class diagrams
1.7.2.7 Class Responsibility and Collaboration (CRC) cards
1.7.2.8 Component Modelling
1.7.2.9 Data flow diagram
1.7.2.10 Data Model (Entity-relationship diagram - ERD)
1.7.2.11 Data Model list
1.7.2.12 Dependency analysis
1.7.2.13 Entity definitions
1.7.2.14 Entity life-cycle analysis
1.7.2.15 Information views
1.7.2.16 Matrix analysis
1.7.2.17 Object think
1.7.2.18 Procedure action diagram
1.7.2.19 Procedure analysis: current systems
1.7.2.20 Process decomposition
1.7.2.21 Process dependency analysis
1.7.2.22 Process logic analysis
1.7.2.23 Screen flow
1.7.2.24 Structure chart
1.7.2.25 System area model
1.7.2.26 System overview model
1.7.2.27 Time box development
1.7.2.28 Use cases
1.7.2.29 User view analysis
1.7.2.30 Work set list

2 ENVIRONMENT
2.1 Organisation characteristics
2.1.1 Organisational culture
2.1.2 Organisational networks
2.1.3 Politics

2.2 Locality
2.3 Atmosphere

2.4 Ergonomics
2.4.1 Position of tools and technology
2.4.2 Type and Position of furniture
2.4.3 Venue

3 CONTEXT
3.1 Group Characteristics (demographics)
3.1.1 Number of participants
3.1.2 Authority of participants

3.2 Requirements Elicitation (objectives)
3.2.1 Goal setting and definition
3.2.2 Expectations clarification and management
3.2.3 Information elicitation
3.2.4 Information sharing
3.2.5 Brainstorming
3.2.6 Dealing with ambiguity
3.2.7 Problem solving
3.2.8 Conflict Management
3.2.9 Negotiation
3.2.10 Persuasion
3.2.11 Decision making

3.3 Systems analyst approach
3.3.1 Awareness of the complexity and size of the organisation
3.3.2 Respect for the organisation
3.3.3 Respect for the end-user

4 SENDER/RECEIVER
4.1 Human characteristics
4.1.1 Age
4.1.2 Aura
4.1.3 Behaviour
4.1.4 Bias
4.1.5 Character
4.1.6 Culture
4.1.7 Education level
4.1.8 Ethics
4.1.9 Experience
4.1.10 Gender
4.1.11 Income
4.1.12 Intellect
4.1.13 Length of interactions
4.1.14 Marital status
4.1.15 Memory
4.1.16 Nationality
4.1.17 Occupation
4.1.18 Perception
4.1.19 Personality

4.1.20 Power
4.1.21 Race
4.1.22 Residential area
4.1.23 Self-perception
4.1.24 Sexuality
4.1.25 Socialisation
4.1.26 Status
4.1.27 Values

4.2 Psychological Factors (Mind set)
4.2.1 Attitude
4.2.2 Commitment
4.2.3 Ethos
4.2.4 Expectations
4.2.5 Mood
4.2.6 Motivation
4.2.7 Preconceived ideas (environment, process, people)
4.2.8 Role

4.3 Interpersonal Skills
4.3.1 Literacy
4.3.2 Oral Literacy

4.4 Interpersonal Communication Tools
4.4.1 Speech
4.4.1.1 Enunciation
4.4.1.2 Flow
4.4.1.3 Grammar
4.4.1.4 Language
4.4.1.5 Pace
4.4.1.6 Pronunciation
4.4.1.7 Style
4.4.1.8 Tone
4.4.1.9 Words used
4.4.2 Voice
4.4.2.1 Pitch
4.4.2.2 Tone
4.4.2.3 Volume
4.4.3 Body Language
4.4.3.1 Chronemics
4.4.3.2 Kinesics
4.4.3.2.1 Facial expressions
4.4.3.2.2 Gestures
4.4.3.2.2.1 Sign language
4.4.3.2.2.1.1 Emblems
4.4.3.2.2.2 Action language
4.4.3.2.2.2.1 Adaptors
4.4.3.2.2.2.2 Displays
4.4.3.2.2.2.3 Illustrators
4.4.3.2.2.2.4 Movements indicative of character
4.4.3.2.2.2.5 Regulators
4.4.3.2.2.2.6 Ritual gestures
4.4.3.2.2.3 Object language
4.4.3.2.2.3.1 Clothing

4.4.3.3 Appearance
4.4.3.3.1 Arms
4.4.3.3.2 Body
4.4.3.3.3 Eyes
4.4.3.3.4 Face
4.4.3.3.5 Feet
4.4.3.3.6 Hair
4.4.3.3.7 Hands
4.4.3.3.8 Knees
4.4.3.3.9 Legs
4.4.3.3.10 Lips
4.4.3.3.11 Nose
4.4.3.3.12 Posture
4.4.3.3.13 Torso
4.4.3.4 Breathing
4.4.3.5 Eye contact
4.4.3.6 Haptics
4.4.3.7 Perspiration
4.4.3.8 Paralinguistics
4.4.3.9 Proxemics (spatial relations)
4.4.3.9.1 Body contact
4.4.3.9.2 Body pointing
4.4.3.9.3 Orientation
4.4.3.9.4 Proximity
4.4.4 Scent
4.4.5 Smile

4.5 Barriers

5 MESSAGE

6 CHANNEL
6.1 Medium
6.1.1 Face-to-face
6.1.2 Computer mediated
6.1.3 Communication Techniques used
6.1.3.1 Brainstorming
6.1.3.2 Decision making
6.1.3.3 Displayed thinking
6.1.3.4 Nominal group technique
6.1.3.5 Problem solving
6.1.3.5.1 Collaborative problem solving
6.1.3.6 Tools used
6.1.3.6.1 Visual Aids
6.1.3.6.1.1 Graphics
6.1.3.7 Technologies used (Use of enabling technology)
6.1.3.7.1 Automated Design
6.1.3.7.2 CASE
6.1.3.7.3 Collaborative Internet-based applications
6.1.3.7.4 Desktop video and real-time data conferencing
6.1.3.7.5 Drawing
6.1.3.7.6 Electronic mail and messaging

6.1.3.7.7 Electronic meeting systems
6.1.3.7.8 Group calendering and scheduling
6.1.3.7.9 Group document handling
6.1.3.7.10 Groupware applications and services
6.1.3.7.11 Groupware frameworks (group support systems)
6.1.3.7.12 Hand writing
6.1.3.7.13 Non real-time data conferencing
6.1.3.7.14 Paper and pen
6.1.3.7.15 Project scheduling
6.1.3.7.16 Spreadsheet
6.1.3.7.17 Text editor
6.1.3.7.18 Video conferencing
6.1.3.7.19 Word processor
6.1.3.7.20 Workgroup utilities and development tools

6.2 Mode
6.2.1 Written
6.2.2 Verbal
6.2.3 Nonverbal

6.3 Noise

7 OUTCOMES
7.1 Requirements Definition
7.2 Requirements Specification
7.3 Stakeholder commitment
7.4 User satisfaction

Appendix B
Questionnaire

Code	DETAILS	RESPONSE

Date:	
Start Time:	

1 DEMOGRAPHICS

1.1	Name	
1.2	Company	
1.3	Type of Company	
1.4	Division / Department	
1.5	Position / Post	

Place an 'X' in the appropriate block.

Are you prepared to be named in the publication(s) resulting from this research project?

1.6	Yes	
1.7	No	

How many years of working experience do you have in the Information Technology field?

1.8	0-3 years	
1.9	4-6	
1.10	7-10	
1.11	>10	

How many years of experience do you have in user requirements elicitation?

1.12	0-3 years	
1.13	4-6	
1.14	7-10	
1.15	>10	

Have you had formal training in user requirements elicitation?

1.16	Yes	
1.17	No	

1.18 If "yes", what training have you had (name the degrees / diplomas / courses)?

What type of projects, where user requirements elicitation was one of the aspects of the project, have you been involved in?

1.19	In-house	
1.20	External	
1.21	Information Systems Development	
1.22	Software Installation	
1.23	Hardware Installation	
1.24	Hardware Development	
1.25	Other (specify):	

2 METHODS AND TECHNIQUES

2.1 What method(s) have you used in order to elicit user requirements?

2.2 At present, what method(s) do you use in order to elicit user requirements?

2.3 Rank the method(s) which you have used in terms of their relative success at eliciting user requirements (where 1 is, in your opinion, the "best" or "most successful" method).

	Question number		
	2.1	**2.2**	**2.3**
Ad Hoc Meetings	2.1.1	2.2.1	
EIP (Executive Intensive Planning)	2.1.2	2.2.2	
Formal Meetings	2.1.3	2.2.3	
Interview	2.1.4	2.2.4	
JAD (Joint Application Design / Development)	2.1.5	2.2.5	
JRP (Joint Requirements Planning)	2.1.6	2.2.6	
Observation	2.1.7	2.2.7	
Prototyping	2.1.8	2.2.8	
Questionnaire	2.1.9	2.2.9	
RAD (Rapid Application Development)	2.1.10	2.2.10	
UIA (User Intensive Analysis)	2.1.11	2.2.11	
Workshops	2.1.12	2.2.12	
Other (specify):			
	2.1.13	2.2.13	
	2.1.14	2.2.14	
	2.1.15	2.2.15	

2.4 What, in your opinion, is significant about the method(s) which you ranked the highest (what makes it (them) better than the others)?

At present, what technique(s) do you use in conjunction with the user requirements elicitation method(s) used?

2.5	Brainstorming	
2.6	Displayed thinking	
2.7	Ice-breakers	
2.8	NGT (Nominal Group Technique)	
2.9	Team building	
2.10	Other (specify):	

Have you been involved in a user requirements elicitation process which has been carried out in a virtual environment (distributed or geographically dispersed, where participants are not located at the same place)?

2.11	Yes	
2.12	No	

2.13 If "yes", please describe the environment in terms of the technology used.

3 FACTORS

There are a variety of factors which contribute to the process of user requirements elicitation. These factors have been grouped into categories. Please indicate the importance of each category to the user requirements elicitation process.

		Very important	Important	Undecided	Unimportant	Totally unimportant
3.1	Project Management	1	2	3	4	5
3.2	Participation	1	2	3	4	5
3.3	Mind set (user and developer)	1	2	3	4	5
3.4	Body Language	1	2	3	4	5
3.5	Personal Appearance	1	2	3	4	5
3.6	Speech	1	2	3	4	5
3.7	Interpersonal Communication	1	2	3	4	5
3.8	Ergonomics	1	2	3	4	5
3.9	Decision-making	1	2	3	4	5
3.10	Documentation	1	2	3	4	5
3.11	System Modelling	1	2	3	4	5
3.12	Standards	1	2	3	4	5
3.13	Technology	1	2	3	4	5

3.1 PROJECT MANAGEMENT

How important are the following PROJECT MANAGEMENT factors / activities in terms of their impact on the success of the user requirements elicitation process?

		Very important	Important	Undecided	Unimportant	Totally unimportant
3.1.1	Financial budget	1	2	3	4	5
3.1.2	Arrange participant schedules	1	2	3	4	5
3.1.3	Assign preparation assignments	1	2	3	4	5
3.1.4	Brief project sponsor	1	2	3	4	5
3.1.5	Customise agenda	1	2	3	4	5
3.1.6	Educate participants	1	2	3	4	5
3.1.7	Gather materials	1	2	3	4	5
3.1.8	Leadership	1	2	3	4	5
3.1.9	Obtain resource approval	1	2	3	4	5
3.1.10	Obtain results approval	1	2	3	4	5
3.1.11	Prepare "script" or notes	1	2	3	4	5
3.1.12	Productivity	1	2	3	4	5
3.1.13	Quality control	1	2	3	4	5
3.1.14	Review background documentation and models	1	2	3	4	5
3.1.15	Schedule, obtain facility	1	2	3	4	5
3.1.16	Schedule project	1	2	3	4	5
3.1.17	Scoping	1	2	3	4	5
3.1.18	Select Participants	1	2	3	4	5
3.1.19	Time budget	1	2	3	4	5
3.1.20	Other (specify):	1	2	3	4	5

3.2 PARTICIPATION

3.2.1 How important is it to have a variety of different people involved in the user requirements elicitation process?

Very important	Important	Undecided	Unimportant	Totally unimportant
1	2	3	4	5

3.2.2 Ordinarily, how many people would you expect to find involved in the user requirements elicitation process?

What "types" of people would you expect to participate in the user requirements elicitation process?

3.2.3	Administrator	
3.2.4	Analyst	
3.2.5	Developer	
3.2.6	Facilitator	
3.2.7	Management: Lower	
3.2.8	Management: Middle	
3.2.9	Management: Upper	
3.2.10	Programmer	
3.2.11	Secretary / clerk	
3.2.12	Technician	
3.2.13	User	
3.2.14	Other (specify):	

In what roles would you expect to find participants during the user requirements elicitation process?

3.2.15	Analyst	
3.2.16	Developer	
3.2.17	Executive Sponsor	
3.2.18	Facilitator	
3.2.19	Manager	
3.2.20	Scribe	
3.2.21	Secretary	
3.2.22	Specialist	
3.2.23	Technician	
3.2.24	User	
3.2.25	Other (specify):	

3.3 MIND SET

To what extent do the following MIND SET factors influence the success of the requirements elicitation process?

		Significant influence	Influence	Undecided	Barely influence	No influence
3.3.1	Attitude	1	2	3	4	5
3.3.2	Aura	1	2	3	4	5
3.3.3	Behaviour	1	2	3	4	5
3.3.4	Expectations	1	2	3	4	5
3.3.5	Intellect	1	2	3	4	5
3.3.6	Memory	1	2	3	4	5
3.3.7	Mood	1	2	3	4	5
3.3.8	Socialisation	1	2	3	4	5
3.3.9	Values	1	2	3	4	5
3.3.10	Other (specify):	1	2	3	4	5

3.4 BODY LANGUAGE

To what extent do the following BODY LANGUAGE factors influence the success of the requirements elicitation process?

		Significant influence	Influence	Undecided	Barely influence	No influence
3.4.1	Arm position and movements	1	2	3	4	5
3.4.2	Body contact	1	2	3	4	5
3.4.3	Body pointing	1	2	3	4	5
3.4.4	Breathing	1	2	3	4	5
3.4.5	Eye contact	1	2	3	4	5
3.4.6	Facial expressions	1	2	3	4	5
3.4.7	Hand position and movements	1	2	3	4	5
3.4.8	Head movements (eg. nodding)	1	2	3	4	5
3.4.9	Head position	1	2	3	4	5
3.4.10	Hearing / listening	1	2	3	4	5
3.4.11	Orientation	1	2	3	4	5
3.4.12	Perspiration	1	2	3	4	5
3.4.13	Posture	1	2	3	4	5
3.4.14	Proximity	1	2	3	4	5
3.4.15	Scent / Smell	1	2	3	4	5
3.4.16	Sight	1	2	3	4	5
3.4.17	Smile	1	2	3	4	5
3.4.18	Voice (accent, inflections, loudness, pitch, tone)	1	2	3	4	5
3.4.19	Other (specify):	1	2	3	4	5

3.5 PERSONAL APPEARANCE

To what extent do the following PERSONAL APPEARANCE factors influence the success of the requirements elicitation process?

		Significant influence	Influence	Undecided	Barely influence	No influence
3.5.1	Body type / shape	1	2	3	4	5
3.5.2	Face	1	2	3	4	5
3.5.3	Hair style	1	2	3	4	5
3.5.4	Hair colour	1	2	3	4	5
3.5.5	Eye colour	1	2	3	4	5
3.5.6	Lips	1	2	3	4	5
3.5.7	Nose shape / size	1	2	3	4	5
3.5.8	Torso	1	2	3	4	5
3.5.9	Arms	1	2	3	4	5
3.5.10	Hands	1	2	3	4	5
3.5.11	Legs	1	2	3	4	5
3.5.12	Knees	1	2	3	4	5
3.5.13	Feet	1	2	3	4	5
3.5.14	Body piercing	1	2	3	4	5
3.5.15	Make-up	1	2	3	4	5
3.5.16	Clothing colour	1	2	3	4	5
3.5.17	Clothing style	1	2	3	4	5
3.5.18	Other (specify):	1	2	3	4	5

3.6 SPEECH

To what extent do the following SPEECH factors influence the success of the requirements elicitation process?

		Significant influence	Influence	Undecided	Barely influence	No influence
3.6.1	Pace	1	2	3	4	5
3.6.2	Pronunciation	1	2	3	4	5
3.6.3	Providing punctuation	1	2	3	4	5
3.6.4	Stutter	1	2	3	4	5
3.6.5	Style	1	2	3	4	5
3.6.6	Words used	1	2	3	4	5
3.6.7	Enunciation	1	2	3	4	5
3.6.8	Inflections on words	1	2	3	4	5
3.6.9	Other (specify):	1	2	3	4	5

3.7 INTERPERSONAL COMMUNICATION

To what extent do the following INTERPERSONAL COMMUNICATION factors influence the success of the requirements elicitation process?

		Significant influence	Influence	Undecided	Barely influence	No influence
3.7.1	Coaching	1	2	3	4	5
3.7.2	Commitment	1	2	3	4	5
3.7.3	Communication Channels (networks)	1	2	3	4	5
3.7.4	Conflict management	1	2	3	4	5
3.7.5	Consensus	1	2	3	4	5
3.7.6	Culture	1	2	3	4	5
3.7.7	Emphasising	1	2	3	4	5
3.7.8	Explaining	1	2	3	4	5
3.7.9	Feedback	1	2	3	4	5
3.7.10	Flirting	1	2	3	4	5
3.7.11	Following	1	2	3	4	5
3.7.12	Group dynamics	1	2	3	4	5
3.7.13	Illustrating	1	2	3	4	5
3.7.14	Individual vs Group	1	2	3	4	5
3.7.15	Inform	1	2	3	4	5
3.7.16	Informal meetings / socialise	1	2	3	4	5
3.7.17	Language	1	2	3	4	5
3.7.18	Nationality	1	2	3	4	5
3.7.19	Negotiation	1	2	3	4	5
3.7.20	Norms	1	2	3	4	5
3.7.21	Orient	1	2	3	4	5
3.7.22	Personality	1	2	3	4	5
3.7.23	Pointing	1	2	3	4	5
3.7.24	Psychology	1	2	3	4	5
3.7.25	Race	1	2	3	4	5
3.7.26	Reflecting	1	2	3	4	5
3.7.27	Roles	1	2	3	4	5
3.7.28	Self-confidence	1	2	3	4	5
3.7.29	Summarising	1	2	3	4	5
3.7.30	Synthesising	1	2	3	4	5
3.7.31	Team building	1	2	3	4	5
3.7.32	Teamwork	1	2	3	4	5
3.7.33	Other (specify):	1	2	3	4	5

3.8 ERGONOMICS

To what extent do the following ERGONOMIC factors influence the success of the requirements elicitation process?

		Significant influence	Influence	Undecided	Barely influence	No influence
3.8.1	Venue	1	2	3	4	5
3.8.2	Position of tools and technology	1	2	3	4	5
3.8.3	Position of furniture	1	2	3	4	5
3.8.4	Position of people (spatial relationships)	1	2	3	4	5
3.8.5	Type of furniture	1	2	3	4	5
3.8.6	Other (specify):	1	2	3	4	5

3.9 DECISION-MAKING

3.9.1 What DECISION-MAKING techniques DO you use in the user requirements elicitation process?

3.9.1.1	Collaborative problem solving	
3.9.1.2	Consensus	
3.9.1.3	de Bono's 6 hats	
3.9.1.4	Decision / impact analysis	
3.9.1.5	Decision matrix	
3.9.1.6	Decision tree	
3.9.1.7	Force field analysis	
3.9.1.8	Forced Choice-Paired comparison	
3.9.1.9	T-chart	
3.9.1.10	Voting	
3.9.1.11	Other (specify and briefly describe):	

3.10 DOCUMENTATION

Which of the following general forms of DOCUMENTATION do you use / create / read / update during the process of user requirements elicitation?

3.10.1	Agenda	
3.10.2	Help facilities	
3.10.3	Minutes	
3.10.4	Project Schedules	
3.10.5	User manuals	
3.10.6	Other (specify):	

Which of the following tools do you use to create the DOCUMENTATION?

3.10.7	Drawing	
3.10.8	Automated Design Tool	
3.10.9	CASE (systems development) tool	
3.10.10	Hand writing	
3.10.11	Project Scheduling Tool	
3.10.12	Spreadsheet	
3.10.13	Text editor	
3.10.14	Word processor	
3.10.15	Other (specify):	

3.11 SYSTEM MODELLING

How important to the success of the user requirements elicitation process, are the tools which you use during the ANALYSIS PHASE?

		Very important	Important	Undecided	Unimportant	Totally unimportant
3.11.54	Action block usage	1	2	3	4	5
3.11.55	Action diagram	1	2	3	4	5
3.11.56	Activity dependency diagram	1	2	3	4	5
3.11.57	Activity hierarchy diagram	1	2	3	4	5
3.11.58	Attribute definitions	1	2	3	4	5
3.11.59	Class diagrams	1	2	3	4	5
3.11.60	Class Responsibility and Collaboration (CRC) cards	1	2	3	4	5
3.11.61	Component Modelling	1	2	3	4	5
3.11.62	Data flow diagram	1	2	3	4	5
3.11.63	Data Model (Entity-relationship diagram - ERD)	1	2	3	4	5
3.11.64	Data Model list	1	2	3	4	5
3.11.65	Dependency analysis	1	2	3	4	5
3.11.66	Entity definitions	1	2	3	4	5
3.11.67	Entity life-cycle analysis	1	2	3	4	5
3.11.68	Information views	1	2	3	4	5
3.11.69	Matrix analysis	1	2	3	4	5
3.11.70	Object think	1	2	3	4	5
3.11.71	Procedure action diagram	1	2	3	4	5
3.11.72	Procedure analysis: current systems	1	2	3	4	5
3.11.73	Process decomposition	1	2	3	4	5
3.11.74	Process dependency analysis	1	2	3	4	5
3.11.75	Process logic analysis	1	2	3	4	5
3.11.76	Screen flow	1	2	3	4	5
3.11.77	Structure chart	1	2	3	4	5
3.11.78	System area model	1	2	3	4	5
3.11.79	System overview model	1	2	3	4	5
3.11.80	Time box development	1	2	3	4	5
3.11.81	Use cases	1	2	3	4	5
3.11.82	User view analysis	1	2	3	4	5
3.11.83	Work set list	1	2	3	4	5
3.11.84	Other (specify):	1	2	3	4	5

3.12 STANDARDS

How important to the success of the user requirements elicitation process, are the following STANDARDS issues?

		Very important	Important	Undecided	Unimportant	Totally unimportant
3.12.1	Quality	1	2	3	4	5
3.12.2	Metrics	1	2	3	4	5
3.12.3	Estimation	1	2	3	4	5
3.12.4	Function points	1	2	3	4	5
3.12.5	Other (specify):	1	2	3	4	5

3.13 TECHNOLOGY

How important to the success of the user requirements elicitation process, is the use of those TECHNOLOGIES?

		Very important	Important	Undecided	Unimportant	Totally unimportant
3.13.18	Electronic mail and messaging	1	2	3	4	5
3.13.19	Collaborative Internet-based applications	1	2	3	4	5
3.13.20	Desktop video and real-time data conferencing	1	2	3	4	5
3.13.21	Electronic meeting systems	1	2	3	4	5
3.13.22	Group calendering and scheduling	1	2	3	4	5
3.13.23	Group document handling	1	2	3	4	5
3.13.24	Groupware applications and services	1	2	3	4	5
3.13.25	Groupware frameworks (group support systems)	1	2	3	4	5
3.13.26	Non real-time data conferencing	1	2	3	4	5
3.13.27	Paper and pen	1	2	3	4	5
3.13.28	Video conferencing	1	2	3	4	5
3.13.29	Visual Aids	1	2	3	4	5
3.13.30	Workgroup utilities and development tools	1	2	3	4	5
3.13.31	Other (specify):	1	2	3	4	5

3.14 OTHER

To what extent do the following factors influence the success of the requirements elicitation process?

		Significant influence	Influence	Undecided	Barely influence	No influence
3.14.1	Age	1	2	3	4	5
3.14.2	Atmosphere of the elicitation environment	1	2	3	4	5
3.14.3	Eating and drinking	1	2	3	4	5
3.14.4	Experience	1	2	3	4	5
3.14.5	Facilitation	1	2	3	4	5
3.14.6	Facilitator's skill	1	2	3	4	5
3.14.7	Follow-up meetings	1	2	3	4	5
3.14.8	Gender	1	2	3	4	5
3.14.9	Industry Knowledge	1	2	3	4	5
3.14.10	Job Experience	1	2	3	4	5
3.14.11	Length of interactions / meetings / sessions	1	2	3	4	5
3.14.12	Meeting management	1	2	3	4	5
3.14.13	Smoking	1	2	3	4	5
3.14.14	Tea breaks	1	2	3	4	5
3.14.15	Other (specify):	1	2	3	4	5

How important to the success of the user requirements elicitation process, are the following issues?

		Very important	Important	Undecided	Unimportant	Totally unimportant
3.14.16	Organised process	1	2	3	4	5
3.14.17	Rational process	1	2	3	4	5
	Other (specify):					
3.14.18		1	2	3	4	5
3.14.19		1	2	3	4	5
3.14.20		1	2	3	4	5

End Time:

Thank you very much for taking the time to complete this survey.

Appendix C
Revised Requirements Elicitation Communication Taxonomy

This taxonomy is a list of terminology relevant to communication in the requirements elicitation process. The list is organised in sections which represent specific areas of the 'requirements elicitation communication model' presented in chapter 5. All terminology which appears in this list is defined and/or explained in the Glossary.

1 GENERAL TERMINOLOGY RELEVANT TO THE MODEL
1.1 Communication
1.2 Interpersonal interaction
1.3 Interpersonal communication

1.4 Interpersonal interaction and communication structure
1.4.1 Informal
1.4.2 Formal
1.4.2.1 Chaired
1.4.2.2 Facilitated
1.4.3 Continuity
1.4.4 Feedback
1.4.5 Norms
1.4.6 Organised
1.4.7 Rational

1.5 Interpersonal interaction and communication network
1.5.1 Psychographics
1.5.2 Structure

2 ENVIRONMENT
2.1 Organisation characteristics
2.1.1 Organisational culture
2.1.2 Organisational networks
2.1.3 Politics

3 REQUIREMENTS ELICITATION ENVIRONMENT
3.1 Locality
3.2 Atmosphere

3.3 Ergonomics
3.3.1 Position of tools and technology
3.3.2 Type and Position of furniture
3.3.3 Venue

4 CONTEXT
4.1 Group characteristics
4.1.1 Number of participants
4.1.2 Authority of participants

4.2 Requirements elicitation method
4.2.1 Structured
4.2.1.1 Formal meeting
4.2.1.2 Interview
4.2.1.3 Workshop
4.2.1.4 JRP
4.2.1.5 RAD
4.2.1.6 EIP
4.2.1.7 Questionnaire
4.2.1.8 UIA
4.2.2 Unstructured
4.2.2.1 Ad hoc meeting
4.2.2.2 Prototyping
4.2.2.3 Workshop
4.2.2.4 Observation
4.2.2.5 Document review
4.2.2.6 Current systems analysis

4.3 Requirements elicitation objectives
4.3.1 Goal setting and definition
4.3.2 Expectations clarification and management
4.3.3 Information elicitation
4.3.4 Information sharing
4.3.5 Brainstorming
4.3.6 Dealing with ambiguity
4.3.7 Problem solving
4.3.8 Conflict Management
4.3.9 Negotiation
4.3.10 Persuasion
4.3.11 Decision making

5 PARTICIPANTS
5.1 Human characteristics
5.1.1 Age
5.1.2 Aura
5.1.3 Behaviour
5.1.4 Bias
5.1.5 Culture
5.1.6 Experience
5.1.7 Income
5.1.8 Intellect
5.1.9 Memory
5.1.10 Perception
5.1.11 Personality
5.1.12 Power
5.1.13 Self-perception
5.1.14 Socialisation
5.1.15 Status
5.1.16 Values

5.2 Psychological Factors (Mind set)
5.2.1 Attitude
5.2.2 Commitment
5.2.3 Ethos
5.2.4 Expectations
5.2.5 Mood
5.2.6 Motivation
5.2.7 Preconceived ideas (environment, process, people)
5.2.8 Role

5.3 Interpersonal Skills
5.3.1 Literacy
5.3.2 Oral Literacy

5.4 Interpersonal Communication Tools
5.4.1 Speech
5.4.1.1 Enunciation
5.4.1.2 Flow
5.4.1.3 Grammar
5.4.1.4 Language
5.4.1.5 Pace
5.4.1.6 Pronunciation
5.4.1.7 Style
5.4.1.8 Tone
5.4.1.9 Words used
5.4.2 Voice
5.4.2.1 Pitch
5.4.2.2 Tone
5.4.2.3 Volume
5.4.3 Body Language
5.4.3.1 Chronemics
5.4.3.2 Kinesics
5.4.3.2.1 Facial expressions
5.4.3.2.2 Gestures
5.4.3.2.2.1 Sign language

5.4.3.2.2.1.1 Emblems
5.4.3.2.2.2 Action language
5.4.3.2.2.2.1 Adaptors
5.4.3.2.2.2.2 Displays
5.4.3.2.2.2.3 Illustrators
5.4.3.2.2.2.4 Movements indicative of character
5.4.3.2.2.2.5 Regulators
5.4.3.2.2.2.6 Ritual gestures
5.4.3.2.2.3 Object language
5.4.3.2.2.3.1 Clothing
5.4.3.3 Appearance
5.4.3.3.1 Face
5.4.3.4 Eye contact
5.4.3.5 Haptics
5.4.3.6 Perspiration
5.4.3.7 Paralinguistics
5.4.3.8 Proxemics (spatial relations)
5.4.3.8.1 Body contact
5.4.3.8.2 Body pointing
5.4.3.8.3 Orientation
5.4.3.8.4 Proximity
5.4.4 Scent

5.5 Barriers

6 ANALYST
6.1 Approach
6.1.1 Awareness of the complexity and size of the organisation
6.1.2 Respect for the organisation
6.1.3 Respect for the end-user

6.2 Process Management
6.2.1 Preparation
6.2.1.1 Logistical arrangement
6.2.1.1.1 Participant selection
6.2.1.1.2 Participant scheduling
6.2.1.1.3 Resource sourcing and scheduling
6.2.1.2 Participant training
6.2.1.3 Team building
6.2.1.4 Select exercises
6.2.1.5 Agenda
6.2.1.6 Minutes
6.2.1.7 Project Schedules
6.2.2 Documentation

6.3 Tools used
6.3.1 Decision making
6.3.1.1 Consensus
6.3.1.2 Decision / impact analysis
6.3.1.3 Decision matrix
6.3.1.4 Decision tree
6.3.1.5 Voting
6.3.2 Problem solving

6.4 Techniques used
6.4.1 Activity dependency diagram
6.4.2 Activity hierarchy diagram
6.4.3 Attribute definitions
6.4.4 Data flow diagram
6.4.5 Data Model (Entity-relationship diagram - ERD)
6.4.6 Dependency analysis
6.4.7 Entity definitions
6.4.8 Procedure analysis: current systems
6.4.9 Process decomposition
6.4.10 Process dependency analysis
6.4.11 Screen flow
6.4.12 Structure chart
6.4.13 System overview model

7 MESSAGE

8 CHANNEL
8.1 Medium
8.1.1 Face-to-face
8.1.2 Computer mediated
8.1.3 Communication Techniques used
8.1.3.1 Brainstorming
8.1.3.2 Decision making
8.1.3.3 Displayed thinking
8.1.3.4 Problem solving
8.1.4 Tools used
8.1.4.1 Visual Aids
8.1.5 Technologies used
8.1.5.1 Automated Design
8.1.5.2 CASE
8.1.5.3 Drawing
8.1.5.4 Electronic mail and messaging
8.1.5.5 Group calendering and scheduling
8.1.5.6 Group document handling
8.1.5.7 Hand writing
8.1.5.8 Paper and pen
8.1.5.9 Project scheduling
8.1.5.10 Spreadsheet
8.1.5.11 Word processor

8.2 Mode
8.2.1 Written
8.2.2 Verbal
8.2.3 Nonverbal

8.3 Noise

9 OUTCOMES
9.1 Trust
9.2 Buy-in
9.3 Requirements Definition
9.4 Requirements Specification
9.5 Stakeholder commitment
9.6 User satisfaction
9.7 User acceptance

Appendix D
Coleman's Groupware Taxonomy

Groupware Taxonomy

Coleman (1997:2-9)

FUNCTIONAL CATEGORY and DESCRIPTION	**ISSUES**	**SAMPLE PRODUCTS**
Electronic Mail and Messaging: includes messaging infrastructures and e-mail systems	< Standards, XAPI, MAPI, X.400, X.500 (directory services). < How to integrate multiple mail systems in one enterprise. < Security, and hwo owns my e-mail? < Etiquette and the efficient use of e-mail. < Filters, agents and the ability to deal with 100s of messages a day.	cc:mail - Lotus Microsoft Mail/Exchange Banyan Intelligent Mail - Banyan Eudora - Qualcomm QuickMail - CE Software OracleMail - Oracle Pegasus Mail
Group Calendaring and Scheduling: products for calendar, meeting, and resource coordination	< Proliferation of meetings because they are now easier to schedule. < Privacy for personal calendars (big brother is watching!) < Having enough users in the company to make it worthwhile. < Scheduling across multiple time zones.	Lotus Organiser - IBM/Lotus Synchronise - CrossWind Technology Microsoft Schedule + Pencil Me In - Sarrus Software OnTime - FTP Software Meeting Maker - On Technologies Network Scheduler - CE Software CaLANdar - Microsystems Software
Electronic Meetings Systems (EMS): real-time conferencing systems (local and remote) as well as collaborative presentation systems)	< Integration with calendaring/scheduling systems. < Post-meeting follow through; action items, goals, commitments. < Affordability of desktop conferencing. < Availability of multi-point conferencing. < Lack of standards is limiting the application of this technology. < Acceptance within the corporate culture.	Group Systems - Ventana Council Services - CoVision Facilitate.com - McCall Szerdy Assoc. Meeting Works 2 - Enterprise Solutions Option Finder - Option Technologies TeamTalk - Trax SoftWorks

Desktop Video and Real-time Data Conferencing (Synchronous): emphasis on real time, plus store documents and/or allow others to see and work on the same document simultaneously, whether on each others' screens or on a shared whiteboard.	< Control of the cursor on the screen? < Number of people who can conference efficiently? < Role of the facilitator. Is a facilitator needed? < Interaction/baud rates, equipment compatibility. < Internet and intranet availability. < Post-meeting follow through; action items, goals, commitments.	ShowMe - Sun Solutions Aspects - Group Logic, Inc. NetMeeting - Microsoft CoolTalk - Netscape RoundTable - ForeFront Group Being There - Intelligence at Large PictureTalk - Picture Talk FarSight - Databeam
Non Real-time Data Conferencing (Asynchronous): like a bulletin board, where a conversation takes place over time; messages are left and answered later. Messages may be public or private.	< Number of people who can conference efficiently? < Role of the facilitator. Is a facilitator needed? < Maximising the benefits of conference/discussion databases; ROI. < Replication, network topologies, scalability. < Transaction-based vs. store and forward databases. < Support for worldwide locations. < Integration with legacy systems. < Integrating with electronic calendaring and scheduling systems. < Post-meeting follow through; action items, goals, commitments.	TeamTalk - Trax SoftWorks Pacer Forum - NetManage Lotus Notes - IBM/Lotus InterOffice - Oracle WebBoard - O'Reilly WebShare - RadNet FirstClass - SoftArc Inc. News Server - Netscape
Workflow: workflow process diagramming and analysis tools, workflow enactment engines, electronic forms routing products	< Workflow coalition standards. < Passing documents and information between products. < Automating poor processes. < Integration with EDI and other customer services.	Workflow Analyst - Action Technology Staffware for Windows - Staffware Open Workflow - Wang Metro - Action Tehcnologies JetForm - JetForm Corp. Formflow - Symantec Flowmark - IBM Workflow BPR - Holosofx
Group Document Handling: group editing, shared screen editing work, group document/image management and document databases	< Page markup standards such as SGML, HTML, and CALs? < Support for word processors and page layout programs. < Version control and document security. < Integration with enterprise document/image databases or repositories. < Where does group document management stop and multimedia begin? < Data integrity and integration with other documents and repositories. < Compression issues.	Face-to-Face - Crosswise MarkUp - Mainstay Software Documentum - Documentum Inc. OnGo Document Management - Uniplex

Workgroup Utilities and Development Tools: utilities to support, group working, remote access to someone else's computer, and specific tools for workgroup application development.	< What functionality should be part of the operating system (o/s) and what functionality should be part of the application? < What are the decision-making issues when deciding whether to develop for the o/s, graphical user interface (GUI), or network? < How to insure issuer compatibility; standards; object-oriented (reusable) code; licensing (network, multimedia, intellectual property rights).	Windows for Workgroups - Microsoft Lotus Notes - Lotus InterOffice - Oracle CoEX - Twin Sun Replictaion Reporter - Ernst & Young ReplicAction - Cassal
Groupware Frameworks: focuses on products that help integrate "islands of collaboration" to realise seamless integration across computer platforms, operating systems, e-mail systems, and network architectures.	< Integrating the desktop while supporting collaborative efforts. < Security. < Can frameworks-products help collaboration outside of the organisation? < Will establishing groupware standards make frameworks less attractive?	GroupWise - Novell TeamOffice - ICL/Fujitsu GoldMetal Workgroup - Decathlon Lotus Notes - Lotus/IBM OpenDoc - Apple/IBM OpenMind - Attachmate
Groupware Services: services to support collaboration.	< Expertise is a most valuable commodity in the groupware market. It is highly unusual to find all the necessary expertise in-house. Additionally, no single vendor offers a complete groupware solution and re-engineering often requires multiple products and service v4endors in order to collaborate. How do you identify and pull together the resources best suited to your organisation? < How are meetings facilitated succesfully? < What tools are best suited for requirements elicitation-engineering? < How do users identify the problems with the greatest potential for turnaround from groupware? < How are consultants best used? What do they know that people in your organisation don't? < It is imperative that top management and all stakeholders support any	Planning and implementation Application development Training and maintenance Change management Business process re-engineering Knowledge management Electronic meeting facilitation Consulting

Groupware Applications: vertical applications that use collaborative technologies to either enhance processes o support collaboration in a specific work environment.	< Customising applications; infrastructure and cost issues. < Vertical market competition. < Does application solve specific collaborative business need? < Integration with existing legacy systems.	BAI-5000 Distribution Management System - Business Automation Patient Tracking System - Management Directions CustomerFirst - Repository Technologies HelpDesk - Trellis ProTEAM - Scopus CenterPoint - Bank of Montraal
Collaborative - Internet-based Applications and Products: use the Internet as the input and output while still using traditional groupware on the LAN.	< Application customisation fro seamless collaboration on the WWW. < Costs of publishing to/from the WWW. < Data/information storage. < Balance between security and collaboration. < Limitations of traditional groupware relative to WWW applications. < Limitations of WWW applications relative to traditional groupware. < Integration with existing legacy systems.	InterNotes Publisher - IBM/Lotus RoundTable - The ForeFront Group SamePage - WebFlow PCS 50 - PictureTel Metro - Action Technologies

Appendix E
EWG/IVC Services Taxonomy

DRAFT

EWG/IVC Services Taxonomy

2/3/97

http://www.nist.gov/itl/div894/vvrg/nist-icv/pages/services.html

People collaborate in order to share information and solve problems: perhaps thousands of years ago speech evolved as a natural tool for cooperation. However, writing was invented as a technology for enlarging man's memory and communicating information asynchronously. Within the last fifty years, computers and networks have been invented to store vastly enlarged quantities of information, solve problems rapidly and communicate information and solutions to audiences, small or large. Collaborative computing is not new, since E-mail, news groups and file transfer have been gaining popularity over the last 15 years as ways of sharing information with other individuals and groups, and with indefinitely large audiences over unbounded time spans.

However, the introduction of multi casting, hypertext, audio and video encoding techniques and techniques for sharing windowing environments is providing enlarged technological support for collaborative problem solving. But the introduction of diverse collaborative computing solutions brings further problems: which is the best technology for solving a particular problem? Are there problems for which no collaborative solution exists, which can only be solved by physical and temporal collocation of the task force?

In order to develop a mapping from human problems onto technological solutions it seems necessary first to define a set of problems which are usually amenable to group solution and perhaps provide a stepwise decomposition into functional primitives. This might then lead to classifying problems into their functional requirements, on the one hand, and collaborative tools into their functional solutions, on the other. A method may then be developed for selecting appropriate technological solutions. It may also be possible to classify problems which can be solved using collaborative computing technologies which have hitherto not been amenable to solution at all.

This section of the Evaluation Methodology document essays a classification of typical collaborative activities into domains in which functional characteristics can be identified. The Terms used in the remainder of the document are defined in 3.1 and Subsection 3.2 develops a view of the services which stand between tasks and technologies, to assist in providing a selection function for scenarios. Subsection 3.3 summarizes.

Definition of Terms

This Evaluation program is concerned with the three principle variables of task, technology and people. We know that people are the human actors who engage in collaborative activity, but what do we mean by task and technology? and are there levels of abstraction between them, or orthogonal to them?

We define task as a collaborative activity that a system might support. Service is defined as the capabilities of a system for providing support for a task. Technology is the hardware, software and interconnections that make it possible to instantiate a service. For example, a task is to hold a meeting. The services needed to support this are at a minimum: a synchronous mode for conversation, sharing of common documents, and single point of control of the session. One set of technologies to support this is: synchronous audio, shared display for briefing slides, and session management via E-mail to establish timing and the point of contact for the briefing slides.

A proposed taxonomy of Services is developed in the next subsection, in terms of capabilities and their abstractions.

Abstractions of Services

1. Awareness: Awareness of objects and their attributes. This ability can be specialized for the sub task to indicate the objects and attributes participants need access to, such as (people / availability to participate in collaboration), (people / areas of expertise), (documents / means of viewing), (applications / who can run), etc... Awareness can be maintained through such as the following:
    1. Radar views.
    2. Group versions of traditional widgets, such as multiuser scrollbars.
    3. Graphical activity indicators.
    4. Auditory cues.
2. Coordination (management), it relates to the mechanisms and rules established to use shared resources, such as:
    1. Basic features: Concurrency control, access control, session establishment.
    2. Technologies: Calendar and scheduling, workflow management, project management.
    3. Linguistic Communication: Synchronous or Asynchronous; with 1 or multiple people; private or public; visible or invisible (i.e. do others know they are communicating).
3. Capabilities:
    1. Human Communication (or Communication with Intelligent Agents).
    2. Coordination/Collaboration Management (e.g. lecturing, brainstorming, command and control).
    3. Integration (e.g. ability to move data/content between multiple services, translation between modalities).
    4. Persistent Shared Object Manipulation (e.g. ASCII, 2D or 3D objects).
    5. Archival and Review of Collaborations .
    6. Sharing Capabilities:

1. Shared Context (knowledge).
2. Awareness of how others are using shared objects.
3. Shared work spaces.
4. Visualization.

7. Sharing (work space), it relates to those tools that allow a shared input from participating team members, such as:
    1. Realtime: Whiteboards, application sharing, meeting facilitation, Multi User Dungeons, virtual worlds.
    2. Asynchronous: Information and document management, threaded discussions, hypertext.
8. Sharing Data, specifying: document type, who can see it, who can annotate it, who can modify it, for example:
    1. Sharing a static document.
    2. Sharing a changing document in a Master-Slave mode (only one person can make changes, but multiple people can see the changes as they occur).
    3. Sharing a changing document in Peer-to-Peer mode without shared objects (where everyone can add annotations to the document, but no one can change anyone else's annotations or the base document).
    4. Sharing a changing document in Peer-to-Peer mode with some shared objects (where participants can change some of the objects in the document that they did not create, i.e. the base documents and others' changes).
    5. Sharing a changing document in Peer-to-Peer mode with shared objects (where anyone can change any object in the document, including the base documents and others' changes).

4. Ability to establish a collaboration...
    1. with unlimited participants.
    2. with a limited set of participants.
5. Ability to review a prior collaboration...

   1. in which you were involved.
   2. in which you were not involved.
   3. for which you don't have all the tools used in the original collaboration.
6. Ability to transport data using different channels of communication.
7. Interactive (communication), it deals with means of communication and models of interaction among participants, such as:
   1. Realtime: Audio and video conferencing.
   2. Asynchronous: E-mail.
8. Integration, it relates to understanding the language format of other software packages, such as:
   1. Links with the Web (i.e., recognition of html, java applets).
   2. Links with user-specified editors (i.e., EMACS, Microsoft Word, WordPerfect).
9. Object, it relates the use of icons to encapsulate functional behaviour, such as:
   1. a contained audio clip.
   2. a contained video clip.
   3. a contained document embedded with knowledge of the editor that created it.
10. Visualization (presentation), used to establish how participants, artifacts, and tools are displayed. It includes the aspects such as WYSIWIS and man-machine interaction, such as:
    1. Windowing capabilities across platforms.
    2. 2D and 3D presentation capabilities.
11. Participation (. . . to User Interface), it defines mechanisms that determine how participants interact with the application, such as:
    1. Help menus.
    2. Tutorials.
    3. Directive error messaging.