EXPLORATIONS OF KNOWLEDGE MANAGEMENT IN A DEFENCE ENGINEERING ENVIRONMENT

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ABSTRACT

This thesis originates from first hand early experiences of the researcher regarding current processes and practices in operation in BAE SYSTEMS Ltd (now referred to hereafter as 'the Company'), and recognises the potential for improvement within the realm of knowledge management. The huge volume of internal and external information overwhelms the majority of organisations and knowledge management provides solutions to enable organisations to be effective, efficient, and competitive. The software agent approach and information retrieval technique indicates great potential for effectively managing information.

This research seeks to answer the questions of whether software agents can provide the Company with solutions to the knowledge management issues identified in this inquiry and whether they can also be used elsewhere within the organisation to improve other aspects of the business. The research analysis shows that software agents offer a wide applicability across the Company; can be created with relative ease and can provide benefits by improving the effectiveness and efficiency of processes. Findings also provided valuable insight into human-computer-interface design and usability aspects of software agent applications. The research deals with these questions using action research in order to develop a collaborative change mechanism within the Company and a practical applicability of the research findings in situ. Using a pluralistic methodology the findings provide a combination of the subjective and objective views intermittently within the research cycles thereby giving the researcher a more holistic view of this research.

Little attention has been paid to integrating software agent technologies into the knowledge management processes. This research proposes a software agent application that incorporates: (1) Co-ordination of software agents for information retrieval to manage information gathering, filtering, and dissemination; (2) To promote effective interpretation of information and more efficient processes; (3) Building accurate search profiles weighted on pre-defined criteria; (4) Integrating and organising a Company resource management knowledge-base; (5) Ensuring that the right information gets to the right personnel at the right time; and (6) So the Company can effectively assign the right experts to the right roles within the Company.

Keyword: knowledge management; software agents, defence, usability

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ACKNOWLEDGMENTS

This research was undertaken as an opportunity to investigate the Company's use of information and knowledge and to establish a practical application through analysis and design, which will benefit the Company as a specific outcome of this research. Software intelligent agents were the technological mechanism for this innovation.

The author wishes to thank the supervisory assistance from Bournemouth University, in particular the encouragement and advice given by Professor Colin Armistead, Professor Brian Hollocks and Dr Julia Kiely. The ability to carry out this thesis would not be possible without the assistance of BAE SYSTEMS Ltd., Christchurch and in particular Dr Derek Rigler and Mr David Hoyle. I would also like to thank those who have supported and encouraged my completion of this course and include my parents, and close friends Andrew Wilson, Hazel and Mike Aston and Susan and Tony Birtwell.

AUTHOR'S DECLARATION

This research has been created in collaboration with BAE SYSTEMS Ltd., Christchurch, Dorset (UK) who have provided the data used and facilitated the access to the information required for its completion. All names and identifiable projects have been deliberately concealed within the content of this thesis for confidentiality purposes. No material in this thesis has been presented before and it is wholly my own research.

INTRODUCTION

This introduction identifies the overview of the thesis in a summary format in order to give the reader an overall insight into the research.

The Scope of this Research

This research takes place within the confines of BAE SYSTEMS Ltd., where the main source of data has been isolated and analysed. BAE SYSTEMS Ltd. is a defence engineering organisational environment, which has its own bearing upon the research. The Company exists as a supplier of defence software systems and services. In this market there are few competitors since the players are either very big or very small players. The former are far less in number and offer extremely similar solutions whereas the latter are more commercially aware, often with more modern technological approaches and provide only small and specific elements of a much larger contract.

My original interest in knowledge management and organisational effectiveness evolved out of my early months working at BAE SYSTEMS where I had views of processes and project management issues which I initially felt were inefficient and to some degree ineffective. This inspired me to examine the literature in the knowledge management domain for some guidance, understanding and possible solutions. As for my interest in the area of software agent technology this developed through a piece of work I undertook at BAE SYSTEMS for an innovation award. This piece of work uncovered the potential of this technology for application within my originally chosen domain of knowledge management on the DBA.

The creation of an effective mechanism for managing organisational knowledge has been on the agenda for many companies at the forefront of business in the twenty-first century. To this end I examine the scope and definitions within the knowledge management domain in order to establish my premise for the research. This is followed by an evaluation into the organisational need to manage its knowledge and the applicability of software agents as a candidate solution.

Software agents have been undergoing increasing research over the past five years as the potential for resolving many information or knowledge management based issues. They are particularly suited to filtering and reducing the amount of information available to individuals. They are also conducive to automating tasks and to identifying and retrieving specific information.

The aim of this research will be:

- To understand the literature on knowledge management in order to identify areas of weakness and strength for use within the scope of this research
- To investigate the knowledge management problems in existence within BAE SYSTEMS through investigation into the Company's current practices
- To examine the effectiveness and appropriateness of the application of an intelligent software agent application for the resolution of knowledge management issues which have arisen within this research.
- To demonstrate through the practical implementation of this technology. This will then be analysed and compared with the original findings to establish improvements made.

Overview

The first research cycle is an exploratory element of the research (Figure 0-1). It examines the current situation in the Company for the retrieval and efficient distribution of information. It seeks to identify the employees' views and opinions of the information they require in order to carry out their roles effectively within a large engineering corporation. This cycle involves the collection and assimilation of data from thirty interviews. The interviews are conducted in the same environment and have the same open-ended single question thereby retaining as much equality as possible with every individual interview. The data collected in this cycle is divided into two major groups – manager and engineer. The views of the management and engineering groups are likely to give a business and an engineering perspective respectively. The aim of this cycle is to identify all the sources of information relating to information systems and the associated problems and issues divulged by the employees. This information is coded and discussed in detail in this thesis.

The second cycle of the research takes the problems identified and refines these to a sub-set that can be investigated further (Figure 0-1). In this cycle the main problem areas are clustered and some are excluded from further research. The aim of this cycle is to adequately identify a suitable set of problems, which could be addressed using software agent technology. The cycle identifies three potential areas for the application of this technology and several other areas that can also be addressed by this research. Further investigation is then carried out using various methods of analysis in order to identify one area for the application of software agents.

Cycle three begins by identifying the technology in more detail and provides the reader with far more information regarding the application of such technology (Figure 0-1). Secondly, the cycle takes the resource management problem area identified in cycle one and examines it in more detail using a software demonstrator. A quasi-experiment is set up and tested to identify whether this kind of application can resolve any of the identified problems.

The final elements of this thesis concern the re-engagement with the literature and a discussion of the theory and practice, followed by the reflective practitioner view that examines the action research cycles learning. These are followed by a short summarised conclusion of the research conducted.

The research relies heavily upon the collection of data from surveys, interviews and questionnaires, which are presented in the Appendices of this thesis.

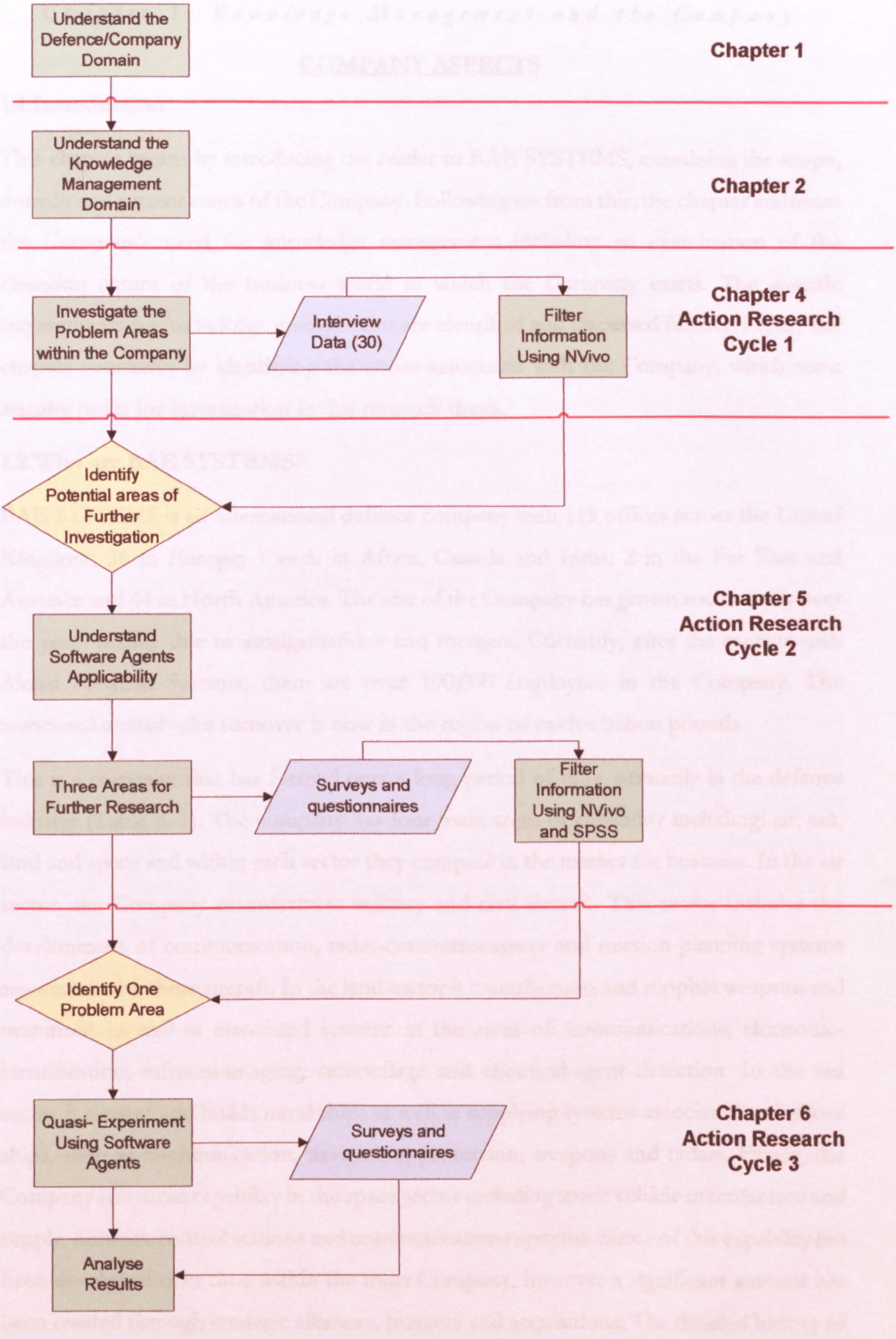


Figure 0-1: Research Cycles Mapped

COMPANY ASPECTS

1.1 Introduction

This chapter begins by introducing the reader to BAE SYSTEMS, examining the scope, domain and current status of the Company. Following on from this, the chapter addresses the Company's need for knowledge management including an examination of the changing nature of the business world in which the Company exists. The specific requirements for knowledge management are identified and discussed further. Finally the chapter concludes by identifying the issues associated with the Company, which are a starting point for investigation in this research thesis.

1.2 Who are BAE SYSTEMS?

BAE SYSTEMS is an international defence company with 119 offices across the United Kingdom; 36 in Europe; 1 each in Africa, Canada and India; 2 in the Far East and Australia and 44 in North America. The size of the Company has grown successively over the years mainly due to amalgamations and mergers. Currently, after the merger with Alenia Marconi Systems, there are over 100,000 employees in the Company. The associated annual sales turnover is now in the region of twelve billion pounds.

This is a company that has formed over a long period of time, primarily in the defence industry (Table A-1). The company has four main areas of capability including: air, sea, land and space and within each sector they compete in the market for business. In the air sector, the Company manufactures military and civil aircraft. This sector includes the development of communication, radar-countermeasures and mission-planning systems associated with these aircraft. In the land sector it manufactures and supplies weapons and munitions as well as associated systems in the areas of: communications, electronic-identification, infrared-imaging, camouflage and chemical-agent detection. In the sea sector it designs and builds naval ships as well as supplying systems associated with those ships, such as communication, navigation, protection, weapons and radars. Finally, the Company has some capability in the space sector including space vehicle manufacture and supply, network control stations and communications systems. Some of this capability has been developed over time within the main Company, however a significant amount has been created through strategic alliances, mergers and acquisitions. The detailed history of the significant events leading to the Company we see today is amalgamated in Appendix A. From this table it is possible to see how the Company has moved with the economic changes, we see its early diversification and later the sale of those diversified elements. All of this information has led to the current Company in existence today with its associated complexity and its all-time-high staffing and defence business growth. All of this information is the historical backdrop against which this thesis is written. This also provides the context against which knowledge management is carried out and this is seen to be potentially difficult, for example, by having so many different directions – even the defence market may not be the most appropriate method in which to manage the Company's knowledge.

Appendix A gives a strong indication of the way in which the Company has developed its capabilities in the areas of systems integration and prime contractorship, warship design and development, radar systems, communications and associated management systems, C4I systems, naval combat systems, logistics operational analysis, simulation and modelling, air support systems, underwater systems and sensor systems including unmanned air vehicles.

1.3 Why is knowledge management important to BAE SYSTEMS?

In examining all of the sectors identified in the previous section it is clear that there is a great diversity of applications in the product ranges and associated systems development as well as the integration and services provided with these. The size of this Company is far greater than it was, say, ten years ago and the number of international sites and employees all add to the complex nature of the Company as a whole. Within these realms there is a great deal of knowledge and associated information that must be managed in order for successful outcomes to be achieved for the business. When exploring the company from a purely defence perspective there are specific aspects of knowledge which are far more important to the Company than to other industry sectors.

In the first place there is the whole aspect of creating new knowledge through the discovery and use of information that is interpreted. This can be tacit in nature and based upon an individual's understanding or learning experience. Employees at all levels within the Company gain knowledge and experience that may never be captured and utilised by others (Von Krogh et al., 2000). This aspect is familiar to most organisations but with the growth and the large scale of diversity and amalgamation or mergers of BAE SYSTEMS over the years the scope for new knowledge is potentially very high.

Then there is the aspect of knowledge protection, which includes the security aspects of that knowledge as well as the business element of intellectual property rights (IPR) (Wiig, 1997a). The IPR can be seen as an asset on the Company's accounts too. Protecting the knowledge and information relating to secure systems is dealt with by having individuals' security cleared before being offered a position with the Company. Secondly, individuals sign the Official Secrets Act on admission, which ties them to remaining silent about the work they do and the projects that the Company is working on. Remaining quite closed about the types of devices, products and systems the Company develops was probably more important during the Cold War period. There has been less secrecy since the end of the Cold War. Even so with the recent advent of growing terrorism in the world this need for enhanced security may once again come to the fore. Here the desire is to keep all information, knowledge and data secret for the protection of the United Kingdom and its people.

There is also the aspect of organisational learning and the whole dimension of making learning and training available across this global Company. Here the Company created one of the very first corporate learning establishments, the Virtual University, in 1998. This deals primarily with the kind of learning that is based upon the training needs of those within the company. But what are not really addressed by the Virtual University are issues like learning from the successes and the mistakes of other projects and past experience; or the cross-pollination of knowledge across the organisation e.g. from project to project.

Finally, there is the whole aspect of retaining the knowledge associated with defence projects that are extremely lengthy. During the length of such a project, knowledge can be lost through staff leaving the project or the Company. It is important to note here that knowledge is limited in its use by a time scale within which it must be utilised. Knowledge has a shelf life, its context and timing is the key to its potential and real value. Unless knowledge is exploited within that time scale there is a risk that either someone else will come along and steal it, or its value will be lost and it will be worthless. The knowledge opportunity is a time-based pattern, whose exploitation creates new value. One other aspect of long-term defence projects is the decisions made early on in a project to adopt particular solutions. This kind of decision can have devastating effects on the successfulness of such projects if the dynamic nature of future technology is not given consideration. Within the Company there appear to be a number of traditional engineers who fail to keep abreast of the new and leading-edge technology that could affect a project outcome. In many cases the longer projects that have been deployed are technologically outdated by the time they are commissioned into the Ministry of Defence. This kind of knowledge and understanding of future trends and predictions of future technological advances is extremely important to these kinds of defence projects.

1.4 The Problems - Why knowledge management?

What is it about knowledge management that makes it so important today? Organisations have begun to recognise that today's markets are changing and that basic products do not differentiate a Company. Instead there is a rise in the service business and the commodity of knowledge. This has been referred to as the knowledge economy (Choo, 1998). The changes in business, which have led to globalisation, have encouraged customers to expect the delivery of expertise, services and products in the global domain. With this the development of technology, which spans the global arena, is not only allowing the transfer of data and information but is less expensive to provide. Other changes include the increased requirement for workers to be mobile and a need to re-skill them for this purpose.

Figure 1-1 (Company Document A21098451) illustrates BAE SYSTEMS current high performance applications; the biggest areas being production (30%), product development (25%) and project management (10%). This figure relates strongly to Figure 1-2 (Company Document A21098451), which examines the primary objectives of that implementation. The emphasis is upon leveraging best practice, creating collaborative project teams and producing a product or supplying a service. All of these activities are part of a knowledge management solution but in this case BAE SYSTEMS are not having much success based upon the research in this thesis.

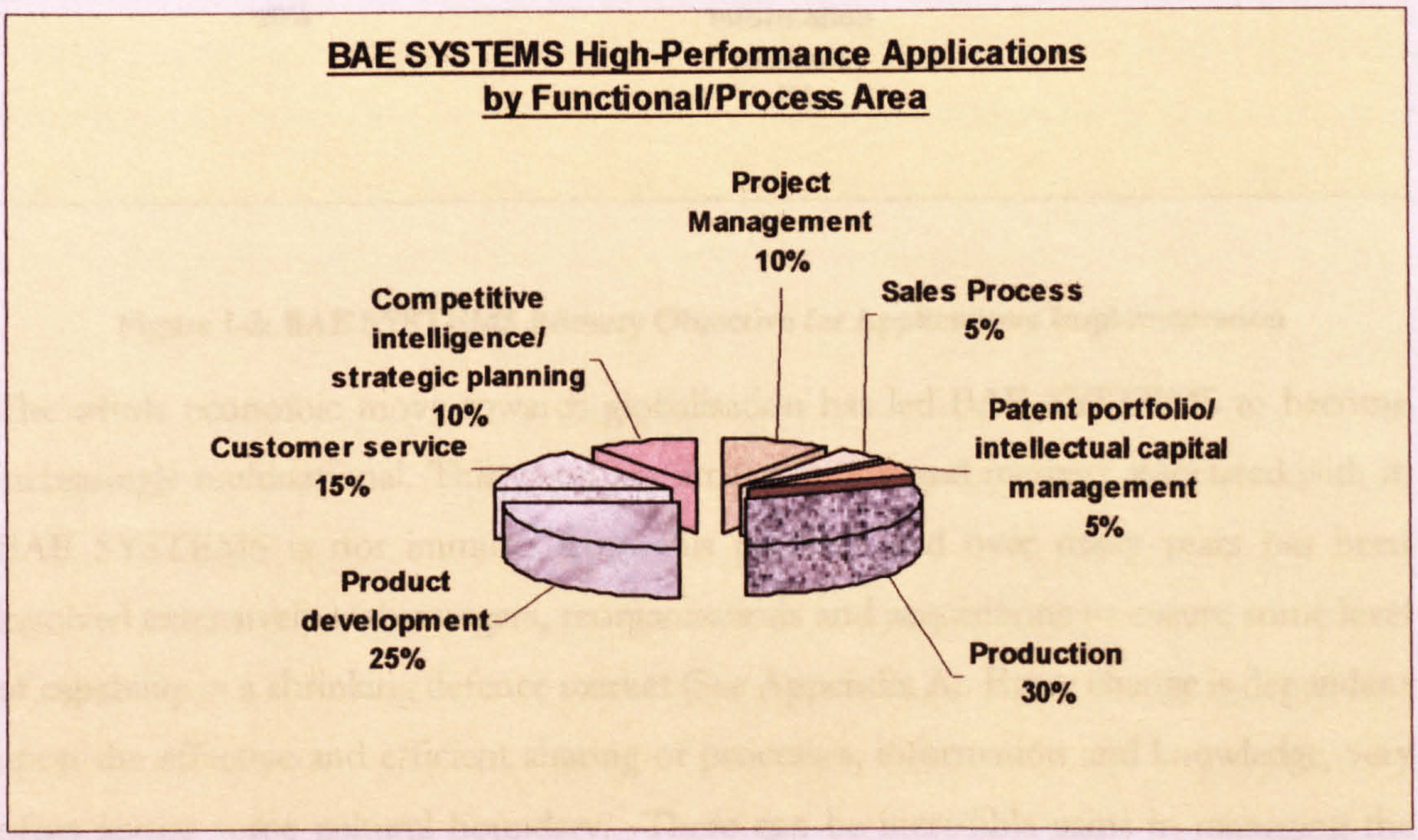


Figure 1-1: BAE SYSTEMS High-Performance Applications by Function/Process

Organisations are increasingly aware of the need to manage their knowledge (Offsey, 1997). The need to share knowledge across Divisions or Departments, across site locations and even internationally is seen as a core competency for BAE SYSTEMS (Newman, 1997). Knowledge management applications enable the delivery of expert knowledge to all sites within the Company. BAE SYSTEMS can assist in preventing the effects of personnel turnover and job changes because knowledge can be captured so that it remains accessible at all times. Knowledge management solutions can also be instrumental in delivering the latest and most-up-to-date answers and information throughout the Company by encouraging knowledge sharing and replication. This ensures that all captured knowledge is current and available.

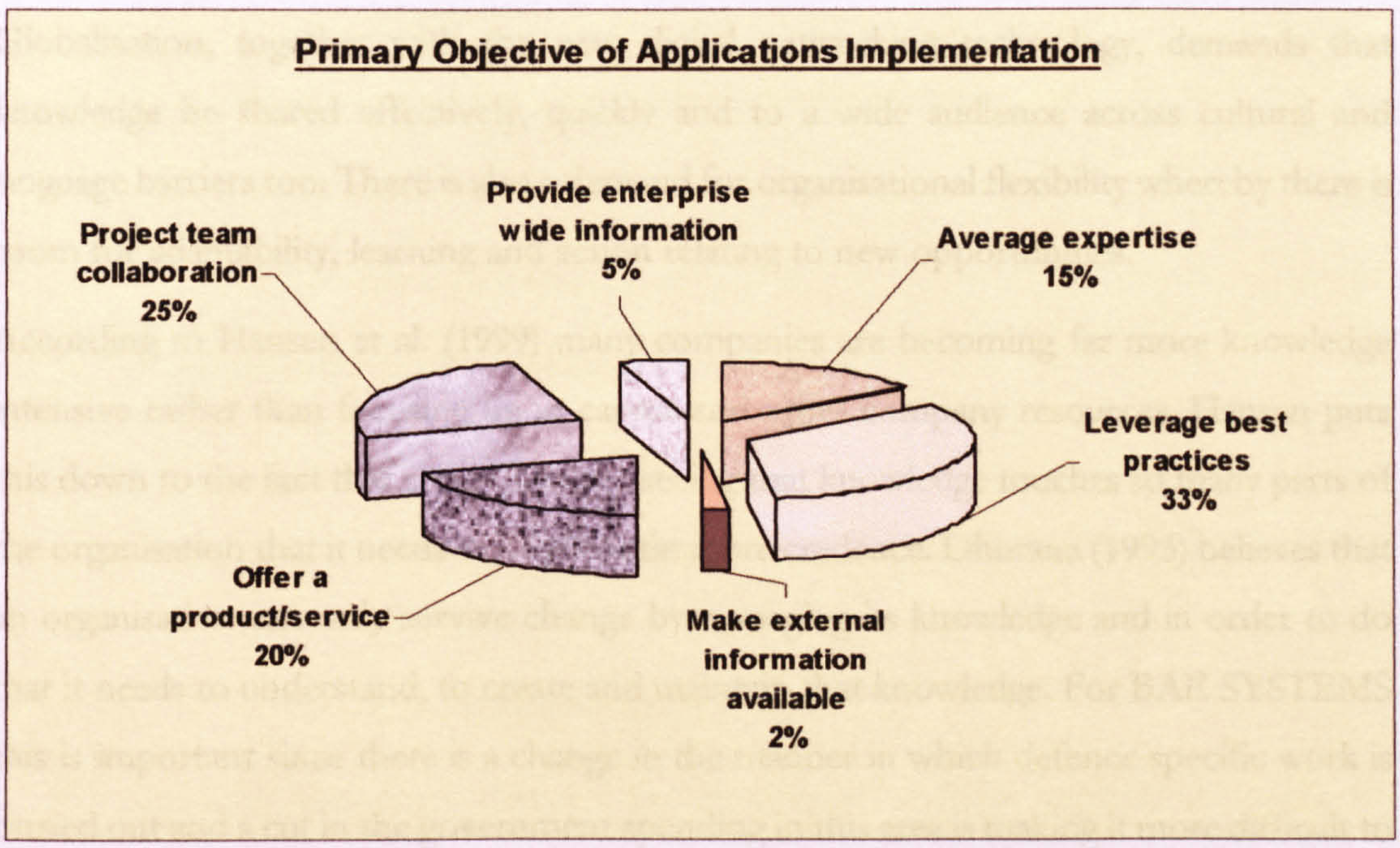


Figure 1-2: BAE SYSTEMS Primary Objective for Applications Implementation

The whole economic move towards globalisation has led BAE SYSTEMS to become increasingly multinational. This trend has amalgamation and mergers associated with it. BAE SYSTEMS is not immune from this pressure and over many years has been involved extensively with mergers, reorganisations and acquisitions to ensure some level of capability in a shrinking defence market (See Appendix A). Every change is dependent upon the effective and efficient sharing of processes, information and knowledge, very often across some cultural boundary. There can be incredible gains in managing the knowledge within the Company, or even considering it before initiating any change.

It is true that in the aerospace defence industry there are only a few suppliers worldwide, and this trend is intensifying. In order to compete with other big competitors in this market BAE SYSTEMS has to be that much better. This puts the onus upon the Company having superior knowledge by identifying what knowledge it has and managing that knowledge thus enabling them to get the competitive edge. In sectors like aerospace and defence, the cost of developing new products can be so high there is little room for mistakes, which may be terminal. Small profit margins mean it is essential to get the right knowledge, which can make all the difference between a profit made from a competitive product and a loss. Therefore if the Company wants to remain competitive in globalisation it needs to be proactive in developing and accessing world-class knowledge and needs to position its intellectual capital. BAE SYSTEMS should examine where it has to foster this world-class knowledge, where it has leading knowledge that is not currently being used, and finally to locate the markets and value chains in where it can use it. Globalisation, together with the new digital networking technology, demands that knowledge be shared effectively, quickly and to a wide audience across cultural and language barriers too. There is also a demand for organisational flexibility whereby there is room for adaptability, learning and action relating to new opportunities.

According to Hansen et al. (1999) many companies are becoming far more knowledge intensive rather than focusing upon capital and other company resources. Hansen puts this down to the fact that companies are seeing that knowledge touches so many parts of the organisation that it needs to be given far more credence. Dhurana (1993) believes that an organisation can only survive change by managing its knowledge and in order to do that it needs to understand, to create and maintain that knowledge. For BAE SYSTEMS this is important since there is a change in the manner in which defence specific work is carried out and a cut in the government spending in this area is making it more difficult to achieve profitable outcomes without some changes to the business.

There are many reasons why knowledge management should be considered by BAE SYSTEMS in order to improve the effectiveness of the Company. There is a need for the Company to gain a better corporate understanding of the business including its core competencies and capabilities. There is also a requirement to access information from various sources, in varied formats and from many locations in order for employees to perform their roles effectively. There is a need for cultural changes and new ways of working. There is also a need to establish the framework and measures required which facilitate the development of new and improved business capabilities and processes. Knowing what knowledge exists in the Company and managing it, will mean an improvement in overall business performance.

1.5 Summary

This chapter has introduced the reader to the scope of BAE SYSTEMS and identified my perceptions of the requirement for knowledge management. Several issues I have raised in this chapter will be investigated during the literature investigation in order to scope the high-level problem domain and these areas can be summarised as:

1. Creating new knowledge for use within the Company including for example:
   - i. Discovering what knowledge already exists in the Company
   - ii. Generating understanding of that knowledge and information
   - iii. Facilitating the utilisation and usability of that knowledge and information
2. Protecting the knowledge within the Company including for example:
   - i. Security considerations
   - ii. Retaining employees
3. Organisational learning including for example:
   - i. Preventing duplication
   - ii. Learning from previous experiences and mistakes - both positive and negative
   - iii. Re-skilling employees
4. Retaining knowledge through the lifecycle of defence projects including for example:
   - i. Retaining employees
   - ii. Making effective decisions concerning future technology
   - iii. Timely use of knowledge
5. General knowledge management issues which affect the above (1-4 points) including for example
   - i. Understanding what knowledge exists in the Company – including information sources and true expertise
   - ii. Facilitating the sharing of knowledge within the Company

Therefore the next step in this research will be to seek to identify the scope of the literature as a means to identify the research boundary and the researcher's perspective.

FROM SMALL ACORNS

2.1 Introduction

This chapter of the thesis deals with the range and importance of knowledge management literature within the scope of the research undertaken. By positioning the work within the existing literature it is an aid to the reader who will be able to understand the scope of my research and the material I have explored throughout my thesis. This thesis also captures literature from relevant domains as necessary.

2.2 Towards a better understanding of the nature of knowledge

Before we can assess the effectiveness of knowledge management within the organisation it is important to clarify the terms, definitions and meanings integral to this thesis. There is a vast amount of literature in the area of knowledge management that approach this subject from many perspectives.

To understand the concept of knowledge and knowledge management we need to start with a definition of the smallest element of the equation, data. Data is the smallest unit of storage; it can be as simple as a single binary digit or as complex as that stored in a relational database (Dhar & Stein, 1997; Newman, 1997). Data is most usually stored in some accessible manner such as in a document or a database. Data is often meaningless out of context, for example the fact that a light is red has no relevance or meaning, unless you are aware that it is in the context of a traffic light or alarm system. Data can show trends or correlation with other bits of data using statistical analysis or similar approaches making comparisons with data (Koch et al., 1996). It is normally highly structured but no interpretation has been added to this raw data (Tirwana, 2000). Importantly for most businesses it is certainly possible to drown in data but thirst for the relevant information.

Information is data in context, which helps to give the data meaning, patterns and shape. Drucker (1999b, p.67) describes information as: "*Data endowed with relevance and purpose*". Devlin (1999 p.337) takes this view further in stating that information is: "*....a 'substance' that can be acquired, stored, possessed either by an individual or jointly by a group, and transmitted from person to person or from group to group*". Converting data to information involves interpretation by valuing the information (Davenport & Prusak, 2000). One failing of information is that it is limited in life span in terms of relevance. "*Understanding the interplay between data, information and meaning will ask much more than sophisticated models of data storage and will force us to understand the process of creating meaning*" (Von Krogh, et al., 2000 p. 24). According to Devlin (1999) people invariably use the words "information" and "knowledge" interchangeably as if to say these are the same things. This is not true. Neither is it correct that "data" is "information".

Understanding will result from the process of converting data into information. When understanding is combined with a person's belief and experience it often leads to decision-making or some other form of action. Understanding and knowledge are related and interdependent. Davenport & Prusak (2000 p.5) define knowledge as: "*Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices, and norms.....Knowledge exists within people, part and parcel of human complexity and unpredictability.*" Devlin (1999) argues that knowledge is *only* in the heads of the individual. But knowledge can be internalised and then converted into information that can be used by others (Von Krogh et al., 2000). This may be harder to achieve (as this thesis will explain later) but it is not impossible. Meaning can also be added to information converting it into knowledge through groups of individuals (Wiig, 1994a). The important aspect is that people add significant value to the information in order for it to be transformed into knowledge.

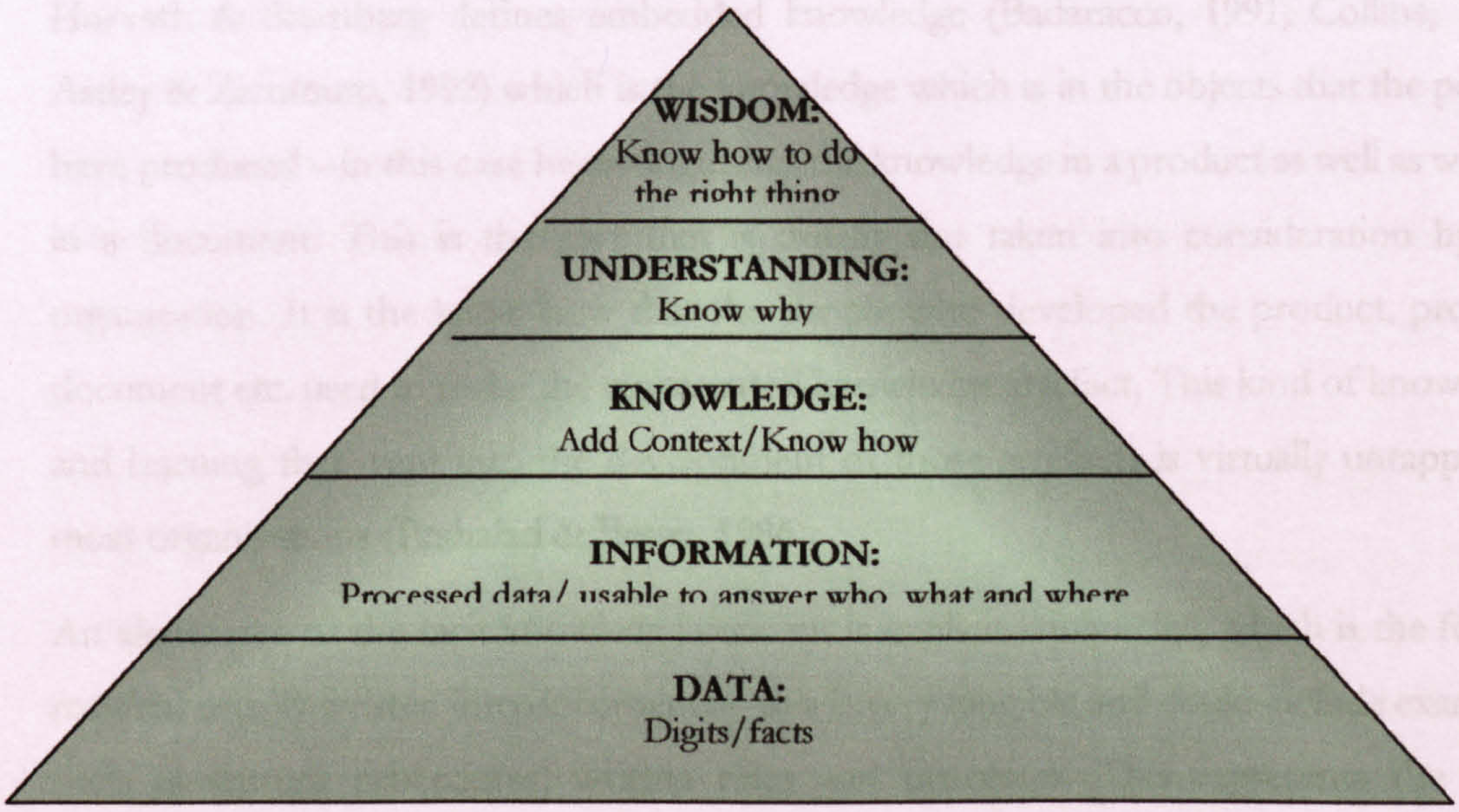


Figure 2-1: Relationship of Concepts of Knowledge to One Another

Wisdom is knowledge used to take the right action to do the right thing (Godbout, 1999). It is based on experience and know-how of the individual or group using it. The dictionary definition includes the ability to act and to think using knowledge, understanding, common sense and insight. It is based on an accumulation of knowledge and understanding. The terms identified have been graphically represented in their relative proportions in Figure 2-1 below:

Other definitions relevant to this thesis and encountered in the literature include tacit knowledge, which has been described as knowledge that is deeply rooted in the mechanisms that individuals use inside their brains to respond to situations (Polanyi, 1958; 1966; 1969). Tacit knowledge often refers to the know-how, intuition, skills and experience an individual has developed and which are extremely hard to capture or share (Nonaka & Takeuchi, 1995). Horvath & Sternberg (1999) takes the definition of tacit knowledge further in describing three types of tacit knowledge. Horvath & Sternberg (1999) describes embodied knowledge (Zuboff, 1988; Blackler, 1995) as the kind of knowledge that is inseparable from the knower and by its very nature, is hard to articulate and therefore codify (Polyani, 1966; Reber, 1996; Collins, 1993). This embodied knowledge can reside in groups, teams and other forms of communities and is often under-utilised. Next, Horvath & Sternberg describe represented knowledge as the kind of knowledge that is stored in documents, databases and records. This is visible and identifiable but the knowledge that was gained from the interpretations of the information to produce that represented knowledge is not included in the final material. Thirdly, Horvath & Sternberg defines embedded knowledge (Badaracco, 1991; Collins, 1998; Astley & Zammuto, 1992) which is the knowledge which is in the objects that the people have produced – in this case he distinguishes the knowledge in a product as well as what is in a document. This is the part that is usually not taken into consideration by the organisation. It is the know-how that the people who developed the product, process, document etc. used to make the represented knowledge artefact. This kind of knowledge and learning that went into the development of those artefacts is virtually untapped in most organisations (Prahalad & Bettis, 1986).

An alternative to the tacit knowledge concept is explicit knowledge, which is the formal material usually written into documents – this is very tangible and could include examples such as written procedures, written rules and processes. This represents the main knowledge that organisations capture if they capture it at all. This can be poorly captured and poorly utilised by organisations but is easier to visualise and produce than tacit knowledge.

Other writers have coined other terminology including encoded knowledge (Zuboff, 1988; Collins, 1993) which is used to denote the fact that the knowledge is in a form that makes it separate from the people in an organisation, such that it exists without them – this knowledge is very much in the same category as explicit knowledge, it is normally documented or stored. Finally, procedural knowledge (Zander & Kogut, 1995; Bohn, 1994) which is a scenario view, for example, if you do x then y will result. This is another dimension on the process of knowledge development.

Philosophers look at knowledge in its form or structure in relation to other concepts however it seems equally justifiable to define knowledge in relation to its usage or function. In order to be able to introduce new ways of dealing with knowledge within an organisation we need to understand the nature and the process of development of knowledge. Arce and Long (1992, pp.211-46) describe the nature of knowledge as: *"Knowledge is constituted by the ways in which people categorise, code, process and impute meaning to their experiences.... knowledge emerges out of a complex process involving social, situational, cultural and institutional factors. The process takes place on the basis of existing conceptual frameworks and procedures and is affected by various social contingencies, such as skills, orientations, experiences, interests, resources and patterns of social interaction characteristic of the particular group or interacting set of individuals, as well as those of the wider audience".* According to Von Krogh, Roos & Klein (1998) knowledge management is rooted in three flavours of epistemology. The first is the cognitivist (Simon, 1993), which states that organisations are extremely open systems and they model the pre-defined world by drawing together increasing amounts of data, which is then disseminated throughout the organisation - see Table 2.2, Von Krogh, Roos & Kleine, 1998 p.39. This puts data and information as the highest priority for knowledge management. But taking this view means that all knowledge is seen as fixed and explicit, however by its very nature it can be most easily transferred throughout the organisation.

The second, the connectionistic epistemology (Zander & Kogut, 1995) still holds onto some of the notions of the cognitivistic understanding but relies heavily upon networking of information through experts and social relationships and is detailed in Table 2.3, Von Krogh, Roos & Kleine, 1998 p.41). The focus is really on process and procedure in this interpretation (Bohn, 1994; Winter, 1987). Zander & Kogut (1995) intimate that providing the right syntax is used to code knowledge it can be transmitted with ease and without losing the true content.

The third epistemology is the autopoietic (i.e. self-producing), which really concentrates on data as the foundation of most importance - see Table 2.4, von Krogh, Roos & Kleine, 1998 p.43) Nonaka and Takeuchi's (1995) work is most closely related to autopoietic as they view the world as objective, flexible, transitional and in flux. They also see the organisation as a living organism as do Maturana and Varela (1980). Thus within the scope of these definitions individuals create their own knowledge through individual experience with the data.

Von Krogh, Roos & Kleine (1998) maintain that knowledge development is dependent on the context so it is important to understand and be able to interpret what is really happening using the knowledge of the root organisational epistemology. It is important to identify the Company's and the researcher's epistemological stance and the three profiles already identified are a suitable starting point I will use to assess this.

Knowledge management has also been defined many times, ranging from definitions which describe applications or systems which hold, collect, index, map, search and deliver information to people within an organization effectively (Zuboff, 1988; Blackler, 1995). This view seems to fall within the cognitivistic epistemology described earlier (Simon, 1993). Secondly, knowledge management may be seen as the process of creating, arranging and organizing an environment where people can operate and share, generate, consolidate and exploit knowledge for the business (Astley & Zammuto, 1992; Collins, 1993; Zuboff, 1988). This view seems to fit with the connectionistic epistemological view of knowledge management (Zander & Kogut, 1995). Other views include the view that knowledge management is generating value from intangible resources, such as brand, customer knowledge and innovation capacity (Nonaka & Takeuchi, 1995; Prahalad & Bettis, 1986; Trushman & Moore, 1988), or an interdependent system where the whole is not the sum of the parts (Kiesler & Sproull, 1982). At the sociological end of the spectrum knowledge management has been described as changing mental behaviour and emotional attitudes of personnel and therefore the culture of an organisation – this is closely tied with the learning organisation advocates (Senge, 1994; Probst & Buchel, 1996; Probst, Raub, & Romhardt, 1999). In the information technology domain, knowledge management has also been reduced to a rather simplistic view in that it is purely the technology infrastructure and nothing more (Winograd & Flores, 1986; Davenport, 1989; Scarbrough, 1993; Davenport et al., 1989).

Knowledge management has its foundations in many specialist areas of research, which has caused the development of many of the terms already described and many more. There does not appear to be a definition of knowledge management which is universally accepted by all of these identified specialist areas. For the purposes of this thesis the definition of knowledge management I have created through my research on this subject is: *"The process of acquiring, representing, storing, assimilating and manipulating the categorisations, characterisations and definitions of data or information and their associated relationships for the purpose of providing organisational effectiveness."*

2.3 Attaining value from knowledge

Now that we understand the nature of knowledge better and the epistemological perspectives of it we need to consider how to quantify and measure it in order to make it available to others within our organisation. As a starting point Hayek (1996, p.20) seems to think this may be an impossible task when he states: *"Making knowledge widely available can be very difficult to achieve"*. According to Badaracco (1991, p.133) organisations should be measuring and using the knowledge they have: *"Managers are playing with fire when their company does not own and control its crucial resources, core capabilities and key technologies"*.

There are a handful of big name companies advocating that they have processes and mechanisms to measure knowledge and use it efficiently including: Skandia (1996) of Sweden (See Edvinsson, 1997), IBM (1998), KPMG (1998), S.A. Armstrong (Canada), UK Post Office and Xerox. Skuce & Lethbridge (1995) researched the measurement of knowledge and the development of a suitable tool for knowledge acquisition and representation called CODE4. Skuce & Lethbridge (1995) concludes that expert/intelligent systems are useful in measuring knowledge but that the software tool (CODE4) needs to have high usability for it to be of much use to an organisation. There are many knowledge management tools in today's software market and each one approaches the management of knowledge in a different way. Measuring the business benefit of knowledge and KM is difficult but there are useful indirect measures (Bertels & Savage, 1998). Some of the metrics that have been and are being used include:

- Numbers of knowledge based projects / initiatives underway (in relation to plan) (O'Connor, 1999).
- Cumulative progress e.g. where each project is in relation to capturing processes, info and knowledge inventory, making knowledge and info available on an 'as appropriate' basis (Bukowitz & Petrash, 1997; O'Connor, 1999)
- Progress made on establishing a coherent, company-wide information systems infrastructure (Bohn, 1994)
- Progress made in training staff (Augustine, 1979)
- Improving business processes (Von Krogh et al., 1998; Dhurana, 1993; Levin, 1999)
- Are benefits being tangibly realised – tracking and measuring the internal and external customer satisfaction, for example? (Roos & Roos, 1997)

- Intellectual capital gains or competitive advantage measures (Edvinsson, 1997; Roos & Roos, 1997; Skandia, 1996; KPMG, 1998; Brooking, 1996)

Myers (1996) suggests that corporate success is based upon acquiring, codifying and transferring knowledge more effectively than the competitors. Nonaka & Takeuchi (1995) state that only the most highly innovative organisations are able to acquire, codify and transfer knowledge. But what does 'transfer' mean? Does this mean turning knowledge into a product? Products rely on marketing and on customer relationships. In fact a product can be half as good as a competitor's and still be produced and sold competitively. The Company is selling the business as well as the product and there is a lot in a name. Products do not get sold in isolation; for example, services are often provided with a product.

'Transfers' - does this mean passing the information on to another part of the business? If that information is available there is no 100% guarantee that it will be used and that knowledge will be transferred. If the knowledge is not re-used it has no value. You can capture the best knowledge in the world out of your business and make it accessible, make people aware that it exists. But if it is not utilised then the company ends up with a bunch of really informed people who do nothing with their new knowledge, or they take it to another company and get paid more to share it with them. 'Transfer' means the effective transfer, not merely passing on of that information, but where the recipient has enough understanding to act upon it (Jensen & Meckling, 1996). The knowledge here will require time to assimilate and understand the information transferred.

How about 'Codify' – what does this really mean? There has been a suggestion in other research that this means defining syntax and using heuristics to properly encode the knowledge as it is acquired (Polanyi, 1966). Codify is defined as (Collins English Dictionary, 1993): *"To organise or collect together (laws, rules, procedures etc.) in to a system or code"*.

And finally, how about 'Acquire' - is this capture? What methods will be used to capture the knowledge? How much is the company willing to invest in capturing that knowledge? What is the management strategy on knowledge management? What percentage of the information is tacit knowledge and explicit knowledge? How do we capture this? Earlier I discussed the types of knowledge currently defined – the literature researched suggests that explicit knowledge is the easiest to acquire, codify and transfer within the business. Depending on the organisation's own stance this may be enough for them. However, when we move to the realm of tacit knowledge this is far more difficult to ascertain and to transfer. How we convert tacit knowledge into explicit knowledge is still something which has only had relatively limited success in the literature covered within this thesis.

2.4 Perspectives on Knowledge

In order to consider the application of any knowledge management software to the organisation it is essential to have an understanding of the nature of that organisation and aspects such as its culture and examine how this affects knowledge management. I have first taken a look at the literature on knowledge management from the perspective of the organisation then focused a little on organisational groups, before completing the picture with the individual perspective.

According to Pinchot & Pinchot (1996) bureaucracy focuses the organisation on the internal development of the company and promotes a lack of innovation and creativity. Bureaucracy is seen as a hierarchical chain of command; specialised by function; with uniform policies covering rights and duties; having standardised procedures for each job and a career based on promotions for technical competence and impersonal relations (Hall, 1963). In addition all co-ordination is done from a level or more above the work being carried out (Emery & Trist, 1965). But the bureaucratic system was developed to manage companies with assembly lines, factories and organisations today need to be more flexible in many respects (Pinchot & Pinchot, 1996). More and more organisations today are knowledge-based and require skilled workforces (Drucker, 1999b) who can gather information, experiment and integrate the knowledge. Because of the changing nature of work towards self-direction and teamwork it makes it difficult for distant bosses to control it successfully (Pinchot & Pinchot, 1996; Mohrman, et. al. 1995).

Bureaucratic organisations fail to be, in particular caring, thus stifling creativity and innovation because they promote obedience to the boss, autocracy and rules and regulations. Once again bureaucracy creates sterile environments where working together cannot grow properly. There is power in teamwork, sharing knowledge, creating and innovating towards solutions and finding new improvements. The change in the organisation has to move the emphasis from the senior managers doing the decision-making and thinking towards the team doing this with the managers encouraging and assisting them instead. This latter method creates the appropriate environment for creativity and innovation. Teams of multidisciplinary backgrounds learn together as the project evolves and manage the team-level decisions. To make the best use of individuals' knowledge they need to be in teams where there is a sharing environment. As problems become more complex due to the amount of information the more individuals' viewpoints are taken into account (Pinchot & Pinchot, 1994). I have already said that I believe no one person has 100% of the knowledge required to solve a problem. Isolated thinking and reasoning can help to classify things in an individual context but it is only by joining in a team environment that more of the views, concerns, and issues are encountered, and some of these isolated and resolved. In this situation management should provide only the necessary guidance.

Bertels and Savage (1998) discuss various aspects of knowledge management questions, which they regard as being highly relevant. In looking at assets and aspirations they conclude that assets are not just the concrete pieces of physical information, sometimes termed explicit knowledge by other writers (Nonaka & Takeuchi, 1995; Kogut & Zander, 1995; Nonaka, 1991) and that businesses should be looking at ideas and aspirations of their employees as assets too. Once again businesses concentrate on the tangible, profit making (Davis & Botkin, 1994) as the valuable knowledge but Bertels and Savage (1998) are pointing at the alternatives, even though they may be more difficult to visualise and measure on the same terms. Bertels and Savage (1998) also examine the business boundaries but once again they criticise the businesses for concentrating on the physical aspects such as products and targets, goals and competitors. They suggest an alternative perspective would be for companies to consider their boundaries in the light of measuring their core competencies and looking at the companies' knowledge portfolio as well. By looking at the latter the Company can see its strengths and its uniqueness and gain guidance into the markets that they can match more appropriately. However, there still remains the problem with how we can measure this in the Company. No doubt there would be a need to change the culture too since the competencies need to be identified and that may mean more communication, more participation and perhaps more of an open and honest culture. Bertels and Savage (1998) also look at ways the business can keep continuity in an ever-changing business arena. It is also difficult to get consistency across a business, and although Bertels and Savage (1998) raise this issue there is no suggested way to deal with it. Bertels and Savage (1998) also discuss the under-utilisation of employees' capabilities and suggest that by encouraging a diversified workforce businesses can encourage a cross-fertilisation of knowledge.

Hall (1993) has concentrated his work on exploring the way that businesses can utilise their personnel via their tacit knowledge by motivating companies to consider practical collaboration and assisting businesses to develop a creative environment for fruition of the knowledge assets.

One common organisational strategy used to promote better knowledge management is the formation of joint ventures. Joint ventures and other alliances can, over time, provide the environment that allows such transfer of knowledge to become more effective (Hayek, 1996; Dhar & Stein, 1997). Joint ventures and partnerships allow knowledge creation and new learning practices (Kanter, 1983; Lewis, 1995; Yoshino & Rangan, 1995). Lots of companies today are forming knowledge alliances with other companies in areas where they believe they need strengthening (Badaracco, 1991; Levine, 1997) examples include GM and IBM in the 1980's (Badaracco, 1991). These knowledge alliances can be with other peers, universities, customers and suppliers. They are mainly in support of long-term joint objectives and strategies. Learning and creating knowledge is central to the alliance. Closer relationships are required between the parties. Wide ranges of potential alliances can be made (Polanyi, 1958). Forming such alliances often means shared control, ownership and social systems but the amount shared will depend on the alliance partners. Organisations forming such alliances are hoping to gain new strengths in knowledge access e.g. using their partner's capabilities; this is an extension of knowledge in the company. Alternatively organisations can work with the partner to create new capabilities thereby broadening the knowledge in the Company.

The environment, philosophy and culture of an organisation determine its ability to acquire, codify and transfer knowledge. Organisations have knowledge in the following areas: business strategies, products and services, organisational structures, policies and procedures, culture and values, information systems and their business processes. Some of that knowledge is explicit and has been recorded by organisations. However, the rest of that knowledge is tacit and exists in individuals' heads or in a collective group of individuals. Other knowledge is yet to be created ('new knowledge') and in Nonaka's (1995) writings is the most valuable source for organisations. In all these cases the organisation needs to seek practical ways of acquiring that knowledge or creating it. This next section looks at some mechanisms for doing this and explains in more detail the social issues surrounding these methods.

2.5 Practical Applications of Knowledge

There are many issues surrounding the whole idea of sharing and transferring knowledge within an organisation. The first one is whose knowledge is it anyway, who owns that knowledge? Knowledge is in people's heads and what is in an individual's head cannot be owned by the organisation. But information can be owned as can any other type of explicit knowledge. So if individuals own the knowledge in their heads then are organisations going to, in some way, pay for a release of the knowledge to be transformed into explicit knowledge in order to be utilised by the organisation? So from an organisational perspective – what will it cost them to extract that knowledge?

If we look at the cost of extracting knowledge it is rather obvious that knowledge, which is a by-product of some other process, costs nothing to the actual acquirer of that knowledge. Looking at decision-making we can often see with hindsight that a piece of relevant information could have been passed on at a low cost, but predicting this before a decision is difficult to achieve. If we are not sure that this knowledge will be required we tend to err on the side of caution and pass on much more information than is required or will be used in reality to make that decision. The decision-maker can become overloaded with information, which takes longer to process. This then costs a great deal more in the transfer with no guarantee of success. In addressing the issue of the cost of transfer the Company needs to consider what it is willing to invest in the transfer of knowledge process and whether the returned benefit is worthwhile. If the right knowledge is transferred then the outcome is likely to be of more value to the Company than if the knowledge was not transferred.

If organisations begin to 'pay' for the sharing of the tacit knowledge that comes from individuals and collective groups of individuals then this will affect the culture of the organisation. How this will affect any one organisation is hard to tell. But it also true to say that we can probably isolate the problems reasonably well at this point.

Looking exclusively at individual expert knowledge in an organisation we can see that it is possible for an individual to abuse his position and treat his knowledge as a tool for exploitation or promotion for example. If an expert wants to remain an expert then how much of his knowledge will he truly share with his peers and juniors because of fear of losing his own position and authority within the organisation? Looking at a more specific example, how do we use knowledge that is scattered across many individual minds within the Company? Hayek (1996) believes this is solved by decentralisation of that knowledge and he proposed that the decision-making should be delegated to the individuals with the relevant knowledge to make those decisions. However, Hayek (1996) never told us how he proposed that this would work in reality. If the authority is with one expert and they do not have the extra unique knowledge of a particular circumstance then the decision could still be wrong.

This process needs to be taken much further to be of value to the organisation. I suggest that if decision-making is passed to an individual expert then the organisation can learn from the decisions being made if a process was in place to record that decision and the basis upon which it was made (Choo, 1998). If the justification for making the decision was made available and at a later date the decision was changed or reversed then the new change in circumstances should be recorded to explain to those that are affected by that decision. This process allows for the later analysis of decision-making factors and this reflection can be flowed back into the company to improve future decision-making. In this way the decision-maker is not held to blame in any way because he can show his justification for that decision.

It is also true that humans have limited mental capacity therefore they are not omniscient. This gives rise to the collective group sharing of knowledge in order to get the bigger picture and put other perspectives into the equation (Lewin, 1966). Groups of individuals are greatly affected by the softer issues of the social domain. Groups need to relate reasonably well together and create their own culture and environment in order to share their knowledge successfully. It is also far more difficult for the organisation to reward the group unless it is as a group and this can have a negative effect if individuals feel they have contributed more than others within the group, for example (Russo & Schoemaker, 1989; Lewin, 1966). The difficulty is compounded if some members of the group fail to participate and contribute. There are many social reasons why this may not work, as team dynamics is a complex subject in its own right.

The whole area of resourcing the knowledge management environment means that organisations require knowledge workers (Drucker, 1999b; Blackler, 1995.). The whole area of resourcing and recruitment is addressed in more detail in this thesis but it is sufficient to state that organisations need to attract knowledge workers (human assets) and this is a limiting factor for organisational success in the future (Handy, 1993). Motivating these knowledge workers as valued assets, providing them with good working environments and quality of life issues. Organisations need to address workers' personal and social objectives as one key to success in this area.

The whole area of knowledge management is connected with the research surrounding learning. Organisations need to have a better understanding of individual and collective learning processes, what happens when people learn, what impulses drive learning and how an organisation get its workforce to unlearn outdated practices, methodologies and traditions (Cope, 1998; Garratt, 1987). Organisational learning helps us to understand how raw data and ideas are generated and knowledge management may assist in seeing how these ideas might be used for business advantage (McGill & Slocum, 1994). The whole arena of organisational learning is not covered in any great depth in this thesis but it should not be ignored in organisational equations relating to knowledge management (Cope, 1998).

Another key aspect that organisations need to consider is that knowledge has a limited lifetime (Tiwana, 2000). Its value to the organisation decreases over time. This aspect means that an organisation needs to get its information and knowledge just in time to make decisions or resolve issues or whatever it needs that knowledge for.

Concerning technological solutions available to resolve some of the transfer issues there are many ways to represent knowledge through multiple examples of multimedia e.g. digital, visual, mechanical etc.

2.6 Technological assistance

Looking back at the previous discussions on the definitions of knowledge, data and information etc. there are various ways in which the use of technology can assist in managing these items. In the model devised in

Figure 2-2 I illustrate the way in which knowledge and its derivatives can be managed using different kinds of technology. This model illustrates the technologies available to add value for an organisation.

The types of knowledge being used are distinguished, together with the balance for the transfer process.

The technology options that exist today mean that information can travel at the speed of the Internet but making sure that this is the right information at the right moment in time is the more difficult element of the transaction. Making technology available to people in the Company will in no way guarantee they will utilise it.

The key deliverable from managing knowledge and information is to capture the resources and capabilities of the organisation in order to enable the Company to learn, adapt and change with the changing environment (Choo 1995, Choo and Auster 1993). Knowledge creation, transfer, acquisition, storage, analysis and use provide the framework to support the growth and development of the Company. One of the main resources for knowledge management is the end-user community if technology is to assist this group in managing the knowledge or information that they require (Adams & Freeman, 2000; Bukowitz & Petrash, 1997; Johannessen & Olaisen, 1999).

Figure 2-2: The role of technology in knowledge management

2.7 Conclusion

Having reviewed the whole area of knowledge management in this chapter I now intend to raise some problem areas and research questions that have implicitly arisen through this evaluation of the literature.

What do organisations want or expect from KM? Organisations want to use knowledge management to keep a competitive edge. In meeting this objective they need to recruit and retain the best people, even knowledge workers specifically. Organisations also expect to keep the value of the knowledge when people leave their company. They also want the capacity to change rapidly in order to retain competitiveness. They therefore want the ability to rapidly update and re-skill their employees. Organisations also see the need to improve the organisational and individual ability to learn, internally and externally. In order to remain competitive and effective, organisations accept that there is a need for them to deploy knowledge in three dimensions: just in time, just enough and to know what they know. Organisations also want to develop cost reductions and increased effectiveness in education and training by alignment with strategic business, more for less, proven, measurable results.

Why organisations see the need to use knowledge management has been studied recently (Macintosh et. al. 1998) and the main results of the study are illustrated:

- The marketplaces are becoming more competitive and the rate of innovation is also rising
- Because there are reductions in staffing, due to competitive pressures, this has created a need to replace informal knowledge with more formal methods
- This reduction in staff also means that there are fewer people in the workforce holding the knowledge available
- There is less time during working hours to acquire knowledge and to gain more experience
- A higher percentage of staff are opting for early retirement and a greater proportion of employees are mobile – both factors lead to a loss of knowledge from the organisation
- Strategic change and organisational re-structures may lead to a further loss of knowledge
- The majority of work in organisations today is information based (Meek, 1999)

- Knowledge is now the basis upon which organisations compete in many cases
- New products and services are much more complex than in the past and they carry with them significant volumes of information
- There is a general need for life-long learning in all organisations and workforces.

So how can the organisation practically apply knowledge management techniques to resolve some of the issues raised here?

In considering the definitions and discussion on knowledge management above we can identify the several mechanisms for putting knowledge management into practice, for example, identifying and mapping intellectual assets within an organisation; generating new knowledge; making vast amounts of corporate information accessible; sharing best practices (including supporting distributed groups to share best practices); utilising technology to manage the knowledge; form and use communities of practice (including supporting individuals and groups to improve their work practices); and promoting the establishment of "virtual centres of excellence" by bringing the relevant knowledge together (across time and geography).

Explicit knowledge is codifiable and technology can be readily used to assist in managing this type of knowledge, however there may be specific problems in locating, validating, and assessing it (Tiwana, 2000; Dixon, 2000). There can also be difficulty in obtaining it at a reasonable cost, integrating it with anything in the existing organisational system and also making it available to the right population in the right format (Dixon, 2000). Deciding what technology is appropriate and how to measure the benefit can also be a deciding factor when looking to implement technology to manage explicit knowledge.

Tacit knowledge is personal and is fluid in nature, obtaining it and transferring it into explicit knowledge or capturing it are both difficult tasks because of social issues such as the reluctance to share it by those who own it (Reber, 1996; Von Krogh et al., 2000). It is hard to code because it is experiential. This kind of knowledge is extremely hard to capture and there is very little technology available to assist in this particular process (Bukowitz & Williams, 1999).

2.8 Summary

Bertels and Savage (1998) have declared a cynical view of the business world, which searches for a radical silver bullet in knowledge management after dispensing with the last fad. Most of us in the business world will find these views easy to agree with. They also argue that the business world is not demonstrating the kind of culture in which knowledge can grow and where people are happy to contribute their own knowledge.

There is a suggestion that knowledge management is a well-defined concept. However, one of the characteristics of KM is that there is no universal recipe, no simple paradigm. Every organisation has to find the approach that works for its staff, its culture and its business. Some organisations define knowledge management very broadly to encompass almost all of the function in the organisation; others define it narrowly. Some organisations emphasise the technology aspects – codification, information management, search engines, groupware and knowledge stores. Others focus much more on the people issues - behaviour, knowledge-oriented culture, fostering creativity, building trust and a positive environment for innovation and sharing, managing and developing knowledge workers. Others emphasise processes – coupling knowledge into business processes, linking it to workflow, proceduralising knowledge transfer and innovation, capturing process knowledge and sharing best practice. Some organisations focus on managing collective knowledge at the level of the organisation and of its external network and outsourcing. Others focus more on managing knowledge at the level of groups, projects, teams and individuals.

In this chapter I have identified the areas of knowledge management that raise issues and these areas relate to the points raised in chapter one concerning the Company domain areas of investigation. With these two elements side-by-side I will consider the development of the research thesis and reflect upon these elements during my research process.

In the following chapter I set out to identify the methods and the methodology, which will underpin this research before moving into the research proper.

METHODOLOGY AND METHODS

3.1 Introduction

This chapter deals with the methodology and the methods I adopted throughout this research. It also deals with the issues raised concerning the data and evidence I collected and the manner these were used.

3.2 Background to the Company Views

BAE SYSTEMS, Christchurch, is defined and exists at two distinctive layers: the corporate level and the local level. All material communicated to the staff is always directed at these two levels. This is illustrated in the corporate strategy and local strategic value plans, which are a subset of the overall corporate level strategy. The Company's responsibilities and decision-making also operates on these two distinct levels. The reflection of process improvement for example is analysed and applied at the local level but is a part of a wider corporate level strategy of the global Company aims. I felt that it was important to be clear about the underlying Company visions in order to build a more concrete topology of interventions (Schein, 1987). The corporate level vision is: -

"We are dedicated to working together and with our partners, to become The Benchmark for our industry, setting the standard for customer satisfaction, technology, financial performance and quality in all that we do"

By its very description the Company vision implies that it needs organisational change to grow and facilitate this vision into reality (Cecez-kecmanovi, & Moodie, 1999). As the researcher in this Company I wanted to be a contributor in seeing the Company meet this vision in the area of my research and as such I believe the best method of achieving this is action research. Involving the people within the Company to achieve the objectives and aims of the Company has already gained me the support of key managers and employees and I believe it will continue to do so. Since beginning this research strong relationships have been built up between the Company staff and myself not only at the Christchurch but also across other sites. These members of staff have begun to see that the problems they face with information retrieval, and that these requirements can be met using their own input and ideas, to find the most appropriate solution. Everyone I interviewed contributed with enthusiasm and provided invaluable assistance in being a part of the solution themselves. Several people interviewed were keen to learn of the techniques that I use to gain information and develop my research. As part of my research I have passed on appropriate techniques and information relating to various software packages, processes requiring evaluation and change, issues of weakness or strength in the Company processes.

3.3 The Methodology and the Process

Action research and my choice of a pluralistic methodological approach are as a result of reading the literature concerning knowledge management and organisations. In particular I was concerned to see that my work was of practical use to the organisation (Gibbons, Starkey & Madan, 2001). Action research allows me to gain a more holistic view of the organisation through my interaction with others and my changing perspective of subjectivity and objectivity. In this way I did not want to impose a deliberate separation or distancing of myself (the researcher) in the action (research). I realise that I will not have the opportunity to examine and analyse ever single factor or variation surrounding my research however, I do feel that I will get a far better view using a pluralistic approach than that taken for either one stance or the other from a methodological point-of-view. The knowledge management literature has failed to provide me with specific practical implementations of knowledge management techniques that are based upon such a holistic research methodology (Dixon, 2000; Tirwana, 2000). Therefore by utilisation of action research I am able to gain insights into the applicability of new technology for knowledge management based upon a pluralistic view of my organisation. The literature on organisations tends to highlight the complex nature and the existence of interconnected domains, such as, culture, environment and strategy (Probst & Buchel,1996; Von Krogh et al., 1998; Astley & Zammuto, 1992) which all influence the Company. In this respect action research can match this complexity and allow me to see my findings in context and to see how others in the Company view those same issues. In this way the explorations of solutions to problems raised in my research can to a certain extent be related to the particular circumstances and nature of the Company at that point in time. This also allows me to make inferences as to the applicability of certain solutions to particular opportunities within the company. Organisations appear to focus upon the explicit knowledge management solutions as there is a tendency to seek business benefit and calculate return on investment in order to gain funding (Davis & Botkin, 1994; Bertels & Savage, 1998). This research examines both the explicit and the social aspects of knowledge management, which is easily facilitated through action research.

My choice of utilising action research came from my desire to involve Company representatives in my research in a formal manner. The whole process of action research involving the collaborative understanding and knowledge development with others within the Company is a method that appealed to me immediately as it suits my personality and personal preferences. The whole idea of interacting with others and being a part of the research inspired me because I feel that I do not want to isolate my own views outside of the research material and I also have the opportunity of learning through the discussion of my own research perspective with others. I feel that action research employs the valid use of collaboration with the organisation or community. In this respect it is very different from other research methods, which act clinically using a detached method of investigation and does not get to the real heart of the matter. I did not think I would enjoy the kind of research that distances itself from participation and is purely scientific black and white, as I believe that there are issues in the social research domain that influence and affect the kind of research I am doing. By building up trust and relationships with others within the Company I hoped to gain a real insight into these stakeholders' perspectives of the Company they work in. In this way I hope to see them learning about their Company, to reflect on the research and to encourage them to collaborate with my research. As well as this aspect I captured my own reflection and learning in the action research that gave me a second perspective on my research.

Although I felt that a combination of both the hard and soft dimensions of my research would give me a better understanding of the research issues, from a practical point of view. The research was carried out in my employer's Company, which makes this method of research an appropriate tool. Since the Company is eager to gain knowledge and understanding through the research they were quite happy to participate too.

Often management research doctorates are regarded as providing little value to industry because they are perceived as too academic and of little practical use. In this research I am particularly keen to emphasise the practical application in order that my research will benefit the Company where I work (Gibbons et. al. 1994; Starkey & Madan, 2001 [e.g. Mode 2 knowledge). Through the mechanism of action research I am in a sense additionally educating the Company as part of the practical value of my research.

In my view, action research does not ignore formal research methods or epistemological matters that underpin social knowledge. Action research uses research (with the researcher and research techniques), action and participation to promote the belief that communities and organisation members can empower changes within their organisations for effective improvements. I think that action research is one of the best mechanisms for generating new knowledge (Greenwood & Levin, 1998). I also believe that collaboration with joint responsibility works to create the right agenda, to evolve the knowledge that will bring about changes as well as implement the results.

I have a philosophy based on both an external ontology, which has an objective view of realism and positivism as well as an internal ontology investigating a subjective view of those participating within the Company. Here I am assuming that people will have different perceptions of reality, I am not dealing with concrete facts but with peoples subjective view of a situation e.g. some people think the internet is an extremely useful tool and others think its not very good. During research cycle one, my enquiry is passive and for this reason I believe I am observing the situation, recording the transcripts of interviews and having little effect on how the situation is perceived by the interviewee. During the collaboration elements of this thesis the group is participating in the research and in this case I am inextricably linked to what the group are discovering and how they perceive the situation around them. This group is also functioning to influence my own views of reality in the research. Many of the surveys carried out collect the opinions of the participants through Likert scales as well as providing feedback through open-ended qualitative questions. These questions may arguably influence the participant's views on the subject being questioned, however I believe I have made every effort to reduce this impact in the manner I have posed those questions I have used.

My epistemological position was based upon a combined hard and soft option. I included the soft systems epistemological approach of Checkland (1981) that involves the analysis of qualitative data produced from some of the methods used e.g. interviews and open-ended questions in surveys and questionnaires. From a hard epistemology stance I used quantitative data gathering through the medium of the questionnaires used and other statistical measures. During each cycle of the action research I used multiple sources of data, which I then interpreted. My only problem may be that from my action researcher perspective it may be difficult for me to untangle the web of rich data sources and factors within the Company.

By utilising action research I hope this will allow the internal resources of the Company to be used efficiently in order to bring about change within the organisation. I think that this approach will not only meet the needs of the issues raised by this research, but also allow individuals to be a part of the change process and learn through it. My research involves the self-reflection by me of the research cycles taking place and my views as both an observer and participator in the research. The main input of the reflective research will be through my management diary. The diary examines my self-reflection of the observed processes and behaviours of those within the organisation. It also captures the practices within the organisation and seeks to illustrate my understanding of what happens day-to-day in the Company as well as examining my own views of my practice and understanding. My diary continuously re-evaluates situations in order to find areas of improvement and effectiveness to guide me in taking various kinds of action, as well as providing me with the opportunity to reflect upon those actions.

The whole idea of action research began when the term was first utilised in the early 1940's when research was carried out into process improvement in industry through participation of the entire workforce (Lewin, 1966). I agree with Lewins' view that if the workforce buys into the research process then there will be improvements for the organisation. Action research involves my participation with Company stakeholders in all aspects of the research including analysing the problem domain, co-generation of knowledge, taking actions and reflecting on those actions (Greenwood & Levin, 1998). In all phases of the research I worked together with the stakeholders in achieving a successful outcome. However, I also recognise that if it is used incorrectly there may be a danger of using participatory research as a mechanism for manipulation (Griffiths, 1990; Landsberger, 1958).

I like Kemmis & McTaggart's (1988) description of action inquiry as a cyclical process, which enables the analysis of issues in a reflective manner consisting of observation, analysis, design and implementation with each stage affecting both the next and last stage. This was the way in which my research was conducted. In using this method I was able construct a view of reality and because we share ownership of knowledge it enabled the Company and myself to change and grow. I also related practice to the theory in order to provide the practice for my next cycle.

Using action research allows me to refine my research findings as the work progresses through the different cycles. This is an emergent methodology that allows me (and my collaboration groups) to critique, review, analyse and interpret my findings before moving on. I also have the opportunity to involve others in the participatory groups within the research thus allowing the opportunity for their buy-in and co-operation and these individuals can then become facilitators of change through the research as they develop their own learning in the Company. This participation provides me with a reasonable level of credibility and trustworthiness of my findings.

I hold the view that it is difficult for me in the participatory process since I have so many different roles and perspectives on the information and data, which can become cluttered and indistinct from each other. Richer data sets also mean a great deal of time is spent analysing and dealing with the issues this data holds. This data can also be particularly messy and difficult to unravel and interpret. The end results however, may not provide too much generalisability but I try to address some of this in the approaches I have taken in my research. I have involved significant numbers of Company individuals each time that I undertake my research in order to gain higher levels of participation and involvement. One downside to the collaboration groups is their lack of understanding of research methods and methodology and the reasoning behind undertaking particular types of methods. A second point is that it is sometimes difficult to control the collaboration groups without influencing them with my own views but also balancing the issue of ensuring that I allow them to participate all their own views that are relevant.

Figure 3-1 depicts the process I followed and the interactions taking place between the organisation and myself. The diagram illustrates the way in which I transferred my research into the Company in the form of reports and statistical analysis. This information deliberately lacked my recommendations for the organisation since at this point it was for the stakeholders to learn and make decisions based upon the information I gave them. I re-visited any decisions made or feedback presented to me during my reflection. I then flowed back to the Company, via the stakeholder representatives, any further secondary learning or points of clarification. Further information, learning and issues were then brought full circle back into my research cycles where I felt that this was appropriate.

I used collaborative participatory investigation, which encompasses joining specialist groups within the Company and working with them. These are detailed in depth in my reflective practitioner chapter eight. I also sampled thirty interviewees in a semi-structured format, which I captured for analysis. I was involved with my stakeholders at meetings and presentations related to my research where all our information and views were shared. I also used questionnaires and surveys.

From an ethical point of view my roles as a software engineer, team leader and then a manager during the development of this thesis have provided me with ethical considerations (these are discussed in detail in the reflective chapter). I considered it unethical to divulge the names of individuals and those they may reference during the research data collection process. I also consider it to be unethical to break confidences made during this research over any issue as my integrity as a member of BAE SYSTEMS Ltd and my role as a researcher representing the University would then be at risk as well as having a negative impact on the relationships and personnel concerned. I am also aware of the fact that some of the data collected may intimate that there are issues and problems within the Company and how I deal with these will affect the relationships I have with others in the Company.

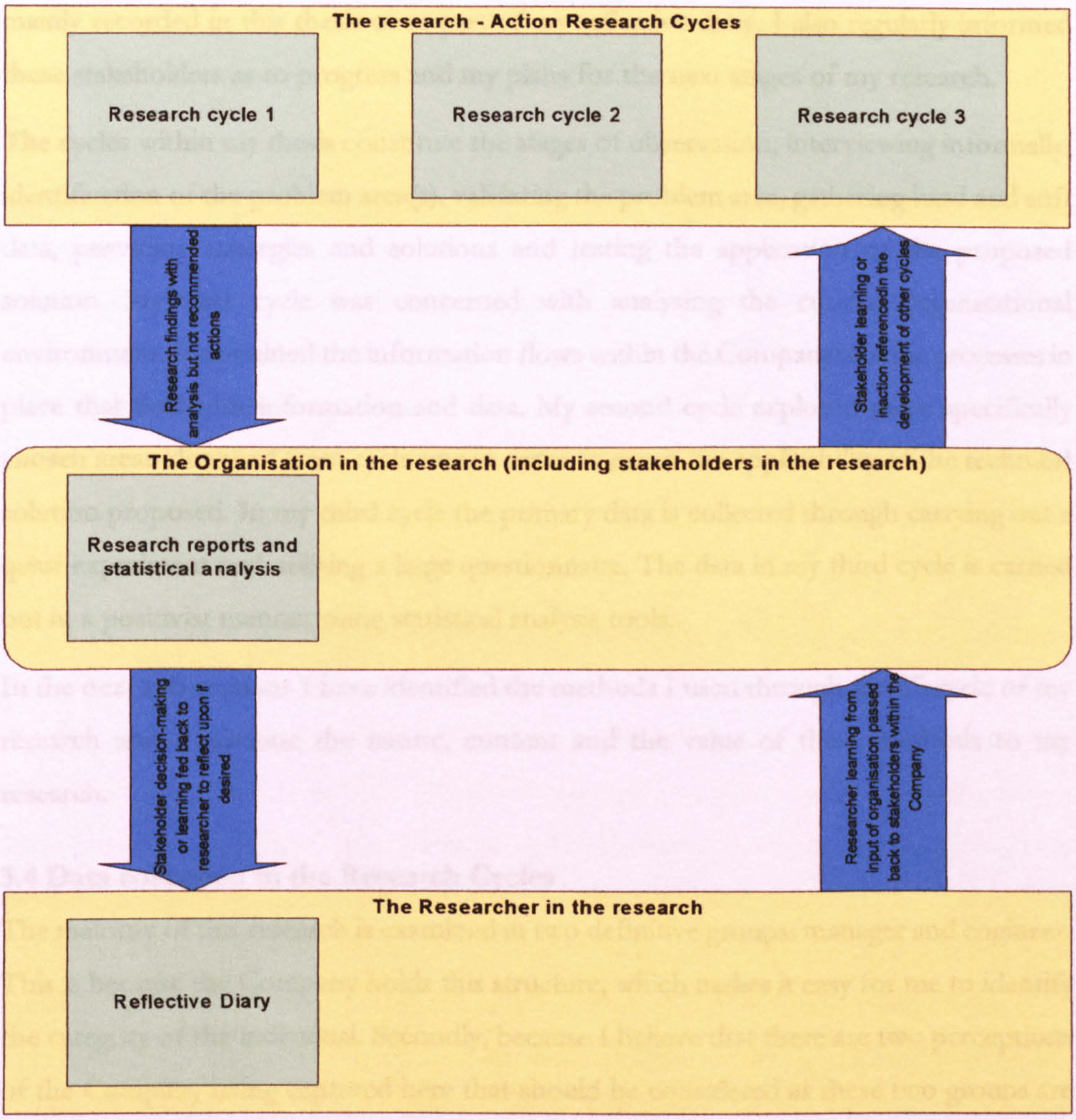


Figure 3-1: The Action Research Process in Practice

As I isolated problems relating to the research through my reflection I adapted the methods and action I decided to adopt in the next phase of my research. In this way each cycle was responsive to the findings of its predecessor, which adds to the rigour of my research. When I examined the data produced from both meetings and interviews I fed the knowledge back to the participating Company officials. In sharing the knowledge gained I agreed the action and a commitment from those involved in order to bring about changes in the Company. I passed on the detailed research material in order to increase the Company's awareness of what was happening internally in the organisation and how it could share the knowledge it has. The staff involved at this point were not included directly in the development of the surveys or interviews therefore their contribution was mainly recorded in this thesis or as part of my reflective diary. I also regularly informed these stakeholders as to progress and my plans for the next stages of my research.

The cycles within my thesis constitute the stages of observation, interviewing informally, identification of the problem area(s), validating the problem area, gathering hard and soft data, providing strategies and solutions and testing the application of the proposed solution. My first cycle was concerned with analysing the current organisational environment. It examined the information flows within the Company and the processes in place that deal with information and data. My second cycle explored three specifically chosen areas identified from cycle one in order to assess the applicability of the technical solution proposed. In my third cycle the primary data is collected through carrying out a quasi-experiment and utilising a large questionnaire. The data in my third cycle is carried out in a positivist manner using statistical analysis tools.

In the next sub-sections I have identified the methods I used through the lifecycle of my research and I examine the nature, content and the value of these methods to my research.

3.4 Data collection in the Research Cycles

The majority of this research is examined in two definitive groups: manager and engineer. This is because the Company holds this structure, which makes it easy for me to identify the category of the individual. Secondly, because I believe that there are two perceptions of the Company being captured here that should be considered as these two groups are distinctly identified by the organisation. So to gain a fuller understanding I have developed my research in these two groups in order to capture their perceptions of the Company from their position in that environment.

My emphasis at this early stage was on building a good researcher/stakeholder relationship in order that I can understand the true nature of the problem that needs to be resolved. What the stakeholders may think is the problem is not necessarily what the problem turns out to be.

To a certain degree I agree with Kurt Lewins' concept of action research (Lewin, 1973; Corsini, 1984), which states that when the stakeholder collaborates in collecting data, that data has greater credibility. I think that any stakeholder is more willing to try to understand what the research is about and therefore could well be more active in deriving the implications for action or change with the Company. I certainly needed the assistance of stakeholders who helped me to determine the kinds of data needed in order to understand the problems I was trying to address. They also assisted in helping me to figure out ways to acquire this data; retrieve it; analyse and summarise it; and derive their most significant implications for a change effort (Corsini, 1984).

In my experience of action research I found that the problem was not a shortage of information but rather an excess of it. Therefore I found choosing the relevant information to be more problematic. For example, in the first cycle I collected a considerable amount of data surrounding a particular Company Process Group that had little value in the research data I finally collated. My initial data collection deliberately included hard data (facts and statistics) and soft data (opinions, assumptions, etc.). In this early phase of my research I collected data that would help me to understand the Company's current 'as is' situation regarding the information sources and related user requirements for that information.

At this early stage I was aware that various constraints (e.g. lack of access to particular information within the Company) influenced my choice of data collection method. Also the type of data I wanted to collect affects how I actually collect it. Some data I wanted to use was already available in 'hard' form and included a range of documents both within and outside the Company. In a positivist view all hard data should be verifiable, however just because it can be verified does not mean it is blatantly true and not open to question. All of this material is also based upon the writer's opinions, which are subjective so there is still a danger of distortion. I attempted to eliminate this problem by using face-to-face interviews in my first cycle, which are better than questionnaires. I preferred to use face-to-face interviews because they had the benefit of helping me to build a rapport, however for this to be successful I avoided the use of value-laden language.

Data collection is an intervention into the Company. When I collected and analysed this data I tried to ensure that the data was reliable and objective. I also tried to select the most suitable data collection technique in each of my research cycles. These are selected not only to help me with developing my research but also to help my stakeholders to identify issues and develop alternative strategies for change within the Company. Therefore I used both qualitative and quantitative methods and allow my stakeholders to interplay dynamically with my research.

The techniques that I used during this research are documented in detail within the following sub-sections.

3.4.1 The Reflective Practitioner Diary

The reflective element of this research was always going to be an important aspect for me but when I started the research I was not aware of the use of such a diary. The DBA course mandated the completion of a reflective diary in my first year of the degree. This was my first glimpse of such a technique.

Although I agree with Strauss and Corbins' (1990) idealistic view that diary writing should begin from the inception of a research project and continue until the final writing, unfortunately with limited time, personal commitments and a full-time senior management role this was not possible for me to attain. I followed the advice of Mills (1959) who suggests that all researchers need to write regularly and systematically about the research in order to reflect individually or with fellow researchers. In my first year of the DBA I wrote nearly every single day in my diary but I did find this to be too time-consuming in the next two years. I found that it was an extremely useful tool for aiding my memory and allowing me to reflect at a later date. I found I learned a great deal and that this was a good mechanism for me to record my views, thoughts and feelings. Many insights into my views, beliefs and opinions are captured in it too. Because action research involves the rigorous reflection on action (Kemmis & McTaggart 1988) it demanded a disciplined way of working. Although this diary was not mandated throughout the rest of my research I still utilised it but in a more concise manner which highlighted main events or incidents rather than everyday events. By the end of my research my diary had become less important than the actual writing of the thesis and the collection, analysis and interpretation of data.

My diary also served as a tool to reflect back into the Company via the stakeholders involved within the Company. I made no recommendations when behavioural or poor organisational failings were uncovered – instead I allowed the stakeholders to do their own reflection and make their own decisions based upon the information I gave them.

I agree with Strauss (1987) who believes that diaries stimulate thinking and re-thinking as well as ideas and questioning some of the research already carried out (Strauss & Corbin, 1990; See also: Maxwell, et al., 2001). I also believe that my diary helped me to do my qualitative analysis and making sense of the research (Miles & Huberman, 1994). More of my thoughts on the diary are explained in detail with the reflective diary in the reflective practitioner chapter.

3.4.2 Surveys

The majority of the surveys I undertook contained both a qualitative and a quantitative perspective. The main mechanism for recording data in these surveys was by a Likert scale allowing the opinions of the candidates to be recorded. This was chosen because I wanted to collect opinions of various aspects of the information systems within the Company. This method was easily implemented in an electronic format, which was made available through the Company Intranet and takes very little time for a candidate to complete. Since a high proportion of the staff are extremely technically aware this method of usage proved invaluable.

The number of choices on my Likert scales is not really due to any particular scientific approach, rather it is a trade-off between the granularity of the data required to satisfy my research goals and the effort on the user to complete the questionnaire (Miles & Huberman, 1994; Strauss, 1987). The more levels offered produces a more refined data set but can annoy or cause users to become bored in answering the questions (Roberts et al., 1999). The Likert scale runs from positive to negative so there is always a middle point that crosses zero and is represented by a neutral opinion (Likert, 1932).

I also utilized open-ended questions on the majority of my surveys in order to capture any salient opinions and views of various aspects of the survey. All of these were optional which allowed candidates the freedom of responding or not.

Other survey data collected was related to time measurements in processes being measured more specifically. This data was collected in order to make some comparisons with other data collected and make inferences about these results.

All of these methods of carrying out surveys were an efficient use of my time since the first research cycle had illustrated how interviews were very time consuming both in carrying them out and analyzing the data. In cycle two I rely more heavily upon the use of survey data that was more easily collected and analysed. These surveys enabled me to focus on specific areas identified in the interviews and contain my time in collaboration with small focused groups too. In this way I was able to see in a relatively shorter period of cycle two the areas where I should concentrate my research.

3.4.3 Interviewing

During my first research cycle my data gathering processes consisted of the information gathered via the Speech Report Questionnaire, a set of informal interviews with Company staff on the Christchurch site and involvement in the Technology or Process Groups.

I chose to use interviews early on in this research because I wanted to get to know the Company staff and build rapport as well as get their views and opinions. I recognised that the interview data can be interpreted and analysed to reveal much about the interviewee's and my own theoretical assumptions and presuppositions. I also thought that it was possible to ignore the respondent's social and personal contexts of meaning, yet these had a bearing not only on the answers I received but also on the interpretative theorising that followed. All the answers I get depend on the way I ask the question and are also influenced by me. At the outset I had to think clearly about the type of interviewing technique I would use in order to retain the purpose of my inquiry.

I chose to adopt a semi-structured interview approach, as my main aim was to develop an understanding of the interviewee's perspective of the Company information systems. In so doing I wished to influence the Company through my research findings in my collaborative relationship with the stakeholders. Secondly, I also wanted to give some consideration to the interviewee's interpretations and the basis of their opinions and beliefs. Thirdly, I believe that my early interactions with the Company raise the issue that some individuals may not be willing to truthfully share how they really feel unless they are in a confidential one-to-one environment. By adopting this method of interviewing I found that the different interviewees reveal more on some topics and provide me with a better picture of the situation. Another strength of this technique was the open discovery through the process, which was quite enlightening and interesting.

The semi-structured nature comes from the fact that I wanted a stable structure and procedure of an interview but this was not confined in terms of the questioning which was basically made up of one open-ended question. In this way the interviewees' are not constrained by a fixed answer either. I was hoping to gain a rich data set by keeping the interview environment the same and the question the same for every interviewee. I also felt that this type of interview was more natural than a strictly structured one and I found the candidates generally very natural in their responses. This also enabled me to analyse the data more effectively afterwards, as there was consistency in responses with little intervention or interpersonal bias on my part.

3.4.3.1 Sample Sizing

BAE SYSTEMS is a large organisation and although as the researcher I was part of one site at Christchurch, Dorset where there are 1016 number of employees. At the time of the interviews, in 1999, the total number of employees is approximately 46,500 over 53 sites. However, this will increase significantly with the merger of SEMA Ltd and GEC Marconi.

I chose to adopt a representative as opposed to judgemental sampling technique because I felt that I wanted to have the opportunity to undertake statistical analysis if I felt that was relevant later in my research. I thought it would be particularly impractical for me to survey the entire population of the Company and this would also be out-of-date by the end of the thesis when the mergers will have taken place. Secondly, this would be impractical from the perspective of my time constraint. Also to carry out research with every member of staff there would be a significant budget requirement by the Company to provide my services to carry this out. In this latter case the analysis of results would utilise a tremendous amount of time and would not be available for the Company to use in the short-term.

My sampling frame concentrated on the grading system division of the Company employees because the whole Company was run and based upon this structure. I chose the number of candidates to be interviewed using the grading of staff and defining the statistical representation of the grades of those staff on the Christchurch site (illustrated in Table 3-1). Using this set of grades and percentage representations I used the figure of thirty candidates suggested by Coolican (1994) based upon the proportional representation of grades across the Christchurch site. I wanted to feel confident about the data I was going to collect in the interviews in order that I could see representative trends and themes across the grading division.

EMPLOYEE GRADE 1998	NEW GRADING INTRODUCED AFTER MERGER WITH MDS 1999	NUMBER OF EMPLOYEES	%AGE ON SITE	No. OF INTERVIEWS FOR RESEARCH CYCLE 1
ALL STAFF ON SITE	TOTALS	1016	100%	30
M3+	EXEC 1-3	103	10.1	11 Managers
GRADE 9	EXEC 4	266	26.2	
GRADE 10	GRADE 5	196	19.3	19 Engineers
GRADE 11	GRADE 6	137	13.5	
GRADE 12	GRADE 6	87	8.6	
GRADE 13 – 15	GRADE 7-8	227	22.3	

Table 3-1: Employee Grade Identification/ Representation

To select the appropriate sampling method I first determined the structure of the Company into a management grade and an engineering grade (marked on Table 3-1). I also had access to the full sample frame of candidates through the computer records of the human resources division of the Company. By extracting the names of all individuals into either management or engineer groups I was then in a position to select individuals randomly from each group. This is also known as a stratified random sample because I was still able to keep the representation element for analysis whereas the alternative methods do not allow proportional representation easily. This was achieved by giving each potential candidate a unique identifier and the picking numbers out of a hat. In this way I had no idea which candidate was associated with the number. Also if a candidate was unable or unwilling to participate I was able to select an alternative at a later date. I agree with the views of Moser and Kalton (1986) and Henry (1990) who suggest that having a proper sample enables a higher overall accuracy and allows me access to more detailed information, which was another reason why I chose to carry out my research in this way.

3.4.3.2 Interview Method

In my interviews I asked all the interviewees a single open-ended question, which they were then given an opportunity to talk about from their own experience, opinion and perspective. I deliberately refrained from asking probing questions during the interviews (unless absolutely necessary), as I did not want to lead my interviewees or distort the interview (Gorden, 1987). I gave my interviewees the promise of confidentiality of everything they said at the interview in order to give them the freedom to say whatever they felt they wanted to. I wanted to let the interviewee's responses determine the narrative direction, not mine.

The interviews were carried out with the representative employees on the Company's Christchurch site. Each of the semi-structured interviews followed the same process by which information was obtained:

1. First candidate employees were selected following the statistical method above. From a list of all possible candidates each was given their unique ID and then selected from a draw of the numbers.

2. Secondly, the candidates were approached by an e-mail correspondence stating the requirement for an interview and the nature of the interview. The method of taping the interview was mentioned together with the fact that the interview would remain confidential. It was also explained that the interview would surround the nature of the information the candidates require in order to carry out their role within the Company. They were informed that the interview would be led by their own desire to say as much or as little as they preferred. They were also told that they would rarely be prompted and probably only if the conversations were drying up. The candidates were given the opportunity to decline the interview if they so wished.

3. If the candidates agreed, an interview time and the room for carrying out the interview was arranged.

4. The interview was then conducted. This was done normally by getting the candidates to say who they were, what role they had in the Company and what grade they were at

the outset. This was followed by asking the open-ended question[1] to start the interview moving

I recorded the interview by using a tape recorder and I typed the transcripts after each interview verbatim. I also recorded details of the contexts, which arose during the conversation where I felt that this was appropriate (e.g. if the interviewee mentioned specific events within the Company where their role was different). I also recorded very brief summaries of any particular nuances and dynamics such as confusion, contradiction, ambiguity, humour and reluctance. I felt that the strength of my research finding would be in the interview data itself but that some minor points such as interview observation might assist me when I came to analyse the data.

Because I was more interested in the interview content than the interviewee's behaviour during the interview I used a software tool called NVivo to analyse the data once it was transcribed. This consisted of coding nodes from the interview data as items were identified (See Appendix E). Nodes are clusters of information that has been coded by the researcher relating to the subject matter analysed. By putting the coded data into this one node it makes it possible to carry out set analysis using other nodes e.g. intersects or excludes type analysis.

The first phase of the analysis divided the data into two specific groups based upon the sampling technique utilised. This meant creating two sets of data: those of the Manager category and those of the Engineer. The first pass of the coding phase identified a group of nodes which were concerned primarily with the types of information the interviewees identified during their interview e.g. databases, newsgroups, world-wide-web, Intranet, QUEST, RPM, e-mail etc. The second phase of the coding phase provided a new set of nodes that contained all information from the two sets in phase one. This allowed the development of NVivo reports on how frequently the individual areas were discussed and how often certain terms were referenced.

Finally, a node called "Problems" was created and used to code all the data in all the interviews where a candidate had stressed some sort of problem identified by the interviewees. The results of the coding of the "problems" node were then used to create a node report, which was then used to aid me in writing this aspect of the thesis. All of the information surrounding the "Problems Node" was then analysed in relation to the candidate status i.e. whether the candidate is in the category manager or the category engineer. Other NVivo reports were also generated and the results of these are included

[1] "Tell me about the kind of information you need in order to carry out your job effectively and can you also tell me what you think about the quality of that information and whether you always get the information you need?"

within the relevant chapters. NVivo was also used to carry out searches of information and counts and frequencies of word types and usage and some hard statistical data was captured for use in another software tool called SPSS.

In this way I was then able to examine the nodes and sets created in NVivo in order to formulate ideas and themes that emerged from this data (Figure 3-2). I was more interested in the problems that the interviewees had than the link from that problem to the information source. I was able to identify which groups had identified the problem and this data was used in the first research cycle chapter. I was not interested in quantifying the statistical differences between the two groups, as I was interested in which groups mentioned the problems. The NVivo tool will allow me to identify the counts of occurrences in an intersection between nodes and sets but this is a tortuous process that I felt added little value to this first phase. My concern was more with the types and categories of problems which were identified so that I could make some decisions as to what my second research cycle will investigate; always holding in the back of my mind the fact that I want to identify a suitable problem area which could be resolved through the use of software agents.

3.4.4. Other Primary Data Sources

Throughout the thesis several questionnaires and surveys were used to collect further data to gain a better understanding of various issues. The analysis of these results is recorded in the relevant chapters of this thesis and the actual questionnaire, relevant data and results reports are included within the appendices of this thesis.

All questionnaires and surveys included data relating to the name of the candidate, their role and their grade in the Company. The names of individuals are removed for the purpose of confidentiality of those providing information. The role and grade have been utilised to identify specific categories for analysis of the data produced.

The questionnaires and surveys utilised in this thesis are described and outlined in Table 3-2 This table gives a summary of the data collection methods used and the research phase they were carried out in. A full description of the questionnaires and surveys can be found in the relevant section of this thesis and cross references are given in the table.

3.4.4.1 Resource Management Survey

This survey was developed in cycle two of this research and is discussed in detail in cycle two, chapter five. This survey sought to examine the factors and issues that affect the resource management process currently used in BAE SYSTEMS. The survey was made up of a combination of Likert scale questions and open-ended comment sections allowing for the collection of both qualitative and quantitative data for analysis.

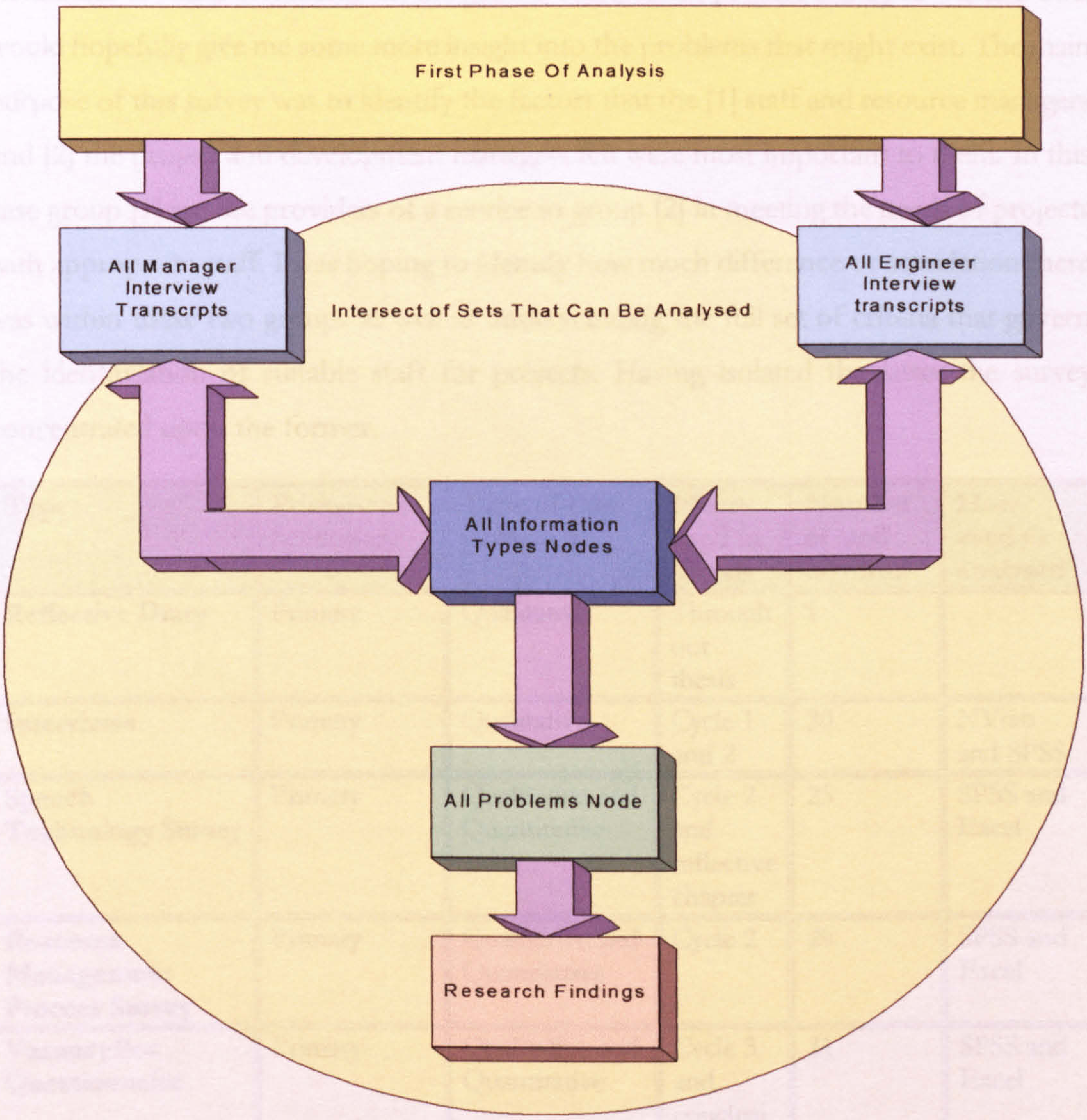


Figure 3-2: Research Node Process Explained

The factors examined in this survey relate primarily to issues raised in the cycle one interviews. However, the majority of the identified factors culminated from collaboration with members of the human resources group. Once a full list was developed through a brainstorming session I took this away and developed the categories which these factors would belong in. I came up with four categories: Technical, Company, Skills and Social that would accommodate all the factors identified. The collaborating group considered technical factors useful since this is the main domain for a large defence engineering company. Social factors were specifically contributed to by the human resources representatives at the meeting and the skills elements gained contributions from most candidates in the group. There was also room at the end of the survey to pick up on any factors which candidates felt were missing from the survey and had some importance to the recruitment process in their view. There were also two open-ended questions allowing candidates to make comments on the general recruitment process if they so wished. This would hopefully give me some more insight into the problems that might exist. The main purpose of this survey was to identify the factors that the [1] staff and resource managers and [2] the project and development managers felt were most important to them. In this case group [1] are the providers of a service to group [2] in meeting the needs of projects with appropriate staff. I was hoping to identify how much difference or correlation there was within these two groups as well as understanding the full set of criteria that govern the identification of suitable staff for projects. Having isolated the latter the survey concentrated upon the former.

Type	Primary or Secondary	Type of Data Collected	Where used in Thesis	Number of staff involved	How used or analysed
Reflective Diary	Primary	Qualitative	Through out thesis	1	
Interviews	Primary	Qualitative	Cycle 1 and 2	30	NVivo and SPSS
Speech Technology Survey	Primary	Qualitative and Quantitative	Cycle 2 and reflective chapter	25	SPSS and Excel
Resource Management Process Survey	Primary	Qualitative and Quantitative	Cycle 2	29	SPSS and Excel
VacancyBot Questionnaire	Primary	Qualitative and Quantitative	Cycle 3 and conclusi on	31	SPSS and Excel
Project X Lessons Learned Feedback	Primary	Qualitative	Reflectiv e	6	NVivo Reflect
Software Agent follow-up Interviews	Primary	Qualitative	Cycle 3	6	NVivo Reflect
Main collaboration Group	Primary	Qualitative	All	7	NVivo Reflect
Resource Management Collaboration Group	Primary	Qualitative	Cycle 3	5	NVivo Reflect
Process Collaboration Group	Primary	Qualitative	Reflectio n	10	NVivo Reflect
E-mail Usage Survey	Primary	Qualitative and Quantitative	Cycle 2	6	SPSS and Excel

Type	Primary or Secondary	Type of Data Collected	Where used in Thesis	Number of staff involved	How used or analysed
BAE SYSTEMS Intranet Surveys	Secondary	Qualitative and Quantitative	Cycle 1	170	Excel
BAE SYSTEMS Employee Opinion Survey	Secondary	Quantitative	Cycle 1 and 2	367	Excel
Internet KPMG Survey	Secondary	Quantitative	Knowledge Management and the Company	Unknown	Unknown
BAE SYSTEMS Chairman's Awards Data	Secondary	Quantitative	Reflection	220	Excel

Table 3-2: Summary of Surveys and Questionnaires Used Throughout this Research

A Likert scale and associated survey was created and the factors and areas for investigation were validated by a senior resource manager from within the Company prior to the survey being carried out. This method was selected in order to capture the attitudes and opinions of those being surveyed. A total of 16 local division resource and staff managers were identified by the human resources group and a balancing number of project and development managers were selected at random from my full set of site project and development managers. Thirty-two candidates in the two groups were asked to complete a questionnaire and give their opinion on the importance of various aspects (the original factors identified) of the recruitment process. A total of 14 out of 16 candidates responded from group one (Resource and Staff Managers) and 15 out of 16 other managers responded to the request. The results of the survey are recorded in Appendix B and are discussed in chapter five.

A specific Company report was developed and passed to the appropriate stakeholders in this research for further exploration and use within the company. After the stakeholders had read the report a short follow-up meeting was used to discuss issues that arose from the results.

3.4.4.2 E-mail Usage Survey

An e-mail usage survey was carried out in order to assess whether the views and opinions captured in the cycle one interview data had any substance. The suggestions from interviewees were that they received an overloading amount of e-mails that were inappropriate, not relevant or interrupted workflow. In order to determine whether this was really the case I set up an initial first survey in order to test this on a small number of randomly selected employees (six in total). Three members of the engineer group and three from the managerial group (based upon grade) were randomly selected from the total staff on the site. A bigger survey at this time in the research had the potential of an extremely large amount of data for analysis, which I felt was not necessary at this point in time. In this investigation I was planning to carry out a second much larger survey if the results gave me good reason to suspect that there was a significant information problem in this domain that may possibly be resolved utilising software agents.

This survey was also carried out in cycle two of this research and the full details of how the survey was conducted and what it contained can be found in chapter five of this thesis. The survey examined the type of e-mails received by a selected number of staff and how much of their time was taken up in dealing with these e-mail types. This survey recorded quantitative data, which was analysed using statistics software.

In my survey design I first gave consideration to the types of e-mail being received on the site and determined that the first categorisation should be either in the category (1) personal or (2) work-related. Next I considered what factors should be used to distinguish the amount of time interruption an employee receives through a certain type of e-mail. I came up with the categories: read only, immediate response and slower response, which relate to the types of e-mail responses determined by the e-mail content. I designed an electronic form that could be utilised by each candidate whilst they examined their e-mail in-tray each day for one week. I felt this would give me enough data for an initial feeling for the severity of the problem. The candidates recorded the type of e-mails they dealt with during the week and calculated the amount of time they spent closing down those e-mails.

The results of this survey are contained in Appendix C and are utilised in chapter five, cycle two. A specific company report was developed and passed to the appropriate stakeholder in this research for further exploration and use within the Company. After the stakeholders had read the report a short follow-up meeting was used to discuss issues that arose from the results. As a result of discussions a communications administrator was given the responsibility of cutting down the amount of duplication and inappropriate communication of e-mails across the division.

3.4.4.3 Speech Technology Questionnaire

This questionnaire was used in cycle two and is covered in detail in chapter five of this thesis. It was actually developed during cycle one. The survey examined the usefulness of a Speech Technology report, as a knowledge asset, to the Company as well as the usefulness of the technology investigated in the report. This came about because I was carrying out the private venture work and related report generation and I was interested in knowing whether the report and the work were of value to the Company and how that information was utilised in the organisation.

The questionnaire collected both qualitative and quantitative data for analysis from the Domain Experts Group on the Company site as these were the main recipients of all such technology reports when private venture funding has been used. This is a distinct group made up of technical and managerial experts. The survey results were thus divided by grade within this group into manager and engineer categories in order to identify differences in opinions in the two groups.

The questionnaire identified two distinct areas for investigation, firstly, the report itself and how useful it was to the candidates receiving it and secondly, to investigate the usefulness of the technology itself. In this way the survey was divided into two sets of questions against which a balanced Likert scale was attached. The questionnaire was passed out in electronic format with single option choices from the survey, which meant the candidates could fill it in quickly and easily. A specific company report (Appendix D) was developed and passed to the appropriate stakeholder in this research for further exploration and use within the company.

3.4.4.4 VacancyBot Questionnaire

The basic elements of this questionnaire were developed originally for use on a project where I worked as an engineer during cycle one of my research. It was used as part of a joint application development process, which I designed to incorporate buy-in from the customer and ensure that the product was fit for its purpose once complete. I designed the questionnaire based upon the International Standards (ISO-1942) and the Military Standards (00-25) for human-computer-interface design analysis. The survey was tried and tested over thirty times with the customer on various aspects of the product interface and was validated by a Company subject matter expert of Human Factors before implementation.

This questionnaire was used again with an additional set of software agent specific open-ended questions tagged on the end, during cycle three of the research and is discussed in chapter six of this thesis. It was created to collect the opinions of those using the VacancyBot application for the first time. It concentrates upon the usability of the application interface and its' fitness for purpose. It records both qualitative and quantitative data for analysis. There were also some minor time recordings taken randomly during the session in order to make some comparisons with the timings given by the human resources department based upon the current way of working without agent technology. The full details of the use of this questionnaire and the analysis of the results are recorded in chapter six of this thesis.

3.4.4.5 The Chairman's Award for Innovation (CAI) Data

This was not developed into a survey by BAE SYSTEMS, instead the statistics available for the CAI website were used to run a minor statistical analysis comparing the current and previous year's results. This data was used marginally in reference to issues identified and in the researcher's reflections. The statistics were passed to stakeholders interested in this research within the company for learning purposes.

3.4.5 Secondary Data Referenced

All the primary sources of data collection are discussed in detail in their relevant chapters of this thesis. The secondary data used is outlined here in order

3.4.5.1 Intranet (CWW) Questionnaire

The Intranet questionnaire was used to substantiate similar findings recorded from this research. It measured some aspects including the CWW, Newsgroups, e-mail and the Internet, which were also covered in this thesis.

The Company Intranet Survey has been run since 1998. It seeks to identify the usefulness of the Company Wide Web (CWW) and staff opinions of its current state. The survey consists of many questions, which were ranked on a Likert scale. These questions were split into separate functional areas. It also had open-ended comment boxes in most sections of the questionnaire. The survey recorded both qualitative and quantitative data.

A full copy of the raw data collected for the surveys was made available to the researcher and analysed for areas of correlation within this thesis. The data was delivered in an Access database, which was then imported into an Excel workspace in order to carry out statistical analysis. Some time of reflection was also spent examining the questions used in this survey with a critical eye in order to understand the results more clearly.

This survey was examined prior to developing the researcher's questionnaires found in cycle two in order to learn from its strengths and weaknesses. The critique of the CWW questionnaire was delivered to the appropriate stakeholders involved in this research in order to learn from the issues raised. When examining the original Intranet questionnaire the following observations were made:

- The questionnaire was only available if the member of staff accessed it on the CWW in the first place. Therefore they would (a) need to be a user of the CWW and (b) find the questionnaire in the first place in order to attempt to fill it in.

- The questionnaire was incredibly long with over 100 questions most of which require the user to choose from a pick list on the screen with a multiple number of choices.
- The electronic version was a good idea but for the less experienced user it may cause problems in some of the usability issues.
- The length of the questionnaire makes it less attractive to fill in especially if people do not have much time to do it.
- Some of the questions were repetitive.
- Some of the questions were ambiguous in what was actually being asked.

A second form of data gathering relating to web usage has also taken place on all Company sites, including international ones. This deals only with statistical hard data using a rational form of analysis. The main input to this report has been the number of hits per site on the Link BAE web pages. From this deductions such as what web pages are the most popular or least popular are deduced by these hit rates. Other factors such as the top entry pages (i.e. those the user first saw when they visited the site), top exit pages, single access pages (where a user accesses and exits without viewing any other page), most active organisations (business units or sites visited), activity levels by day of week, activity per day, activity per hour and many more similar examples. However, the value of such statistics is questionable when they stand-alone. Many examples of user behaviour are not covered and in some cases are totally unaccounted for. Users attempting to use the web for the first time may not know how to navigate and end up visiting sites they do not really want to visit. People may request a search with the current search engine and since this is a poor search engine the results may lead to inappropriate web hits to inappropriate sites (Wei & Marchioninnin, 1996). However, the usage of the web by employees can be a useful criteria to judge how much it costs the Company monthly or yearly etc. at each site for these employees to be looking on the web. However, there are more appropriate measures and analysis that may provide reasons why some members of staff are not using the web facilities at all, or why people want to use the web and how people behave when they are using it.

This survey has been referenced in this thesis during the analysis of other primary data collected during the research. Other responses to CWW Surveys have also been discussed where applicable.

3.4.5.2 Company Employee Opinion Surveys

The Company produces regular employee opinion surveys each year and I participated in giving my own responses in 1999-2001. The specific areas covered by the survey include the employees' views and opinions as related directly to the Company's five values: Performance, People, Customer, Innovation and Technology and Partnership. The survey uses a Likert scale of opinions and after the results are analysed they are published on the Company Intranet and notification is given to all employees as to the content of these results.

3.4.5.3 Internet Survey Material

Other referenced surveys and questionnaires published on the World Wide Web mentioned in the discussions on data analysis and correlating are also mentioned. Skandia in Sweden and KPMG have developed several surveys that specifically deal with knowledge management. These are found on the Internet and their locations are recorded in the reference section of this thesis.

3.5 Summary

This chapter has explained the methodology adopted and the methods that have been chosen in order to collect data for analysis. It also describes the manner in which these methods have been used. Much more detailed descriptions of individual surveys, interviewing and questionnaires is recorded in the action research cycles more appropriately. The action research cycles now develop this further and continue the research through to analysis of the data collection in detail. Therefore the next chapter deals with the first research cycle.

MY FIRST ACTION RESEARCH CYCLE

4.1 Introduction

This chapter will set out to understand the information systems in place in BAE SYSTEMS and will seek to identify the areas of difficulty and problems with these systems through the views of those working most closely with them. To this end this cycle concentrates on the interviewing of BAE SYSTEMS employees within the Company. It uses the interviewing methods already discussed earlier in this thesis and seeks to access and accumulate data on the kinds of information and the way that this is communicated in the Company from an individual's perspective. This information is only half of the equation because I wish to explore with the interviewees whether this is suitable to transform into useful knowledge in order that they can fulfil their role within the organisation effectively.

Each member of staff is asked to answer the question:

"Tell me about the kind of information you need in order to carry out your job effectively. Can you also tell me what you think about the quality of that information and whether you always get the information you need?"

This question is open-ended allowing the individual to talk about whatever information they feel to be the most relevant. The question is based upon the information domain rather than the knowledge domain because I felt that the employees of this large engineering company are familiar with the concept of information and not particularly familiar with the idea of knowledge. Therefore I expected to get the technology part of knowledge management e.g. information rather than the tacit knowledge from these interviewees as a starting point for my research. When I look through the final transcripts, these employees only give me a perspective of information and data as I expected. This also suggests that their perspective is located in the cognitivist epistemology of knowledge (See von Krogh, et al., 1998). In this case the information is an explicit form are perceived as the knowledge. The responses of the employees are recorded in this chapter and concentrate in particular on specific tool sets, applications and company processes. This is unique to the engineering community and I did not expect to gain much, if any, insight into the softer social sciences in this domain. As a reflective practitioner I can wholly appreciate this world of explicit information and data, as I have been involved in the engineering profession for over five years myself. The employees responded immediately to my question with a detailed description of the engineering processes, tools and applications they utilise in their daily work because they come from an engineering background. Very few comments are raised in the soft science area. Details of the statistical analysis of the words used throughout the interviews are analysed more closely in the second cycle of the research, which substantiates these views.

The individuals were in no way primed as to the question they were going to be asked. I also made every effort not to lead or draw the individual along any predefined or biased route. However, if an individual was struggling to discuss things I may have asked another shorter question or made conversation to assist them – this was extremely rare.

4.2 Analysis of the interview candidates

As stated, the analysis of the interview data is split into two sets: one set are the group 'Managers' and consists of eleven candidates; the second group are the group 'Engineers' and there are nineteen candidates. The division is in accordance with the BAE SYSTEMS grading scale and the Manager group all rank at grade E4 or higher leaving the remainder in the Engineer category (See the Methodology chapter). They were selected in proportional representation of the total number of staff at the Christchurch site.

4.3 Identified information sources

The rest of this chapter discusses and analyses the interview transcripts based on a coded set of data relating to the problems and issues the candidates raised during their interviews. Each sub-section begins with a description and detail of the information source identified. These information sources include: resource planning module, QUEST database, newsgroups, company wide web, world wide web, e-mail, electronic project file, lessons-learned log, timesheet entry system, estimating metrics, private venture, communication with others, culture, best practice, expert groups, skills database, SAP database and a requirements analysis management tool. A Manager and an Engineer perspective is analysed and follows this description section. Finally a comparison and summary are made on each information source before moving on to the next one.

Resource Planning Module

(a) Description

BC began by discussing the use of a Resource Planning Module (RPM) database tool within the Company [BC: 1]. This tool is used to identify the resourcing needs of a project within the Company and to allocate appropriate members of staff and levels of staff to fulfil it.

The whole idea behind the RPM tool is that BAE SYSTEMS needs to be able to run projects efficiently and to this end these projects require access to the appropriate resources. The process of resource planning takes account not only of the resourcing needs of current projects but also bids and prospects. According to the Company Engineering Resource Planning Process (A2N40164735) documentation there are six main inputs to this process: (1) Prospects identified (these normally come out of the QUEST database); (2) Milestone Plan estimates; (3) Revisions to project plans in existing projects; (4) Business investment (e.g. through Private venture, overhead-funded innovation work etc.); (5) Skills assessment for long term blue sky technology; and (6) Core specialism (e.g. essential even if not required against specific project at all times) (See Figure 4-1. and Figure 4-2).

The key main output relevant to most Resource Group Managers, project Managers and other Task Managers is the resource plan which illustrates the current resourcing situation as well as the gap or surplus in resourcing and other strategic issues.

The stakeholders are identified and the way the process operates is illustrated in Figure 4-1. Here the key players are the Resource Manager, the Task Manager (this could be a Project Manager, Software Development Manager or similar member of staff), training staff and the Personnel department officials. The data relating to the business prospects in the planning register have certain levels of resources assigned against them. These levels of resourcing, however, are based upon the subjective opinions of those filling in the resource management tool with that data. This subjective view is often based upon past experience. Also the resource demand is calculated by using factors such as the skill level, numbers and time scales and these too are based upon past experience and the expertise of those inputting the data. There is room for making mistakes at this early stage of the process. The reviewing of these figures does not take place until later and there appears to be no mechanism in place to capture how the originator ascertained initially to base any reviews.

The process takes the resource demand and looks at how this will be met. It is also at this stage that all other areas of resourcing demands are identified so that the bigger picture can be evaluated. This is a good practical consideration and certainly needs to be examined early on in the process. The problem still remains as to the validity and rigour of the initial data input. In this step there is verbal communication between the project managers and the resource group managers concerning the changes in project estimates and other demands of the business as a whole.

It is not until the process is in the last stage that the real availability of staff with the right skills and timely availability are actually discussed. In this phase, input to the process is by the resource group managers, milestone owners and named individuals. Here the resource managers have accepted that the demand exists and now look to fulfil the requirements to meet the project needs. Here the resource group managers suggest suitable candidates for the projects and identify any recurring resourcing issues. Once individuals have been selected for interviews on various projects and are accepted they are then removed from the central pool of resources until they have completed their assignment. Once assigned the resource planning tool is updated once again. However this whole process is flawed and the tool is criticised as identified by the interviewees.

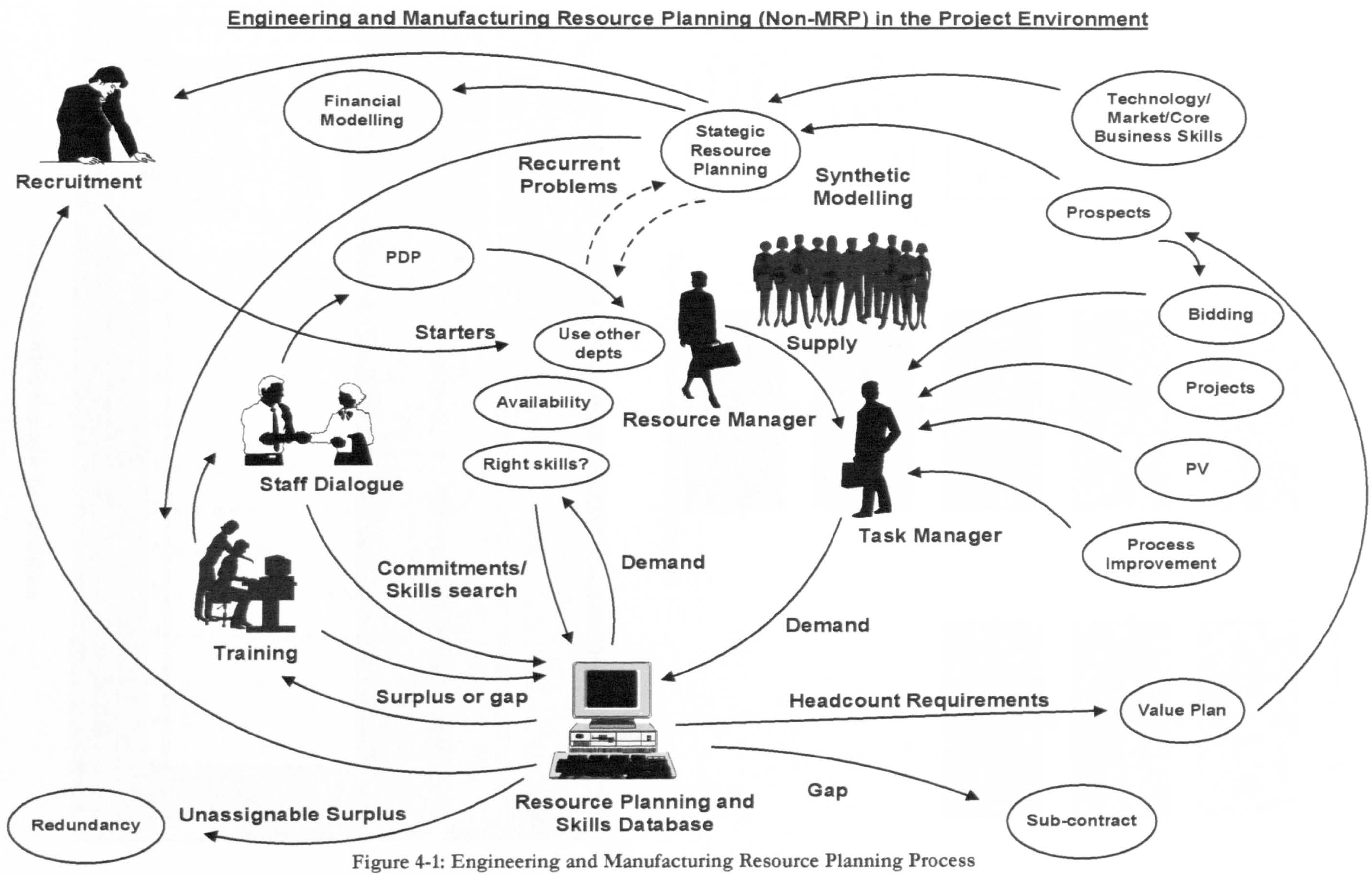


Figure 4-1: Engineering and Manufacturing Resource Planning Process

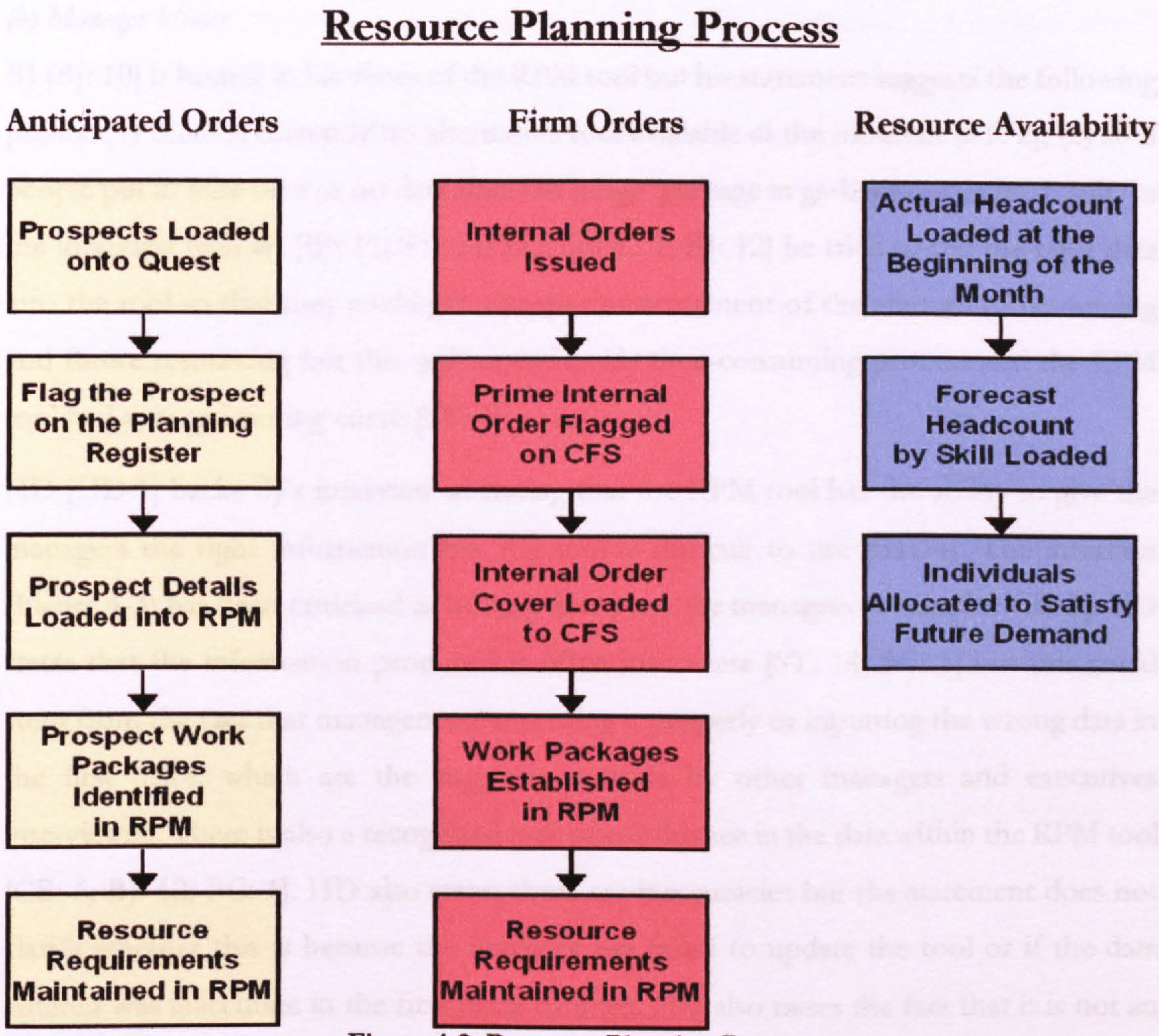


Figure 4-2: Resource Planning Process

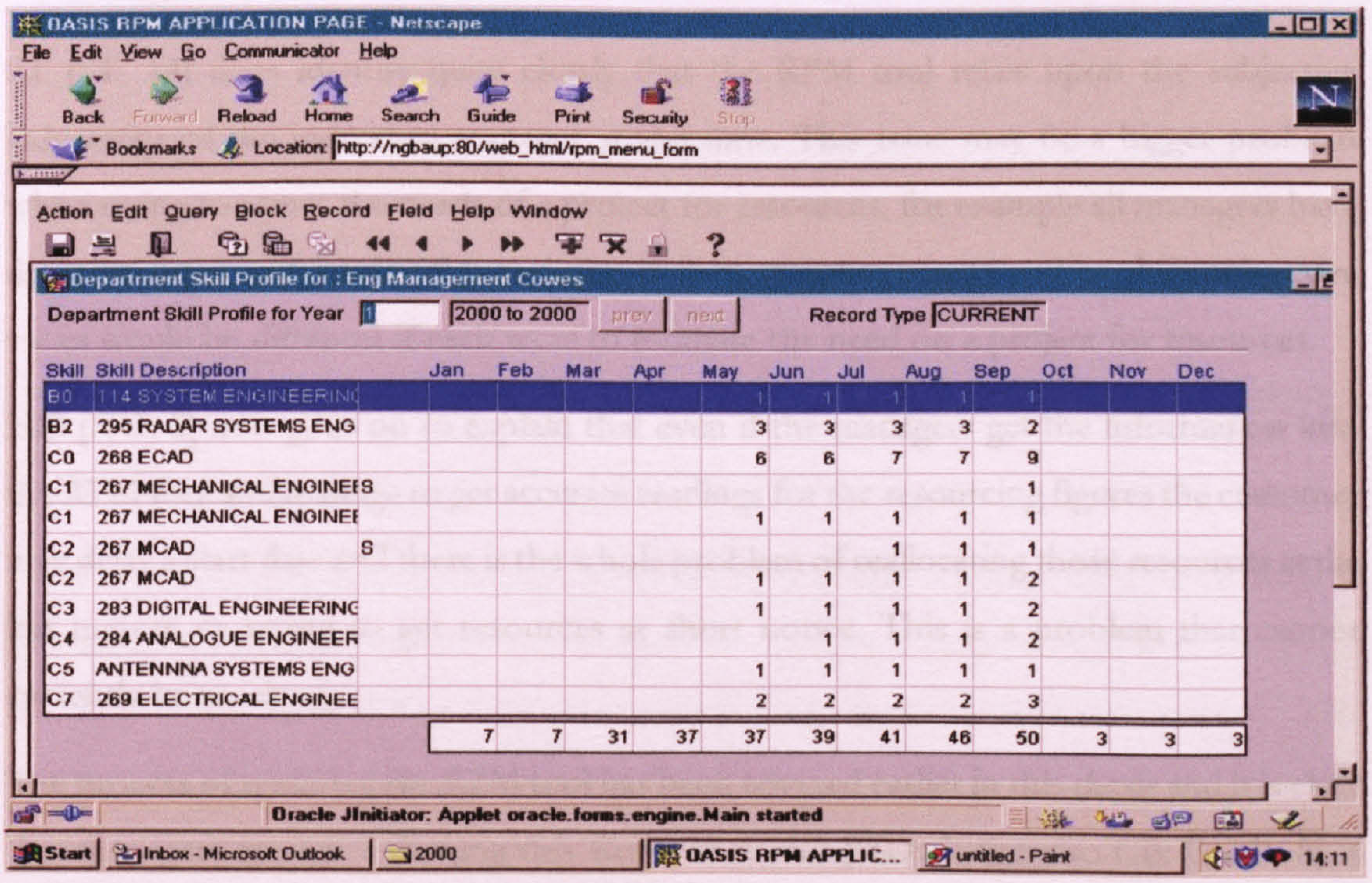


Figure 4-3: RPM Example User Interface

(b) Manager Views

BJ [BJ: 10] is honest in his views of the RPM tool but his statement suggests the following points: (1) there is currently no alternative tool available at the moment [ST: 2], (2) so if people put in false data or no data then the adage 'garbage in garbage out' is the result. In the interview with BJ [BJ: 11; ST: 14; BC: 6; BC: 1; BJ: 12] he tried to put the right data into the tool so that they could get a proper measurement of the amount of resourcing and future resourcing but this was an extremely time-consuming process and the RPM tool had a steep learning curve [ST: 4].

HD [HD:1] backs BJ's interview in stating that the RPM tool has the ability to give the managers the right information but the tool is difficult to use [ST:14]. The interface (Figure 4-3) has been criticised as being pretty poor for managers to use [See CB: 5]. HD states that the information produced is often inaccurate [ST: 14; BC: 1] but this could stem from the fact that managers are not using it properly or inputting the wrong data in the first place, which are the suggestions made by other managers and executives interviewed. There is also a recognised lack of confidence in the data within the RPM tool [CB: 6; BJ: 12; BC: 1]. HD also states there are inaccuracies but the statement does not clarify whether this is because the manager has failed to update the tool or if the data entered was inaccurate in the first place or both. HD also raises the fact that it is not an easy task – this requires clarification as to whether this is due to the process or the tool or something else.

ST [ST: 14] does identify quite clearly that the RPM tool relies upon the subjective judgement of the individual manager at the time. This issue may be a bigger problem when trying to assess the needs of a project for resources, for example all managers have different types and levels of experience in project management and so their subjective views would be different if each were to estimate the need on a project for resources.

HD [HD: 2] now goes on to explain that even if the managers get the information into the RPM tool and manage to get accurate readings for the resourcing figures the customer may delay a start date and there is the whole problem of reallocating those resources at the last minute or trying to get resources at short notice. This is a problem that cannot currently be resolved.

The process of updating the RPM tool has been covered earlier in this thesis and it is clear that managers are not following this from what HD [HD: 3; See also CB: 7; CB: 8] is stating here. HD is a particularly useful manager to interview in this specific case since he manages resources for several of the departments. This puts the emphasis on his views as being particularly pertinent in the discussions on these RPM issues. The RPM process, like many other processes in the Company gives guidelines and statements as to how to run the RPM process, however there is no mandatory command from higher up in the executive ladder enforcing the process or mandating it [CB: 4; CB: 9 – CB: 12]. Managers failing to co-operate with the process remain undisciplined by the Company therefore if managers fail to use it properly there is no comeback on them [CB suggests answers in CB: 13 – CB: 15]. Secondly, there is thus a question over why a manager should have any incentive to use the process and tool at all?

(c) Engineer Views

RPM is seen as an important source of data for planning, but the results produced are often incorrect [WJ: 18; JD: 15] or, complete fantasy [MS: 10]. When this is the case it is difficult to see how such useless information can be used to make the correct business decisions [WJ: 18; JD: 15].

JD states that RPM is: -

"Totally essential for a major element of my job but it is inaccurate, badly managed and an obstacle to resource planning" [JD: 15].

But adds:

"It is a major, acknowledged problem that has been 'getting fixed' for as long as I can remember working here, that is, some fifteen years!" [JD: 15].

(d) Comparison and Summary

The main emphasis on RPM comes from the Management candidates rather than the Engineers (Table 4-1). This is likely to be because the Engineers have very little to do with the tool unless they move up into a quasi-technical role such as a Team Leader where they would need to identify their resourcing needs with their own line-manager.

However, both candidates suggest that the tool does not work properly and is inaccurate at showing the real resourcing requirements.

There is another problem which no-one has mentioned in the interviewing process: that a manager might identify the need for a resource and have a rough idea of the skill set for that individual, but how does that manager perfectly match an individual to a particular and specific role? Having investigated the CWW at the time of the interviewing there was scant material available to identify a particular role and associated description – for example, skill level, educational requirements and experience in lieu (and amounts), grade, Belbin identification on a project to project basis (because it could be a perfect skill match but an inappropriate team member), an employee's preferences and so much more. These issues are dealt with in this research.

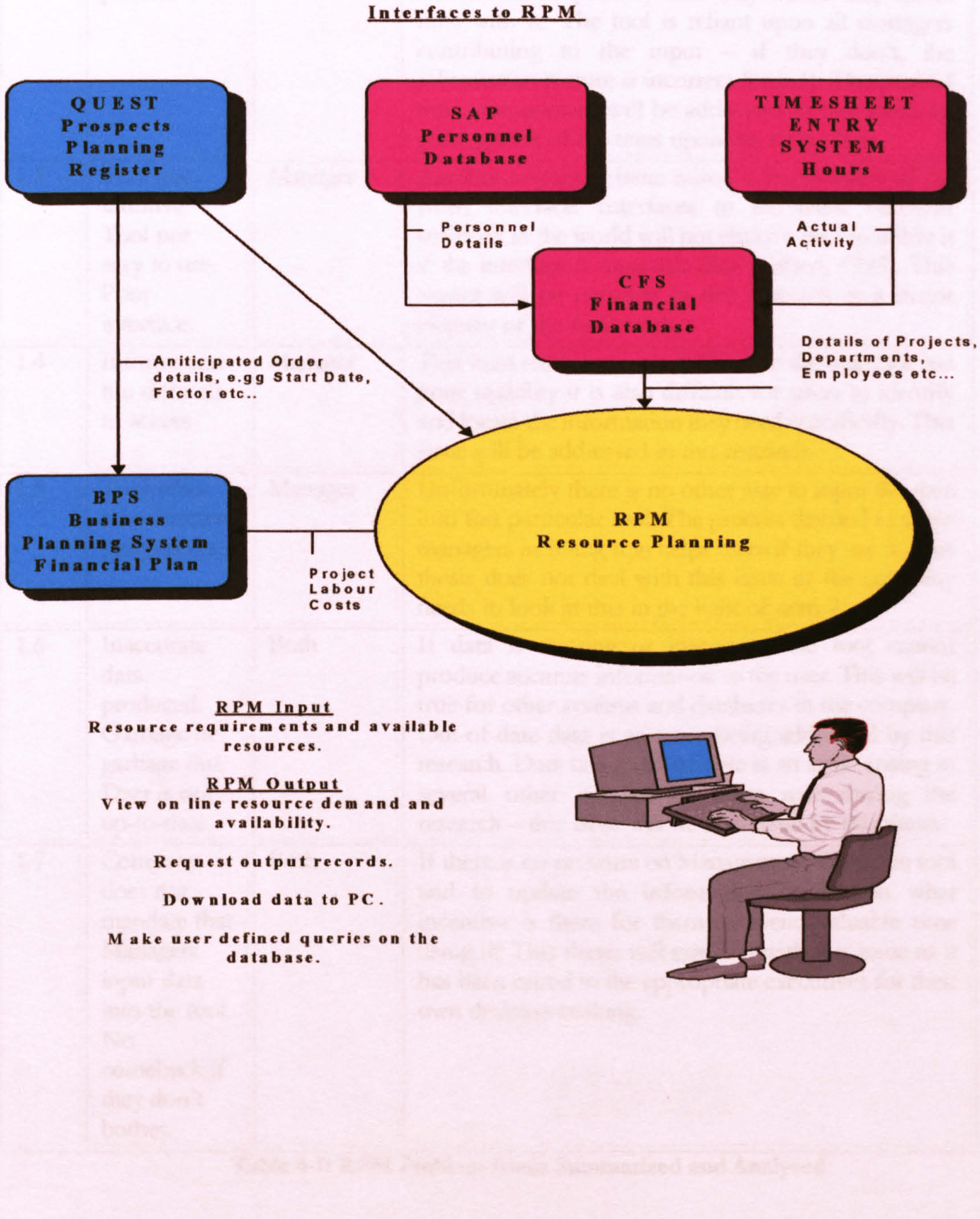


Figure 4-4: Interfaces to RPM

Item	Issue Raised	Manager/ Engineer/ Both	Perception
1.1	No alternative tool	Manager	If there was an alternative it would need to address the majority of issues arising here otherwise it would not be utilised either.
1.2	Time consuming	Manager	Managers' time is very precious. If they cannot use the tool and it's not easy to use (item 4 & 5), as well as

Item	Issue Raised	Manager/ Engineer/ Both	Perception
	process		not mandated (item 7) then why would they spend time with it? The tool is reliant upon all managers contributing to the input – if they don't, the information picture is incorrect (item 1). The issue of time management will be addressed in this thesis by putting a lot of the onus upon the technology.
1.3	Tool not intuitive. Tool not easy to use. Poor interface.	Manager	Another important issue raised is the usability of the RPM interface. Interfaces to the most excellent software in the world will not entice a user to utilise it if the interface is unusable (See Nielsen, 1993). This aspect will be revisited in this research as a major element of the final work.
1.4	Information too difficult to access	Manager	This item related to item 4. Because the interface has poor usability it is also difficult for users to identify and locate the information they need specifically. This issue will be addressed in this research.
1.5	Tool relies on subjective judgements.	Manager	Unfortunately there is no other way to input the data into this particular tool. The process devised to assist managers in filling it in helps them if they use it. This thesis does not deal with this issue as the company needs to look at this in the light of item 7
1.6	Inaccurate data produced. Garbage in garbage out. Data is not up-to-date.	Both	If data is missing or inaccurate the tool cannot produce accurate information to the user. This will be true for other systems and databases in the company. Out-of-date data is an issue being addressed by this research. Data being out-of-date is an issue arising in several other information areas rose during the research – this issue will be addressed by this thesis.
1.7	Company does not mandate that Managers input data into the tool. No comeback if they don't bother.	Both	If there is no pressure on Management to use the tool and to update the information in it then what incentive is there for them to spend valuable time using it? This thesis will not deal with this issue as it has been raised to the appropriate executives for their own decision-making.

Table 4-1: RPM Problem Areas Summarised and Analysed

QUEST

(a) Description

The QUEST database [BC: 1] is a tool used mostly by the marketing division of the Company in order to rank and identify future business prospects. The marketing personnel using their subjective viewpoint update the QUEST database when they have analysed a prospect and enter it into the system. They can enter the prospect under any one of several categories: registration (identification of prospect); go/no go decision (for consideration at a review where funding is considered for the prospect); and bid/no bid decision (formal decision made regarding bidding and funding of the prospect). Accompanying the prospect is a Prospect Action report, which is maintained and updated by the Sales, Marketing and Project Managers with the latest information (Figure 4-5). If the information is out-of-date then a wrong decision could be made regarding the final bidding of the prospect. When a prospect gets to the bid stage of the process it will require estimates on size and therefore the number of resources and types of resources required for the completion of the bid and the final project (See Figure 4-4 which shows the relationship of QUEST with RPM)

(b) Manager Views

BJ [BJ: 3] next identifies the fact that the information is possibly too complex and there is rather a lot of it to look through in order to find something meaningful. At his level BJ needs a summary to indicate key pointers to aid him in getting it right on his project.

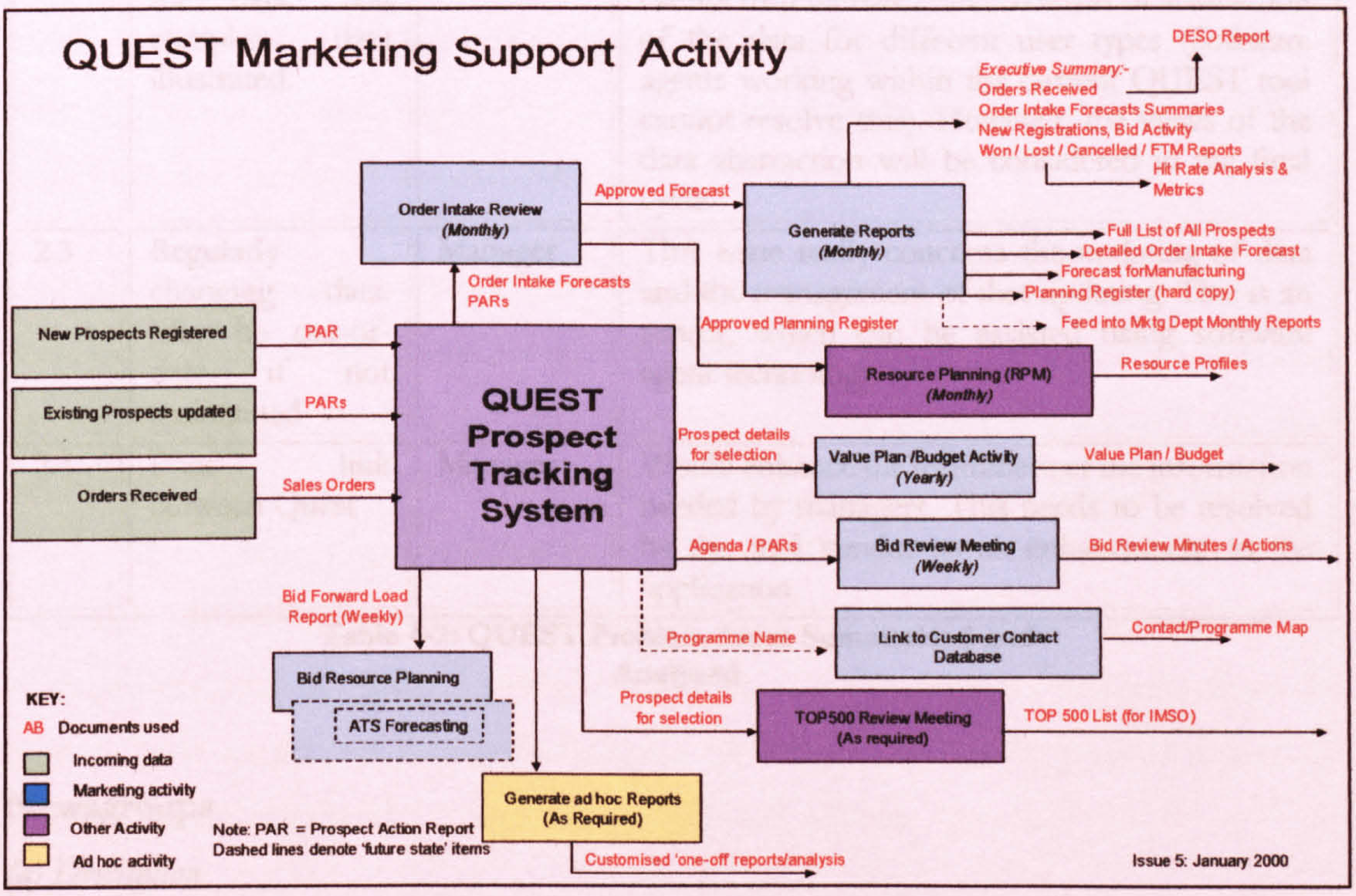


Figure 4-5: QUEST Workflow Diagram

ST states [ST: 12] that QUEST is reliant upon regularly changing data, which he sees as maintainability issue – it would suggest that the database is regularly updated. He also states another problem – that there is a poor link between QUEST and other databases. Finally, he raises the issue that combined data subsets help managers when they come to understand winning new business.

ST [see also ST: 13] also highlights the issue that in practice is difficult to get resources even if a project manager is on top of the issues relating to Quest and RPM (Table 4-2).

(c) Engineers View

Most engineers had never used this tool [WJ: 17]. It was not mentioned at interviews with the rest of the Engineers group. This is probably due to the fact that the Engineers would have no need to utilise such a tool for their day-to-day work (Table 4-2).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
2.1	Once again based upon individual subjective views	Manager	This is a feature of the application that cannot be resolved unless some quantitative measurement or process is developed to assist those filling in the data.
2.2	Presentation of the data. Too complex data illustrated.	Manager	This is a problem with the application, which cannot differentiate between levels of abstraction of the data for different user types (Software agents working within the current QUEST tool cannot resolve this). However, the views of the data abstraction will be considered in the final cycle.
2.3	Regularly changing data. May be out-of-date if not maintained	Manager	This issue really concerns the updating of data and the management of that updating. This is an aspect, which can be assisted using software agent technology.
2.4	Poor link between Quest	Manager	Would enhance the usefulness of the information needed by managers. This needs to be resolved by the tool vendor as an enhancement to the application.

Table 4-2: QUEST Problem Areas Summarised and Analysed

Newsgroups

(a) Description

Newsgroups are a community communications area available on the majority of terminals within the Company. There are specialist communities such as a Software Group and a Software Process Group and there are general groups where employees can just chat (See Figure 4-6). These function like WWW chat rooms and a question or a point of view is expressed and other members of the community join in by answering the question or responding with comments (Tiwana, 2000). This area has been open to the Christchurch site of BAE SYSTEMS for a few years now.

Newsgroups are knowledge communities that are characterised by a sense of belonging on the part of the individual employee; where there is an identity for that group (this legitimises the knowledge claims of that group) (Dixon, 2000). The facilitation of this knowledge community comes from the Company but allows all employees with access to have the freedom of choice as to whether they do or do not join any particular newsgroup. By forming a newsgroup facility the Company is encouraging a cross-fertilisation of knowledge and ideas within the Company.

Newsgroups are a knowledge facilitation mechanism and can be referred to as knowledge communities (McDermott, 1999). Some of the Newsgroups available within the Company are communities of interest, for example Software. On the Software Newsgroup members of the community share their interest in Software and they can participate in resolving problems raised or discussions on solutions whenever they want to. An example of the kind of information discussed on the Software Newsgroup is illustrated in Figure 4-6

Other communities of interest include CWIS (Company Wide Information Services), general, Division Engineering, Recreation Chat (Figure 4-8), Software, Microsoft Office, IT/CWW and Company Announcements.

Newsgroups as a community of interest give the Users a feeling of belonging within that community and a sense of identity with that group (Brown et al., 1989). Each specialist community has its own language and jargon; its own specialism (Figure 4-7) and thus boundary; its own implicit rules and it will involve a co-evolution of the community as a whole. All of these factors will eventually assist the Company when it starts to look in more detail at setting up a knowledge management structure within the Company where all employees can participate. Although there is a reasonable amount of criticism from the Management community within the business via these interviews the positive aspects of what is available need to be recognised by the management.

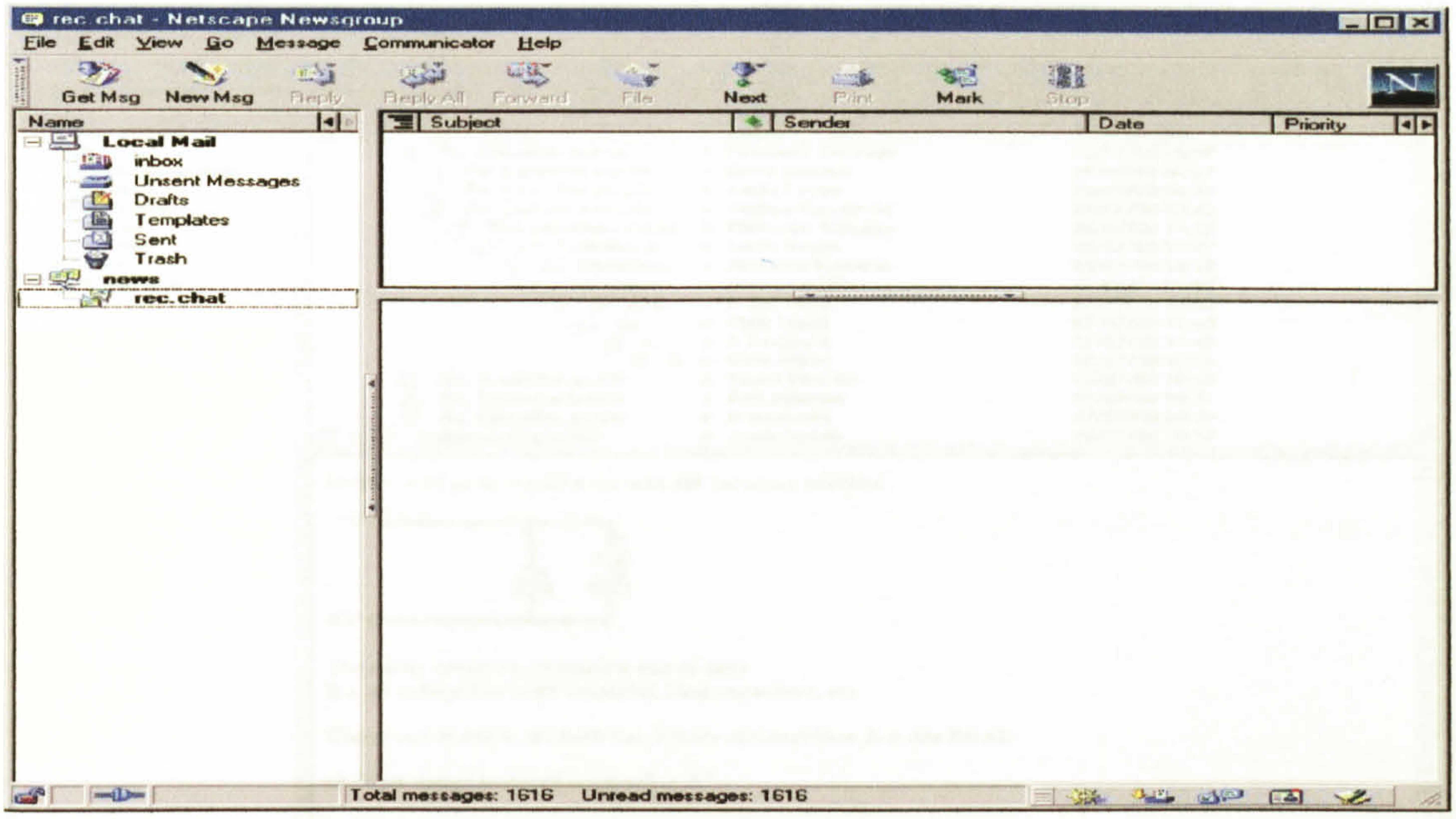


Figure 4-6: General BAE SYSTEMS Newsgroup Facility

(b) Manager Views

BC [BC: 2] now identifies the problem that there is a lot of information on the Newsgroups area too. BC also suggests he has little time to look at all this information and how to locate it efficiently. DR [DR: 2] confirms the lack of time to access the Newsgroups. However, if the Newsgroups were providing the managers with valuable information to assist them they would find the time to use them because they would manage their time to make the effort to use them

According to DR [DR: 3] and others interviewed in management [WA: 3] the population of the Company using the Newsgroups is quite small. Some suggestions were made that this is due to poor access [WA: 4].

In the statement from BC [BC: 3] there arises the issue of not being able to find the information he wants together with the view that he does not know where to find it. Here the information may be on the Newsgroups but he does not know himself.

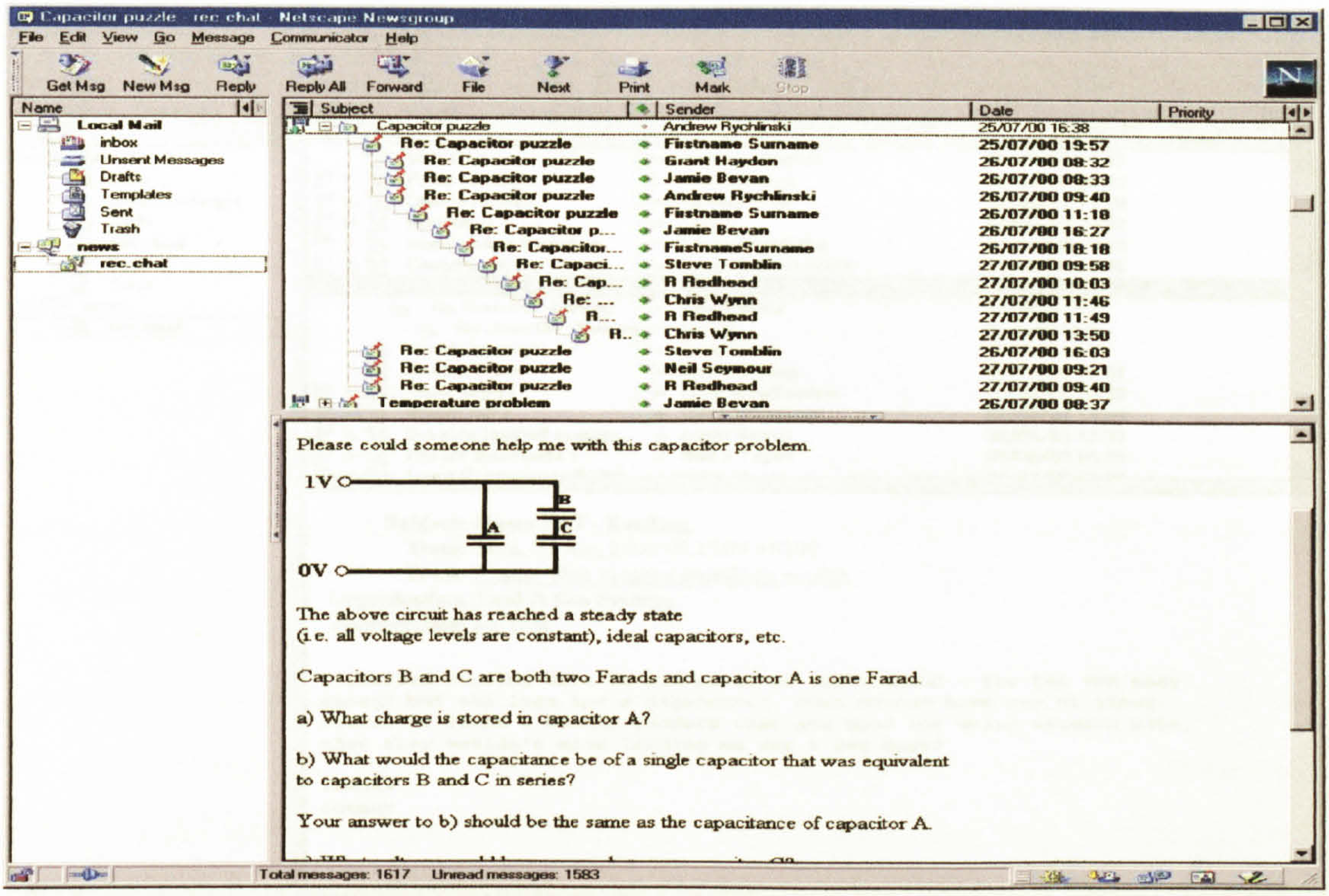


Figure 4-7: Example BAE SYSTEMS Newsgroup Technical Facility

BC [BC: 4] suggests that there is little information of value to him in his role on the Newsgroups. CB [CB: 22] agrees with BC [BC: 4] when stating that there are only limited threads with information of any value to CB. CB feels that social newsgroups are a waste of time [CB: 22] and considers that employees should be getting on with their work instead [CB: 23] (See Figure 4-8).

TH also raises the issue of secure networks and access to the CWW as other reasons why people may not use them, as these physical barriers would prevent usage.

Here DR [DR: 5] suggests that he passively takes from the source rather than contributing to it. This is a real issue in any Newsgroup or Intranet knowledge management site. If people only take and do not feel that they belong to a sharing community then the knowledge management is not working for that community.

AT [AT: 27 – AT: 31] has strong views concerning the fact that members of the Company refuse to share information. AT suggests that people only really discuss social and personal issues like getting a lift home rather than anything of any real significance.

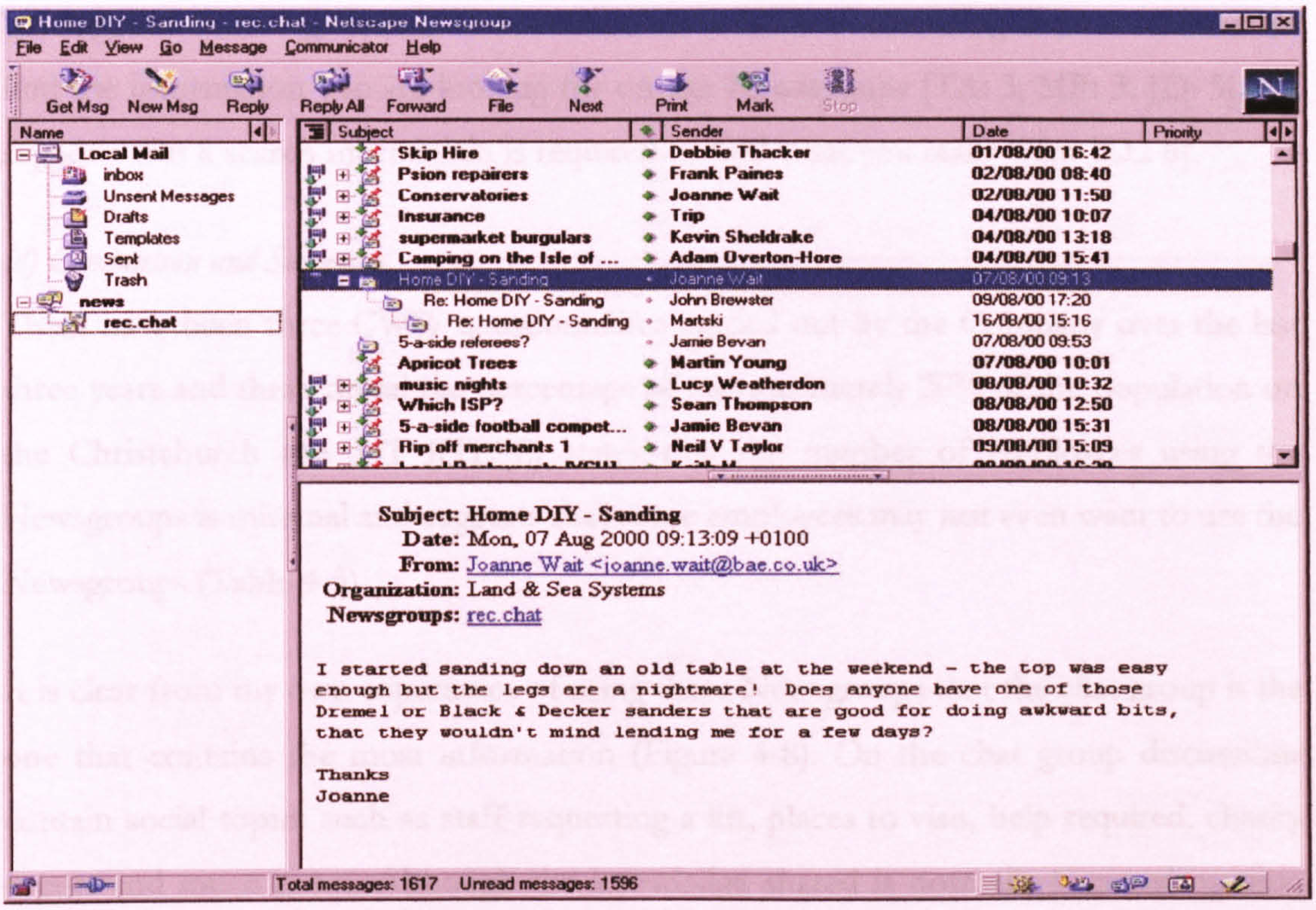


Figure 4-8: Example BAE SYSTEMS Newsgroup Social Facility

(c) Engineer Views

RS [RS: 16] agrees with managers in the first set of interview when stating that the population rarely uses Newsgroups. Other engineers see newsgroups as a tool that is under-used [CL: 3; MS: 6; MS: 5; OJ: 4; WJ: 5; HJ: 17]. For example, in the case of WG [WG: 16] there is recognition that the Newsgroups could be a useful source of information for WG's daily technical work but that he still does not use it very often. WG [WG: 17] clarifies that this is because he does not feel that the Newsgroups are particularly usable due to the structuring of the information he requires.

Several engineers also see the newsgroups as of very little use to them [CL: 3; RW: 23; MD: 2; MS: 6; OJ: 4; WJ: 5; JD: 5]. TA finds the need for specific technical information is not met on the technical newsgroups [TA: 3] (Figure 4-7).

LM finds little time to spend using the Newsgroups facility [LM: 1] whereas EL is angry that employees spend any time at all on the social newsgroups and sees very little benefit in this [See also JD: 5]. RW expresses the view that the Newsgroups appear to be a place for "whinging" and for very insignificant technical help at all [RW: 23 See also: LL: 6; WJ: 5]. MS states that the Company does not support the use of the Newsgroups [MS: 5].

TA suggests that long threads of discussion make it time-consuming and also difficult to find the information you are looking for on the Newsgroups [TA: 3; MR: 3; JD: 5]. LL suggests that a search mechanism is required to find what you really want [LL: 6].

(d) Comparison and Summary

There have been three CWW questionnaires carried out by the Company over the last three years and these reveal the percentage of users as merely 20% of the population on the Christchurch site. HT [HT: 8] states that the number of employees using the Newsgroups is minimal and suggests that some employees may not even want to use the Newsgroups (Table 4-3).

It is clear from my own experience of using these Newsgroups that the chat group is the one that contains the most information (Figure 4-8). On the chat group discussions contain social topics such as staff requesting a lift, places to visit, help required, charity events and much more. Although the knowledge shared is normally personal opinion there are sometimes little gems of knowledge that could be useful to a wider audience (Figure 4-8). However, if employees start to use the chat area of the Newsgroups it is assisting them in learning how to use Newsgroups so that if they do get a problem relating to their work they can put it on the right Newsgroup to get an answer. Secondly, these employees are building relationships over the network with others within the Company – this will help them to share other kinds of information too. Thirdly, by allowing the employees the freedom to access the chat group area of the Newsgroups it is building a trust relationship between the Company and the employees. Finally, the attitudes and motivation to use the Newsgroups are being encouraged within the Company through this open access.

In AT's views [AT: 28] he is stating that employees within the Company prefer to use the Newsgroups facility for personal and social information. There is no problem with the Newsgroups doing that because it is uniting a community for knowledge exchange; it is also suitable for this exchange because each employee has the freedom to decide whether they want to participate or not. The issue raised earlier is that the Newsgroups can become an exclusive group if not all employees have access to it or are not provided with the training necessary to be able to use the Newsgroups.

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
3.1	Poorly structured information	Engineer	This is another more generic problem area associated with several information sources. This aspect will be investigated in cycle three.
3.2	A method for searching the Newsgroups does not exist. It is hard to find the information in amongst the dross.	Both	Suggestions of measuring this aspect of the Newsgroups was communicated to both the CDI and the CARS Intranet Solutions business areas as it was regarded as outside the scope of the resolutions this thesis is currently addressing.
3.3	Lack of usage of Newsgroups.	Both	There are many reasons why employees may not use the Newsgroups facilities. Although several reasons have been supplied at these interviews they are mainly soft science issues and process issues. Because of this it is seen as an inappropriate area to apply software agents specifically.
3.4	They are not particularly useful	Both	The usefulness of the Newsgroups is down to the people using them. If they want information that is important to them they have to ask for it. There is encouragement from the company to allow users to create new groups in other areas too.
3.5	Little time to spend looking on them	Both	Time management is a major issue with most personnel. If the Newsgroups were seen as useful then employees would re-organise their time to utilise them. Currently Item 4 and 5 influence one another. This aspect will be developed further in this research.
3.6	Employees should not spend time using the social Newsgroups when they have work to do instead. Seen as a place for whinging.	Both	A surprising view of the Newsgroups was aired during these interviews. Some elements of the population are from the culture where if you come to work then work is what you should do. As a follow-on, the CDI Intranet Survey 2000 results showed that in a total of 106 comments on what people dislike about the Intranet the Newsgroups accounted for 8% of the total negative responses. This 8% mainly referred to the fact that the Newsgroups are a waste of time and that employees should be getting on with their work rather than writing in a Newsgroup area. But the knowledge management aspects of this will be discussed later in this thesis.

Table 4-3: Newsgroups Problem Areas Summarised and Analysed

One other valid point concerning the Newsgroups is that the Company allows the community using them to state their opinions and views and only looks at any kind of disciplinary action where there is prejudice, racial or sexual material displayed. This opens up a communication channel, albeit mainly social, for those in the Newsgroups community and if it only fulfils this purpose it is achieving a sense of belonging for that community and this kind of relationship may cause the development of other communities within the Company as employees develop trust and relationships. It may take time and changes of attitude to develop expert communities of employees from within the Company utilising the Newsgroups forum and the Company needs to appreciate this is the case.

There are many alternatives that may resolve the usage of the technical aspects of the Newsgroups facilities and these include more generic ideas, which can also be applied to the Newsgroups e.g.:

[1] Providing employee incentives to use the technical Newsgroups sites and the CWW

[2] Make the CWW and technical Newsgroups more interesting e.g. some experts could prime the sites with interesting problem areas to get the technical community interested in answering the complex questions – these questions could relate to real issues on Company products and company projects

[3] Introducing a company specific gimmick e.g. in one company (Dixon, 2000 Re: The Post Office) they have introduced a caricature who needs to be found on the CWW – if found the employee can enter a prize draw to win something at the end of the month. Other companies have run lottery entries, fantasy football leagues and crossword of the week.

[4] Easy to use sites which require very little complex navigation for the Users.

[5] Online FAQ for the Newsgroups facilities/other CWW facilities

[6] Open access for all employees without major retribution for employee opinions on the community pages (with exceptions such as racial hatred and pornography etc.)

Each newsgroup has its own specialisation, language, communication, implicit rules and will co-evolve (Dixon, 2000). The boundaries for these Newsgroups come from four main areas: the organisational, intellectual, social or technological boundary. For example the chat group has a social boundary. But in order for the community of employees to utilise this mechanism the employees:

- Need to be aware of the community in existence – it should be communicated in the first place
- Need to be trained to use the Newsgroups where training is required
- Need to know that they are free to express opinions and views without recourse (except if racial, sexual or similar – where disciplinary action is appropriate)
- Need to be allowed to spend a portion of their time utilising the community during working hours. The Newsgroups should have management commitment and sponsorship.
- The Newsgroups should be embedded in the way the employees work already.

Newsgroups can provide a place to grow ideas and develop expertise and share knowledge in the Company. Everything should be done to bring the value of that knowledge into the business so that it will grow in the learning process too.

From the earlier discussions on creating a knowledge community the Newsgroups are doing their job. But in order to meet the sharing of expert information the Newsgroups may not be providing the answers that the users of the Newsgroups expect or need. This raises the issue as to whether this method of sharing expert information is appropriate to the Company.

Company Wide Web (CWW)

(a) Description

The Company Wide Web (CWW) is an Intranet facility. Intranets are places where information can be found, like the Internet, but they are a closed community, in this case within the Company BAE SYSTEMS. In many new Companies Intranets are the main area used to manage knowledge. However, BAE SYSTEMS CWW did not grow out of the need to manage the Company's knowledge and the comments of interviewees clearly illustrate the strengths and weaknesses of this CWW.

Corporate Intranets are seen as a crucial element of creating a knowledge management solution because they offer the opportunity to share information and to collaborate across all levels of the organisation (Bernard, 1996). The increase in deployment of such Intranets has caused Companies to began to question the real effectiveness of Intranet implementation (e.g. Gartner Group, 1997)

(b) Manager Views

BJ [BJ: 13] states in his comments that it is "frustrating" and that it is not easy to find anything on the CWW unless you know where to look for it. Because it is not easy to find items then it can take lots of time to look for things and from a manager's point of view time is something he

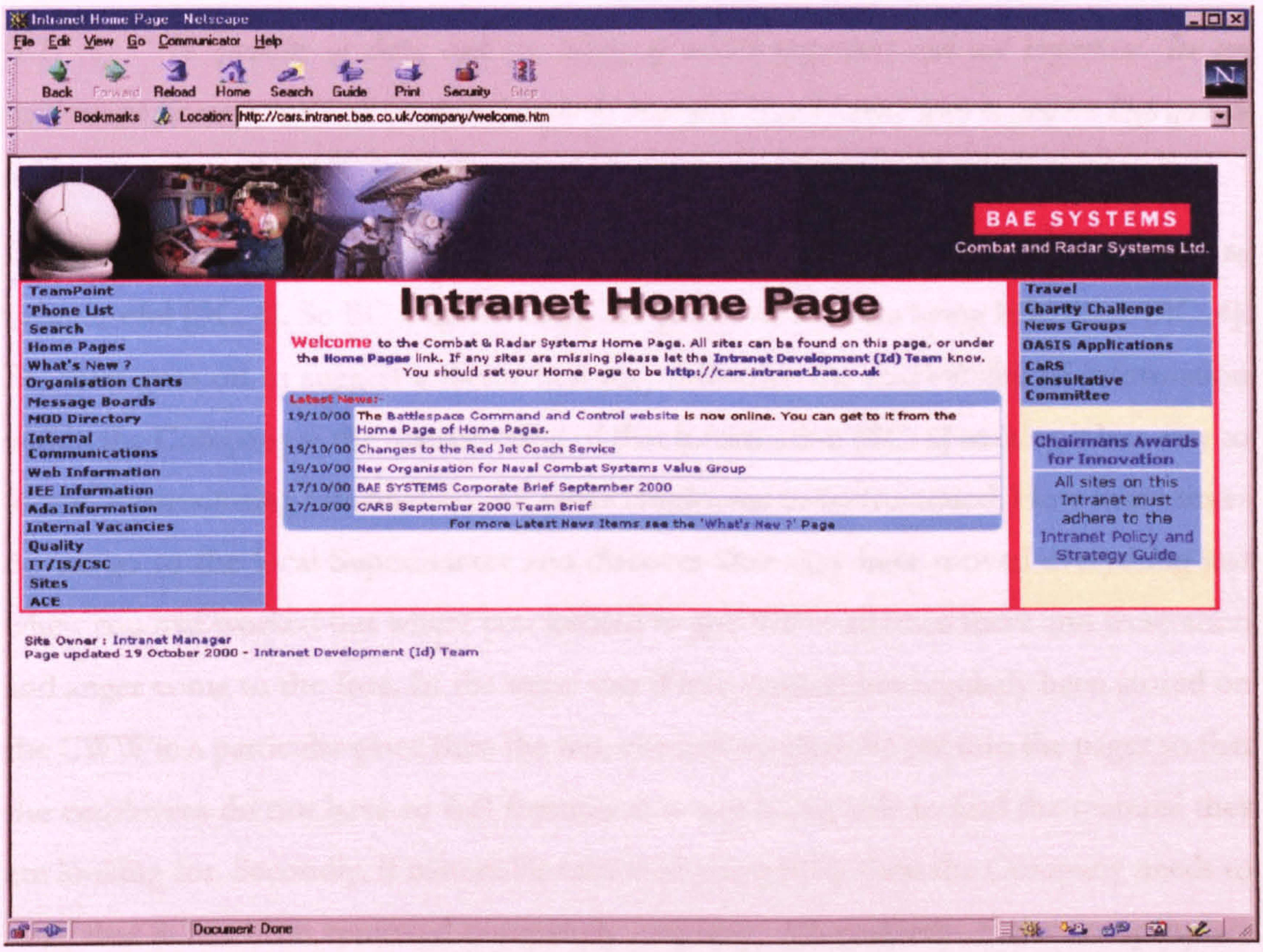


Figure 4-9: Example BAE SYSTEMS CARS CWW Homepage.

does not have lots of. DR [DR: 6; DR: 20] discusses the CWW in the same sort of vein but adds that some of this information is "out-of-date" as well as difficult to find and not presented in a good way. DR [DR: 6; DR: 7] states that he does not find the information very useful. RD [RD: 7] also states that the amount of information available on the CWW is great and he validates DR and BJ when he says that he only finds the right bits of information by mistake [RD: 8]. I feel it is important to note that DR, RD and BJ are all senior managers in the Company and are all educated at degree and in one case Doctorate level and they have all been in the Company a long time. These managers are more than capable of looking at new technology and even using the WWW to find information – however, by their comments they imply that the information stored on the CWW is not structured very well and this makes the information harder to identify. This is backed by other manager's including WA [WA: 5; WA: 6] indicating that there should be better maintenance of the Intranet information and that the current process for keeping information up-to-date is failing. It is also quite clear that managers are becoming aware of the fact that technology is being used to pull data and information from their sources [WA: 2] which means that they need to know how to go and find it or search for it effectively. For some managers who are from previous generations whereby information was produced on their behalf and presented or handed over to them they may find this a cultural change [WA1: 1].

[RD :8] "The quantity of data, and the sifting of what's important and not important. Its too cumbersome for me to trawl all the areas I might be interested in and I don't seem to find the high quality information except almost by accident"

BC is also stating that in his own opinion there is little on the CWW, which he regards as being useful [BC: 4]. So BC is questioning the quality of the data being held there [BC: 4]. BC then goes on to suggest a factor that may influence the accessibility of information within the Company is the restructuring of that information [BC: 6] making it less easy to locate. Restructuring information can cause employees to be frustrated. How many times do we go to the local Supermarket and discover that they have moved everything just when you had worked out where you wanted to go? We've all been there and frustration and anger come to the fore. In the same way if information has regularly been stored on the CWW in a particular place then the web site link needs to be put into the pages so that the employees do not have to feel frustration at not being able to find the material they are looking for. Secondly, if material is removed completely then the Company needs to state that it has been removed completely and why. Alternatively, if the company are updating a site they should wait until they have the new information before removing the old information and update the pages less painfully. These answers resolve the issues raised by the comments made. It is difficult when the Company is going through a merger and some information is not readily available but it is also true that someone needs to own the problem and get that information as soon as they can and communicate it effectively and efficiently to the employees and if this includes updating the web sites then this should be done with expediency.

The Company was divided up into separate Value Streams and Divisions in mid-2000 and this affected the CWW facility provided by different areas of the Company. In a meeting in early February 2000 Intranet Solutions discussed the decisions on how to deal with the amalgamation of Alenia Marconi Systems (AMS) with what is currently termed CARS and its division from CDI and other parts of BAE SYSTEMS. The result of this earlier discussion meant that the CWW was split into separate sites (See Figure 4-9, Figure 4-10 and Figure 4-11) for CDI, VU and CARS. The reason behind this is that the merger with CARS and AMS will mean that BAE SYSTEMS does not own the totality of the

AMS/CARS business and BAE SYSTEMS would like to separate the rest of the business information from this merged section. In the process the Intranet Solutions team, once a central resource, is now a separated team working for one of the three parts named previously. Each of the employees was allocated to a new Value Stream Group instead.

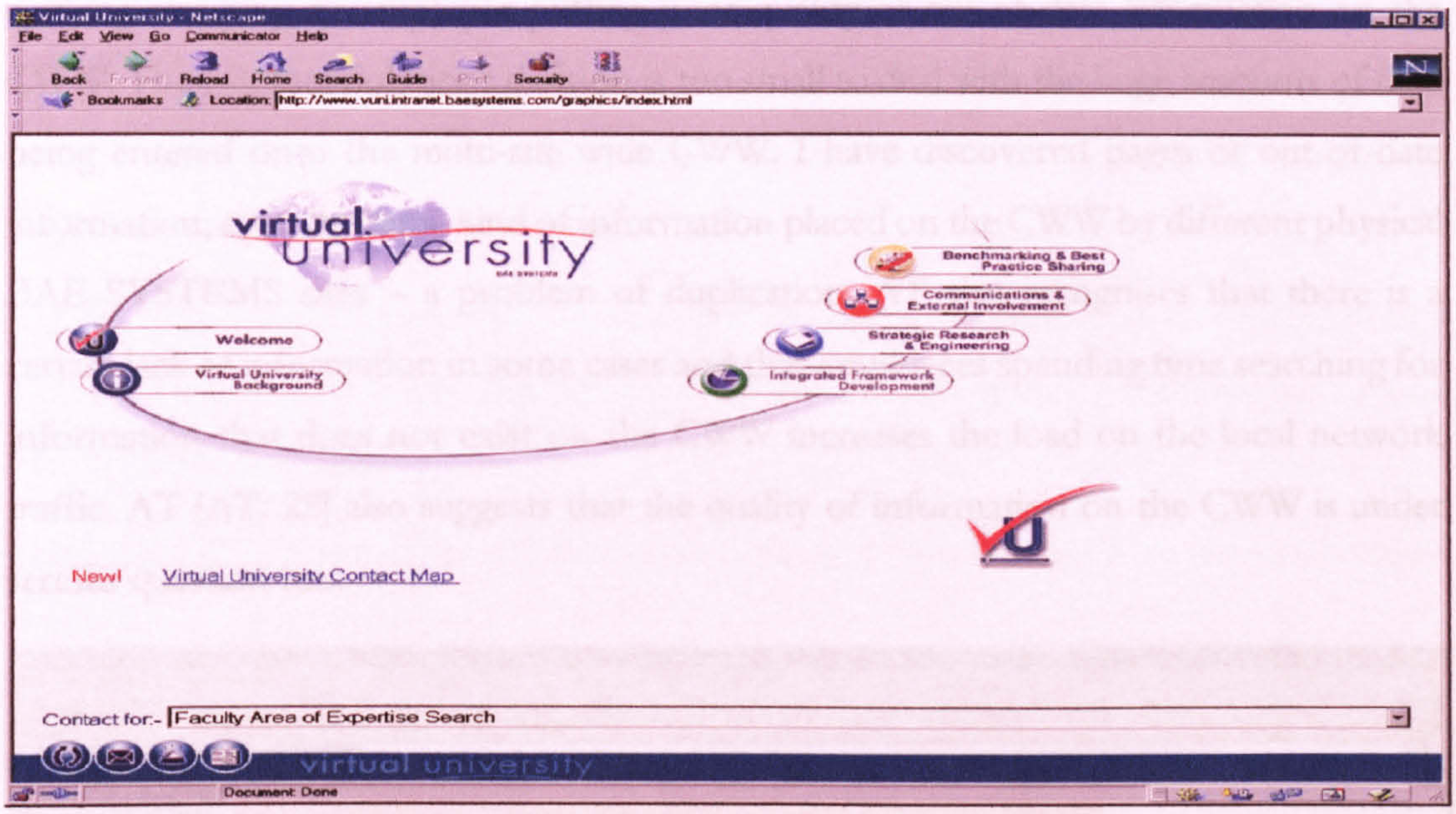


Figure 4-10: Example BAE SYSTEMS Virtual University CWW Homepage.

ST [ST: 9] also verifies the views of the other managers quoted from their transcripts; he states that the CWW gets a lot of information on it and it's a growing source [WA: 5]. AT also verifies this view when he states that it is becoming "more frustrating" to use. ST states that he has to fetch the information himself and he thinks that this is an inefficient way of communicating that information. Once again this is most likely because ST is a manager in the Company and has little time to spend looking for information. The fact that the information could be good and could be there does not affect this view because the issue of having the time to devote to finding that information is the main point that these managers are raising.

[ST: 9] "The information is there but you only get that information if you go and fetch it and personally while I'm happy to browse the world-wide web at home because it is my time and it's me doing what I want to do then I stop doing it when I choose not to want to do it, I do find the company wide web quite an inefficient method of disseminating information because you have to go and look and unless you go and look every day you don't know what's there"

AT adds further issues to the points raised earlier; he believes that the search mechanism adopted makes it more difficult for employees to find information.

AT [AT: 21] also states that a lot of the information stored on the CWW is "out-of-date" – this is another problem that other managers have raised. The Company allows any employee to request CWW web space and the Intranet Solutions division does not then own these pages. In fact what happens is that once sites are created the employee who created the site may do nothing to that set of web pages ever again. There is no real sense of ownership for the web sites created all over the CWW. It is also correct that there is nothing stopping an employee putting poor quality or out-of-date information on the CWW. The Intranet Solutions division is too small to deal with the huge amounts of data being entered onto the multi-site wide CWW. I have discovered pages of out-of-date information, even the same kind of information placed on the CWW by different physical BAE SYSTEMS sites – a problem of duplication. AT also recognises that there is a certain lack of information in some cases and that employees spending time searching for information that does not exist on the CWW increases the load on the local network traffic. AT [AT: 22] also suggests that the quality of information on the CWW is under serious question too.

Figure 4-11: Example BAE SYSTEMS CDI CWW Homepage.

[AT: 21] "I suppose it has grown up and the fact that its now got so many users and it's got so much rubbish around on it means that it is starting to get more and more frustrating to use. Especially as the mechanisms they have on there for finding information just don't work most of the time. The search engines, the mechanism of having to lodge your information with a search engine, because they don't really search at all, is pretty poor I think. And you can see from most of the stuff that they come back with, it is way out-of-date. Often things that don't even exist any more. It's not a good way to advertise the network. In fact I would think it is responsible for a great amount of duff traffic on the net, of people searching for things that don't exist and stuff like that. I think it's a big problem with it"

Both of TA's comments [AT: 21; AT: 22] and DR's response [DR: 19] corroborate the earlier descriptions by other managers in the Company and state that the information stored on the CWW is of little value and not particularly useful to their duties within the Company. The quality of the information stored on the CWW is brought into serious question by these statements and this is another major issue that needs to be examined. RD [RD: 19] does raise a further issue regarding the fact that he believes that managers in the Company fail to communicate effectively and this issue is discussed in section dealing with Communicating With Others.

TA: 1.8 "it is a great disappointment... with the British Aerospace Intranet, seems to be not much better in reality. There are some snippets that you can get now and then but in general I don't find there's a great amount there that is useful"

Using the CWW is not giving ST the valuable return of information he really needs either [ST: 10].

[ST: 10] *"Again, looking every day can often be fruitless - I don't find that terribly helpful"*

HT [HT: 9] believes that there is a limited number of staff using the CWW but states that if everyone used it a new problem would emerge – relating to network access and overload of information. HT [HT: 11] also believes that he cannot get the answer to his problems on the CWW and suggests that it is due to the information being at a too superficial level. But he is also aware that some information is of use and he identifies this as at the telephone directory level. I believe that if this was the only use for the CWW then it is not providing the right information of value to a manager.

A new concept of a web board has now been rolled out [HT: 13]. However, it seems from HT's comments [HT: 12] that it is not getting the usage the Company were expecting. HT can already perceive that the information stored on it could be carried by a medium that already exists i.e. e-mail. So what added value does this web board give employees that they do not already have access to? It seems to me that this web board was not thought about in detail before it was rolled out in the Company. The Company has in my view used time and resourcing rolling this web board out but have failed to analyse the current existing mechanisms or investigate why these current ones are not working so well. The result of this process is that the new mechanisms continue to reciprocate the existing issues of why employees do not use them. If the Company want to test the value of the web board then they should have examined the Newsgroups' usage and identified the problems associated with them and attempted to address these as part of adding value to the business. These displayed options are no different from other CWW facilities and I believe that the added value of this web board is questionable.

BC [BC: 2] thinks there is rather a lot of information and he doesn't know where to find it. By his statements he also suggests that he is not sure he wants to look for the information and that he uses only a small sub-set of that information through choice. BJ also confirms BC's views [BJ: 5], although in BJ's interview transcript he emphasises the fact that he cannot find his way through the information, which suggests it is poorly structured information. As a manager BJ also has particular difficulty in finding the time to perform a search.

DR [DR: 7] gives some reasons in his view of the use of the CWW. It is interesting to note that he feels that some people within the Company are not moving forward with new technology. Surveys have been carried out on the usage of the CWW over the past three years. The CWW survey is discussed in Chapter 2 (Methodology) and the results of the survey are discussed in cycle two of this thesis. DR [DR: 7] also raises the valid point that because the survey is optional and only on the CWW then not all of the opinions have been captured from all the staff. There may be particular reasons why the excluded group cannot access or contribute. In future questionnaires the Company should consider an e-mail distribution to all employees. If I were doing this I would also include a front sheet saying "If you don't want to fill out what is your reason for not doing so?" and give them options like "I do not have time" or "I do not have access to the CWW" etc. at least you can isolate other problems which may need to be addressed this way. DR [DR: 7] identifies good reasons why the CWW questionnaire may not give valuable results overall. I believe by restricting the community able to answer the questionnaire the Company is getting one community's view alone. Also if everyone is not given access to the questionnaire then the real reasons for people not using the CWW, Newsgroups and other information facilities is never identified and captured. Therefore these problem areas will never be fully understood or addressed.

BC also discusses in his interview [BC: 5] the fact that a lot of information is sent in electronic format or stored in electronic format but that he and others regularly print that information out. This is a perfect example of where people refuse to move ahead with new technology and stick to their old ways of doing things, for example:

[BC: 5] "Also there is a phone directory and I suppose the most up-to-date phone directory is on the web, but I never use that because it takes me longer to click on that than to pick up the phone and dial 100

and ask for the extension number if I don't know that extension. I still have my own hard copy of the phone directory"

BC [BC: 15] suggests that it takes a long time to get through the information and that perhaps there is not enough information on how to find things on the CWW (See Table 4-4).

(c) Engineer Views

The main comments relating to the CWW surround the areas of engineers finding it difficult to locate or navigate the information [CL: 1; EL: 1; RW: 4; WS: 1; MD: 1; SN: 2; SN: 5; WJ: 1; JD: 1; WG: 16; RS: 15; WSZ: 37]. EL suggests that it is easier to ask someone than to try to find the information yourself [EL: 1]. TA implies that part of the problem is that the CWW is poorly structured [TA: 1 See also: RW: 4; LL: 1; LL: 2; MD: 1; SN: 1; WJ: 2; RS: 16; RS: 14]. Secondly, that the information on the sites is out-of-date [CL: 1; LM: 1; RW: 4; RW: 5; RW: 6; SN: 3; MS: 1; MR: 2; OJ: 2; WJ: 2; JD: 1; WSZ: 38; WSZ: 39]. It is also suggested that there is a lot of useless information on the CWW [LL: 5; MR: 2; OJ: 2]. Further, that there is contradictory information on various sites and no indication of what an engineer should then do about it [SN: 4].

RS [RS: 13] agrees with the findings of the Company Intranet Survey 2000 – that the search engine on the CWW is not particularly good and using it is not intuitive. LM raises this as an issue [LM: 1 See also: RW: 7; LL: 4; MD: 1; SN: 6; WJ: 3]. EL [EL: 1] suggests that the Internet search engines appear to be a lot better [See also: SN: 6; JD: 4].

Other engineers mentioned that the physical connection can be a problem and can be slow at times [CL: 2; TA: 2; WS: 3]. TA advises that there are peak times throughout the day when the network will run more slowly or is unavailable [TA: 2; WS: 3]. LL states that some members of staff do not even have a physical connection [LL: 1; HJ: 30] (See Table 4-4).

The Intranet web sites are poorly laid out [EL: 1; MD: 1; WJ: 2]. WS states that the CWW has very poor usability [WS: 1; MD: 1; JD: 2].

WSZ [WSZ: 28] describes the process for the development of individual web sites (whether project level, personal or group level) and explains that there is no real chain of authority present in order to ensure that the web pages are kept *up to date.* WSZ [WSZ: 29] follows the argument through stating that the answers on an out-of-date web page give answers to old problems on old systems or in old processes, which no longer exist and are therefore not helpful. The new world of technology is a pretty dynamic one but the CWW fails to keep pace with the changes [WSZ: 30] and so the information we do eventually find may not be the most current preferred Company way of doing things. If decision-making rests upon this out-of-date information it can cause many problems especially in issues such as International Standards and Ministry of Defence Standards where the Company projects need to be compliant (See Table 4-4).

"…. As a result a lot of the information on the company web is what I would liken to an old Radio Times, it is about as useful as that" [WSZ: 28]

There are added aspects such as the issue that no one maintains the data properly and there is no process of ownership and responsibility down to an individual [CL: 1]. TA proposes that there should be a minimum level of standards adopted by the Intranet Solutions group [TA: 1]. The whole issue of responsibility for the websites [WSZ: 31; WJ: 1] placed on the CWW is one which has not been fully addressed by the old ad hoc method of allowing anyone to develop virtually anything and get it added to the Intranet. Even the minimal standards do not enforce enough of a standard for people to using the pages to get some kind of intuitive feel for the pages. Allowing a huge resource of information (a bit like the WWW has) can lead to info glut and if a high proportion of information is of little value people stop looking [WSZ: 32]. Time is an important asset to all employees, as they need to perform their roles effectively and efficiently – if they can't find the information easily and relatively quickly they will most likely stop looking. Instead of making life easier for the employee this kind of approach adopted can produce the opposite effect because the information and knowledge are not being handled properly [WSZ: 33].

"….but unless people are going to take responsibility for things they put on the web once they have created them it is just going to end up choked with crap" [WSZ: 31].

Another important issue raised by MS is that the Christchurch Intranet fails to allow access to many of the other Company Intranet sites [MS: 2]. MS suggests that a large networking CWW would provide a more diverse and useful set of information [MS: 2].

The Company Wide Web and Search Engines

Search engines create listings automatically after crawling the World Wide Web (Koch, et al., 1996). The person doing the search then physically sorts the results returned[2]. Often if

[2] Finding what you want: new tools and tricks. ***IEEE software*, 12 (5), 79-81, 86.**

web pages are altered the search engine notices the difference, as all the elements making up a web page are a part of the search. Search engines are predominantly made of three elements: the spider, the index or catalogue and the search engine software. The spider is a web crawler; it visits the web page, reads it and then follows links to other pages on that same site. This spider can check the web pages for changes to the pages on a regular basis. The spider in the index stores all the findings and the index changes as new items are located and added to it – so that it mirrors the web page details. Finally, the software looks at the index and tries to find matches to a search made and then ranks these in order. All search engines have these basic parts, but there are differences in how these parts are tuned. That is why the same search on different search engines (Chu & Rosenthal, 1996) often produces different results. There is a tremendous amount of research on the capability and the different types of search engines and how they work on the WWW (Sullivan, 2001; ZDNET, 2000).

The company (CWW) search engine is a Netscape compass server (Figure 4-12). It has a searchable database that holds resources from a number of our web servers - CWW, WEBAPPS, COWWEB, and XCHWEB etc. There is a single robot, which runs every night and from a list of starting points, follows hypertext links to locate as many resources as possible (within parameters set by the administrator). Site definitions are declared with the sites you wish the robot to enumerate resources from. For each URL the robot checks out it applies the site definitions and a set of filters to determine whether to process it further. It also checks it hasn't already processed the URL. The filters prevent the robot from indexing types of resource you don't want in the database (i.e. particular file types). For each resource it locates, it generates a resource description, which it then stores in the database. The resource description contains the URL of the resource along with the document title, partial-text extracted from the document, Meta tag information etc. This does not make the search engine the most efficient of engines but it can do a reasonable job especially if the Meta tag data has been stored efficiently with new documentation. Unfortunately, I have been informed that this latter aspect has not been done particularly well in the past, therefore older documents require updating with this information. However, updating the Meta tags on older documentation is not the division's highest priority at the moment which means that the engine will continue to be inefficient in the meantime.

The CWW search engine has been criticised by several managers [WA1: 6; AT: 21; DR: 6; BJ: 5; BJ: 13; RD: 8] who rarely manage to find the information they seek, except by accident. Because this is time-consuming managers are probably more reticent to spend time looking especially if it is not easy to find things.

The Company has looked into the development of Portals that allow the filtering of information on an individual or group basis (depending how they are set up) so that searches can be more efficient. The Virtual University part of the organisation and the Sowerby Research Centre have been setting up Portals and trying them out for the organisation. Portals can be software agent based and this will be discussed in more detail in Cycle three (Chapter 8).

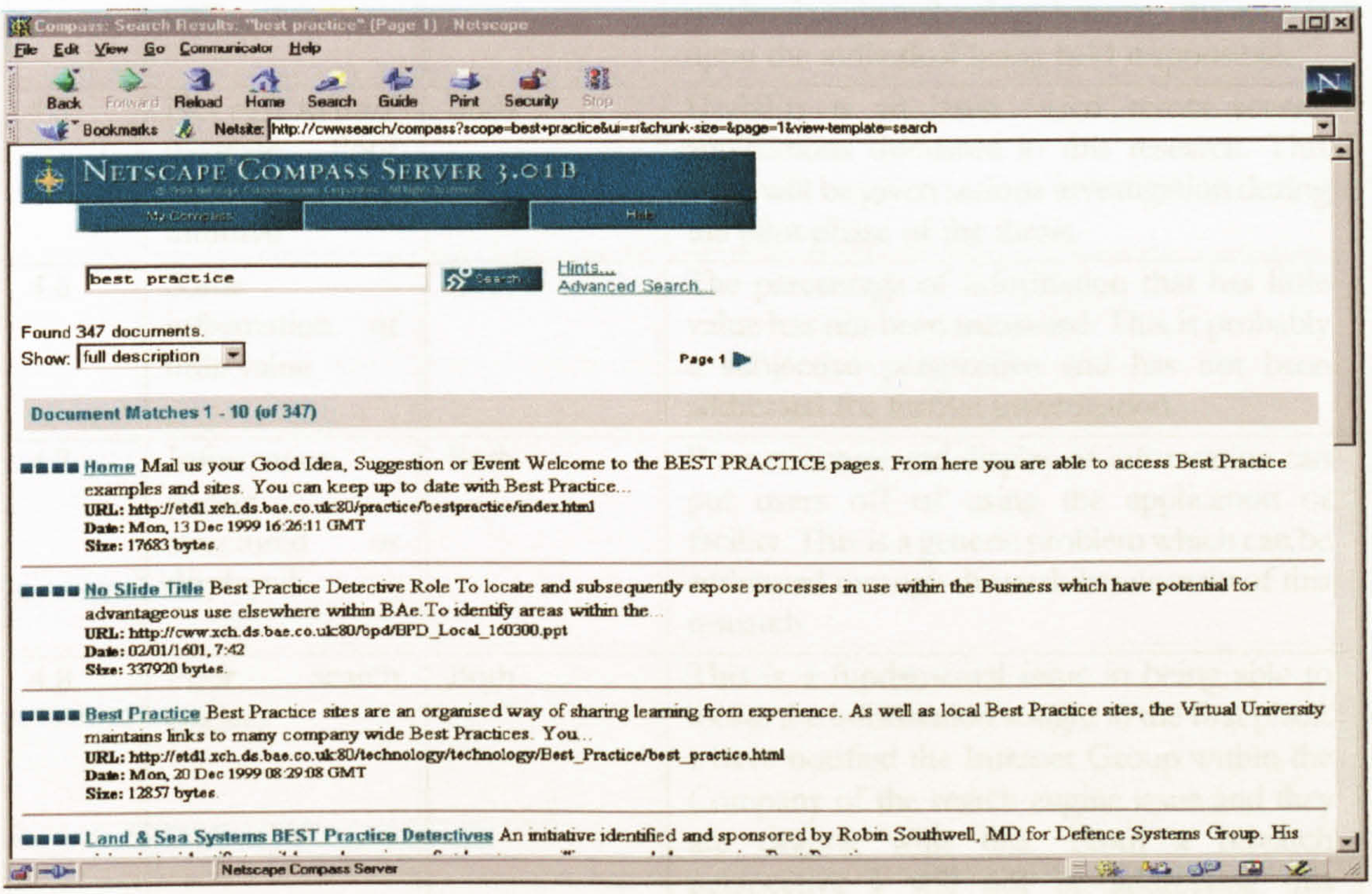


Figure 4-12: Example BAE SYSTEMS CWW Search Facility

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
4.1	Too much information	Manager	This does seem more appropriate for the Manager as opposed to the engineer. Managers normally hold a significant amount of responsibility and must be careful to use their time effectively. Managers would tend to see too much information as a distraction. They would also see the need for a reduced or filtered view, which they can later question if necessary in order to make key decisions.
4.2	Poor physical connection. Slow down times	Engineer	This issue is likely to emanate from the engineering community rather than the managers because issues such as performance of an application are common to the engineers in their everyday work. The issue is beyond the

Item	Issue Raised	Manager/ Engineer/ Both	Perception
			scope of this thesis. I have notified the Intranet Group and they are investigating the alternatives.
4.3	Not easy to locate information	Both	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.
4.4	Out-of-date information. Not maintained well	Both	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.
4.5	Not easy to use/ navigate. Poor usability. Not intuitive	Both	Usability is an issue raised across several applications discussed in this research. This issue will be given serious investigation during the pilot phase of the thesis.
4.6	Some information of little value	Both	The percentage of information that has little value has not been measured. This is probably a subjective perspective and has not been addressed for further investigation.
4.7	Information poorly structured or displayed	Both	Poor structure and display of information can put users off of using the application or facility. This is a generic problem which can be addressed through the usability domain of this research
4.8	Poor search engines	Both	This is a fundamental issue in being able to locate the information sought in the first place. I have notified the Intranet Group within the Company of the search engine issue and they are dealing with this. From a research perspective I will not be addressing this particular issue further.

Table 4-4: CWW Problem Areas Summarised and Analysed

The World Wide Web (WWW)

(a) Description

The World Wide Web is a network of computers, routers and modems that connects people internationally (See Trickey, 1998; Berners-Lee, T., et al, 1994). It enables the transmission of data in the form of text, video, images and sound. In order to utilise the WWW users normally search for topics using a search engine or they use a known address (i.e. a Unified Resource Location – URL), which they type, into their navigation field.

(b) Manager Views

Although some managers made mention of the Internet and the WWW in their transcripts they did not identify specific problems associated directly with it. This may be explained from the perspective that a small percentage of managers will use the Internet directly to get information because they are trying to use their time effectively. Normally Managers tend to request that their staff search the WWW for them and pass on a filtered view of the data in order to help them to make their decisions. Personally, when I changed roles from being an Engineer to being a Manager there was a tremendous drop in the amount of time I could spend looking for the information myself on the WWW (Table 4-5).

(c) Engineer Views

Engineers face some of the same problems noted on the CWW on the WWW. For example, finding the right information [WS: 2; LL: 3; MR: 1; WJ: 4]. The WWW can also be very time-consuming [EL: 2; MR: 1; WJ: 4]. But it is suggested that you can get a lot more up-to-date information in the opinion of JD [JD: 4]. But one engineer rarely has use for work-related information off of the WWW [OJ: 3] (Table 4-5).

Some engineers do not have physical access to the World Wide Web on their local machines [MS: 3; WG: 21]. The physical service for the WWW can often be slow or intermittent [MS: 4; MR: 1; JD: 4].

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
5.1	Being able to locate the information	Engineer	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.
5.2	Time-consuming process	Engineer	Engineers can find that it is time consuming particularly in locating technically specific information. Because there is just so much information on the WWW this is understandable and would also explain why Managers use it a lot less.
5.3	The data is more up-to-date	Engineer	This is a positive point and this probably relates to technical information as this is the most likely information that Engineers are locating and using.
5.4	No/ poor physical connection	Engineer	This is an issue that has been highlighted to the Intranet Group and the IT Support Group within the Company – it will not be considered in the rest of this research.

Table 4-5: WWW Problem Areas Summarised and Analysed

E-mail

(a) Description

The e-mail system most commonly used throughout the Company is Microsoft Outlook. This e-mail software is very easy to use and is quick to learn even if you are a beginner. To assist users there is Outlook training material available online and on CD ROM from the Training Department within the Company. The e-mail facility enables the employee to send and receive e-mails with attachments, it also allows them to run their calendar, book appointments with other employees on the Company sites, helps individuals to manage their daily tasks as well as enabling them to organise their work (Figure 4-14). The e-mail facility allows e-mails to be sent both internally and externally to the organisation (bearing in mind the security issues). The normal Outlook e-mail facility is illustrated in Figure 4-14.

E-mail should save time in the employee's daily tasks if it is used correctly. However, from the comments raised it seems that the e-mail system is more of a burden than a solution to the amount of information people have to deal with. Also as mentioned in some of the interviews people are not using the electronic media but printing out the paper versions of everything, which is rather ignoring the point of e-mail really. If a copy is required it can be stored on a local terminal too.

(b) Manager Views

[BC: 8] "but quite often people put an attachment and I think it is a hassle to have to click on the attachment and open the attachment"

[BC: 9] "I have not come across many people who do it but a lot of the e-mail that flashes around in the attachments we are still printing them all out. so we are not necessarily saving money"

In the above statements there is an implied reluctance by BC [BC: 8; BC: 9] to use the technology and in his tone of voice he appears to me to be rather sceptical of the technology benefits. Throughout the interview the impression of BC and his views implied he was a traditionalist who would rather things were kept as they were in the past and had not moved on. He did raise some important points, which tied in with the views of others interviewed in the Company. But what is alarming is that in his current position as a senior manager involved in the technical expertise of the company he has quite old-fashioned views of what he preferred. RD's view is similar to BC's but in this case RD has a human intervention in order to filter and print and organise incoming e-mails before RD reads any of them. Furthermore another senior manager suggests all meeting minutes and agendas, whilst being available electronically are very often printed out by individuals attending the meetings anyway [ST: 29]. In association with BC's views BJ [BJ: 6] suggests that if the hindrance of reading lots of paperwork were to be reduced he would actually get time to utilise the company wide web. Whereas CB [CB: 18] states that he is not happy that people do not read the mail he sends out.

BJ [BJ: 8] gave positive feedback on the e-mail system, indicating that it is easy to use. However, he makes the point that this is also probably its strongest weakness as we see in his comment:

[BJ: 8] "I find Outlook absolutely outstanding it's just that the volume, it's so easy to use so everybody uses it, you know, it's a bit of a victim of its own success really!"

CB [CB: 20] agrees with BJ [BJ: 8] when he says that everyone seems to copy everything to everyone, which makes the e-mail more of a burden for CB. BJ [BJ: 9] states that e-mails' ease of use has developed the overuse of e-mail. As a manager he has lots of e-mails to answer therefore. His suggestion implies that some of the unnecessary e-mails could just be resolved by phone calls. Other information is sent to BJ when he does not feel it is relevant to him. I agree wholly with BJ's view on this. In my new management role on the Sampson project I have three different members of staff sending me the same e-mail on team briefs. Often these come with large attachment files and this consumes program space causing technical problems as well as being duplication of information. When receiving these duplicated e-mails it takes time and my attention to deal with these, which is an inefficient use of my time (Figure 4-13 which includes duplications).

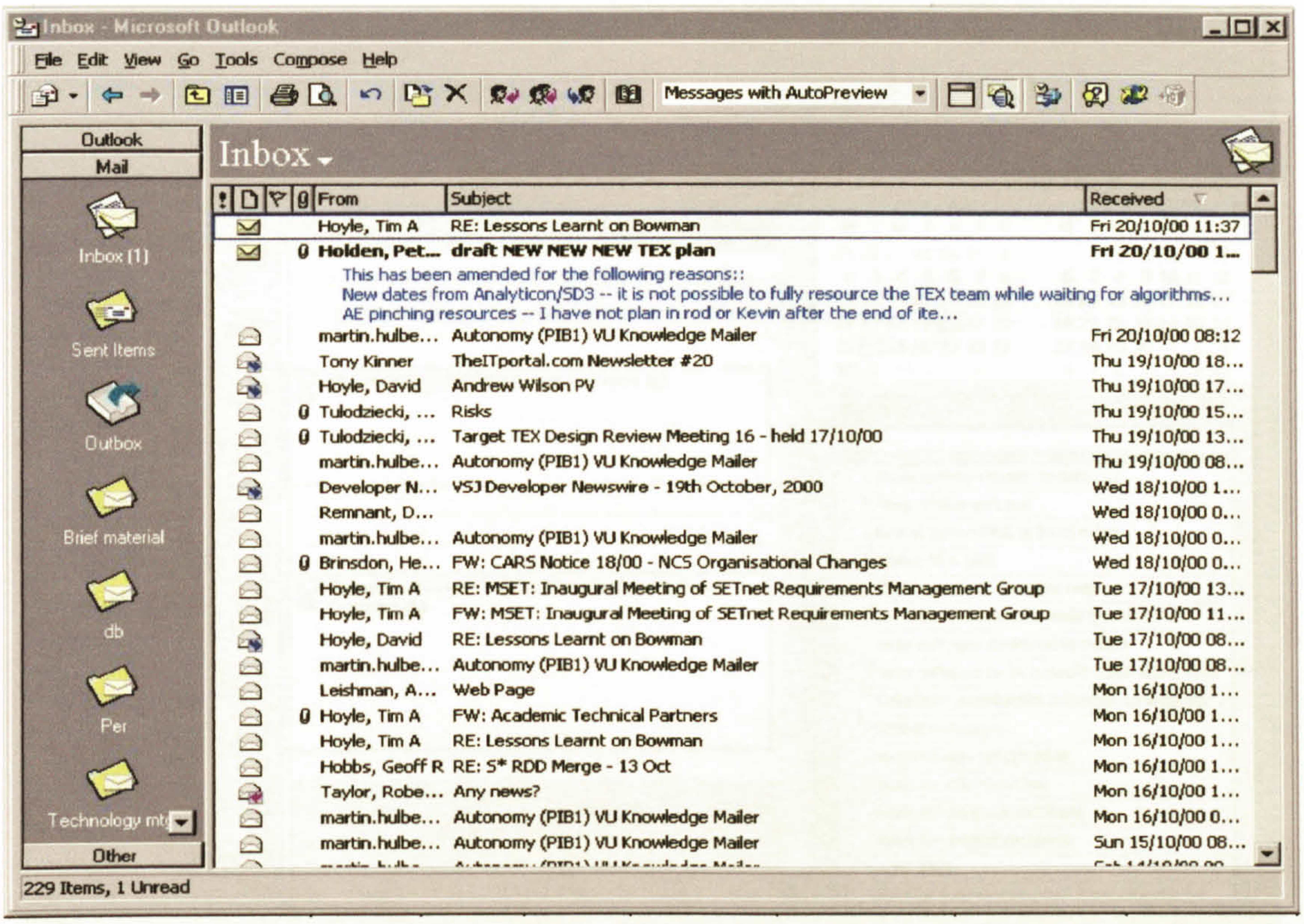


Figure 4-13: BAESYSTEMS Main Outlook Inbox

AT suggests that technology changes need to be adopted by top/senior managers first [AT: 33]. AT's views are really stressing that in order to make progress in using new technologies within the Company then the Senior Managers and Directors need to be seen to use the technology and lead by example. I do agree with AT that if the Senior Managers and Directors advocate and use the technology it does encourage the other employees to use it. But I would think that because new generations of engineers are coming into the Company with training in the new technology areas they will be pushing to use it throughout the Company and the Senior Managers and Directors may be forced to adopt it or be left behind.

HD [HD: 5] states that he thinks he spends 1/5th to 1/6th of his time dealing with e-mails each week. As part of my later e-mail survey (See Cycle 2) I included HD in an attempt ascertain the average amounts of time per week that managers and engineers spend dealing with e-mails. In my survey (See Cycle 2) I have included the time taken to close down the e-mail and this includes all the relevant work associated with that e-mail until the issue is closed (Table 4-6).

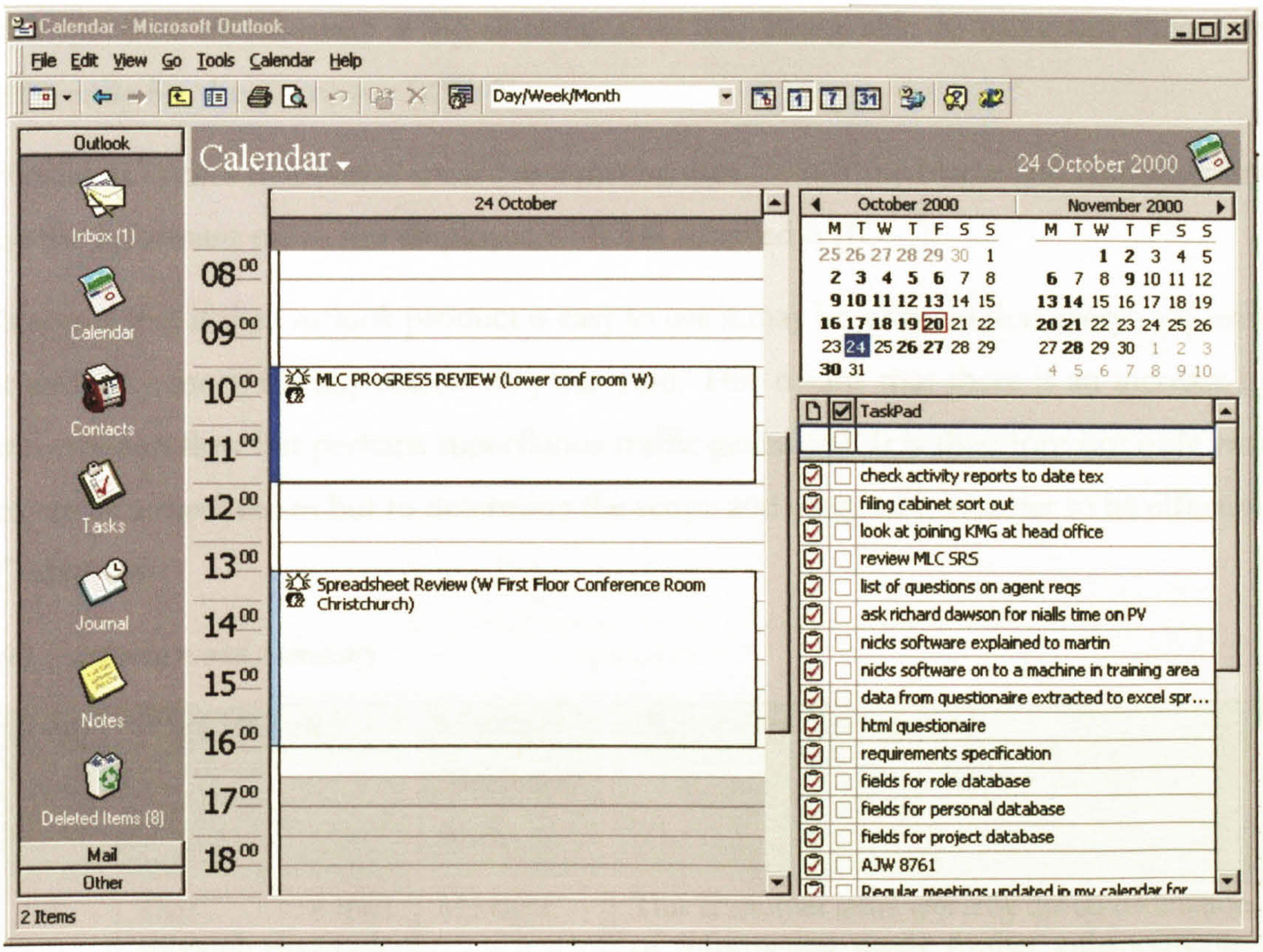


Figure 4-14: BAE SYSTEMS Outlook Calendar and TaskPad Facility

(c) Engineer Views

Engineers indicate from their interviews that they find e-mail to be a very good way of communicating and finding out information [CL: 4; HJ: 29; HJ: 34]. However, there are problems where some information is inappropriately sent via e-mail e.g. large documents [LL: 8]; repetition of Company notices [MD: 3; JD: 6]. E-mail can also be time-consuming [MR: 4; JD: 8; HJ: 5; HJ: 6; HJ: 7] and some people find they get information overload via e-mail [WJ: 6; JD: 6; JD: 8; JD: 9; HJ: 5; HJ: 24].

CL raised the issue of the physical delivery of e-mails sent outside of the Company due to a problem with the 'received' or 'read' flag in the actual Outlook application [CL: 4]. Others state that the service can sometimes take a lot longer than one might imagine [TA: 4; See also: LL: 7; WS: 4; WS: 5; MD: 3]. Another issue is that there is not enough personal storage space in order to keep significant e-mails [LL: 7; See also WJ: 7; HJ: 6]. This can be resolved by saving individual e-mail documents to private folders on the local drive i.e. a technical application setting.

RW states that he gets a lot of e-mail per day but that there is often not enough information in each one to be able to respond properly in his particular role [RW: 1]. This comment may be the exception rather than the rule as this candidate has a specific need for specialist communication that needs to be very specific [RW: 2]. In this case a loss of the specifics would make a big difference to RW being able to carry out their role efficiently for the Company [RW: 3].

Finally, JD states that e-mail is used as a mechanism to shift the blame and responsibility by the informant on to the employee who has received it [JD: 7].

It seems that if the Outlook product is easy to use it may be a flaw in that everybody uses it and they use it for any reason they can find. This means that there is an increase in information flow but perhaps superfluous traffic generated. It is therefore not only vital to create a mechanism but to determine the scope and usage of it in order to be effective (Table 4-6).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
6.1	That e-mail although electronic – it is often printed out	Manager	This is another issue whereby the co-ordination of information needs further enhancements. The purpose and usage of e-mail should be stated through the company guidelines. There are many ways to overcome this issue.
6.2	Mechanism for passing blame and responsibility	Engineer	It was suggested that the informant sending the e-mails passes the burden on to the recipient for the information or decision etc passed to them. This is an inappropriate use of e-mail and notification has been made to Managers within the Company. This aspect is a social/moral issue that is beyond the scope of this thesis.
6.3	Multiple copies of the same e-mail received. Information overload	Both	This is a communication and co-ordination issue. The IT Support and Communications groups have been notified as to the problem and some projects are addressing this through a central co-ordinator.
6.4	Large attachment files	Both	This aspect addresses the knowledge of how to use e-mail efficiently. If employees looked at the size of attachments they could be informed when this is an effective or ineffective way to send that information. Advice on usage and guidance on how to examine and also how to zip files to make them easier to send need to be supplied to users so that they can make the best use of the e-mail system provided.
6.5	Physical memory problems	Both	This is an IT Support issue that has been communicated to that group to deal with. This thesis cannot address this hardware and computer specification problem.
6.6	Time-consuming	Both	This is an interesting view as e-mail is supposed

Item	Issue Raised	Manager/ Engineer/ Both	Perception
			to be a mechanism to lessen the amount of information an employee receives and spends time looking at. This issue is one that relates to item 2 above and may be investigated further in this thesis.
6.7	Too many e-mails/overburden	Both	Both groups mentioned in interviews that they felt they received too much e-mail each day. Managers noted that they felt this was an interruption.

Table 4-6: E-mail Problem Areas Summarised and Analysed

Electronic Project File (EPF)

(a) Description

The electronic project file is a structured organisation of the project's information. Primarily intended for holding data in electronic form, the structure will be mirrored for a hardcopy library for those documents that only exist in paper form. The Project File has a general structure that is used across the Company and is modified by each project to meet its requirements. It is usual to place the EPF on a server area that is accessible to all employees on the project team. Underlying the interface is an Access database. Filing reference numbers are allocated as new documents are recorded in the index. The documents themselves are held in their native application format in the directory applicable to their content and can be opened directly from the EPF application. There are currently 143 electronic project files on several sites and 1116 current users of these. As an example the Sampson Project file is illustrated in Figure 4-15 and Figure 4-16

(b) Manager Views

BC [BC: 10] also discusses other mechanisms used for information storage and retrieval including the Company Project Files, private venture (PV), metrics and estimates and the Lessons Learnt Log. Each of these is discussed below.

[BC: 10] "Also another mechanism used both within the projects and within departments is something called the project file. Within engineering the resource group managers and the administrators have access to a project file. People tend to put things in a project file. Have you ever used one? It takes you about half an hour to drill through to the actual one you want to use, to the file you want. So I don't tend to use the project files much. Also it is not immediately intuitive as to where that information is in the project file"

Once again the EPF information is difficult to locate even though we have a Company level standard hierarchy as a starting point. BC suggests in the above statement that the Project File is not particularly easy to use and the data is not particularly well structured. This obviously puts BC off using this particular information store. If there is poor usability in a tool or user front end this will often cause the user to eventually stop attempting to access the data they need. The user will then seek alternative ways to get that data (Table 4-7).

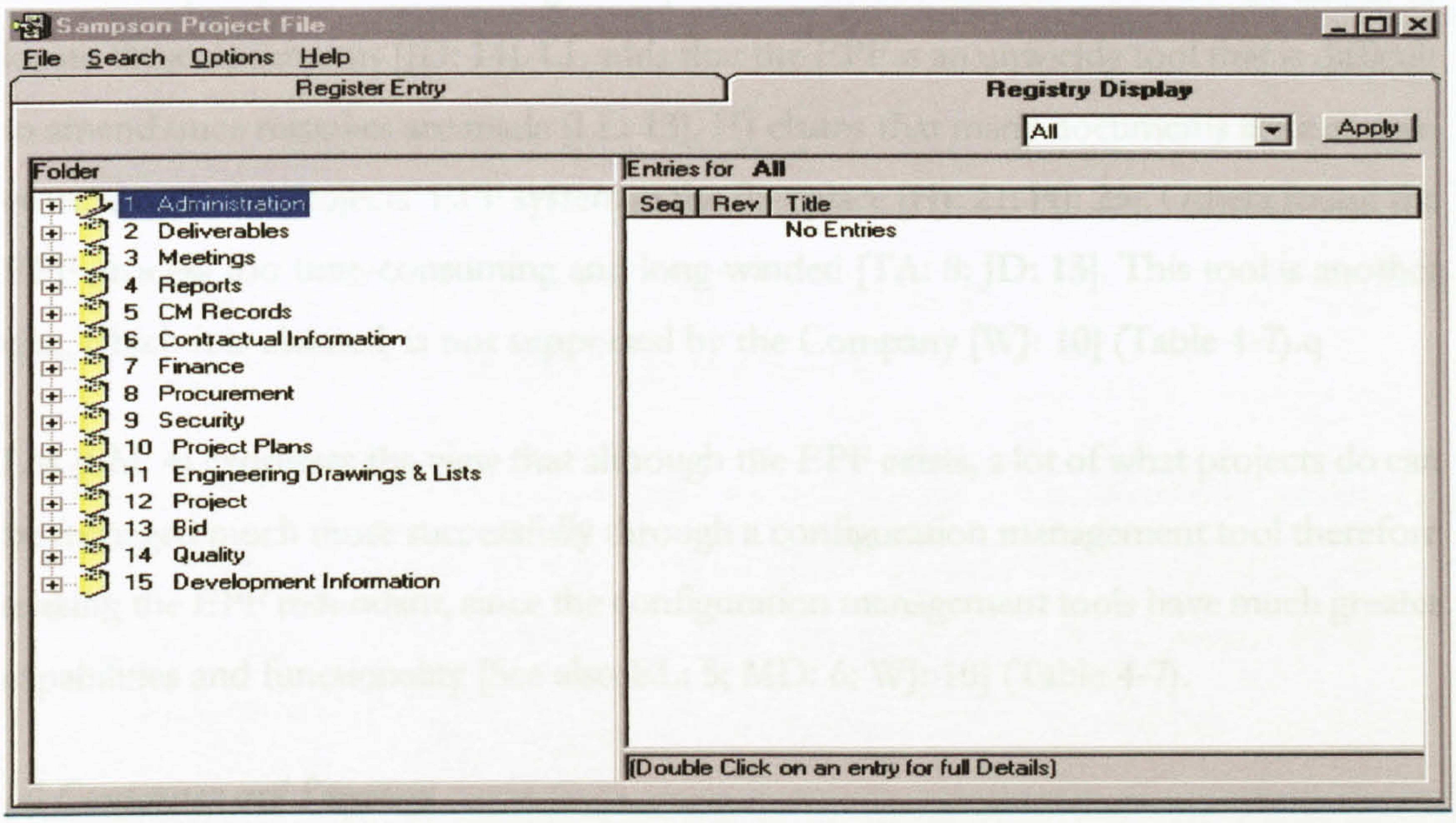


Figure 4-15: Sampson Electronic Project File Facility

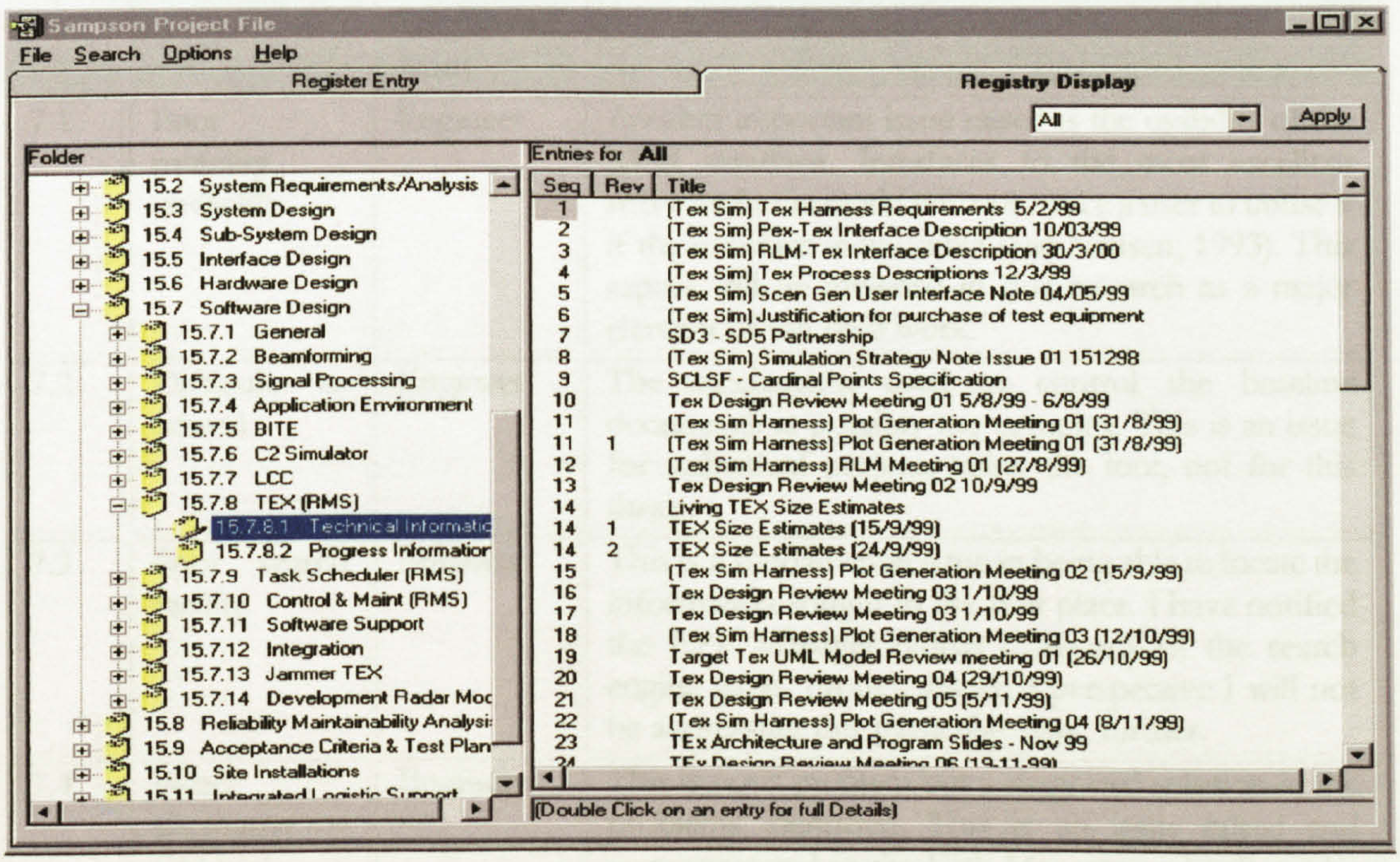


Figure 4-16: Sampson Electronic Project File Software Design Hierarchy with Entries

(c) Engineer Views

Several engineers suggest that the EPF could be a useful tool but it is often illogical or used improperly [CL: 6; LL: 13; HJ: 20]. Others add that the information is not easy to find due to the structuring [EL: 5; LL: 13; SN: 13; JD: 13; JD: 14]. JD suggests that often the only way to find a document is to phone the author and ask them where they stored it and what they called it on their project EPF system [JD: 13]. It is also stated that this is another way to shift the blame and responsibility to someone else if they cannot locate the document you put on the EPF [JD: 13]. A search tool that works would be useful to locate these documents [JD: 14]. LL adds that the EPF is an unwieldy tool that is difficult to amend once mistakes are made [LL: 13]. HJ claims that many documents are not even entered onto the projects' EPF system in the first place [HJ: 21; HJ: 23]. Others found the EPF process too time-consuming and long-winded [TA: 8; JD: 13]. This tool is another one, which it is claimed, is not supported by the Company [WJ: 10] (Table 4-7).q

LM [LM: 4] expresses the view that although the EPF exists, a lot of what projects do can be managed much more successfully through a configuration management tool therefore making the EPF redundant, since the configuration management tools have much greater capabilities and functionality [See also EL: 5; MD: 6; WJ: 10] (Table 4-7).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
7.1	Poor usability, unwieldy	Engineer	Another important issue raised is the usability of the RPM interface. Interfaces to the most excellent software in the world will not entice a user to utilise it if the interface is unusable (See Nielsen, 1993). This aspect will be revisited in this research as a major element of the final work.
7.2	Difficult to amend	Engineer	The mechanism used to control the baseline documents is possibly too complex. This is an issue for individual projects using the tool, not for this thesis.
7.3	Poor search facility	Engineer	This is a fundamental issue in being able to locate the information sought in the first place. I have notified the EPF Manager within Company of the search engine issue. From a research perspective I will not be addressing this particular issue further.
7.4	Better alternative – CM tools	Engineer	This is not a problem but a suggested solution to the problems identified. This is an issue raised and communicated to the EPF Manager and will not be addressed further in this research.
7.5	Time-consuming, long-winded	Engineer	The process associated with this tool is quite long and probably adds to the other issues here when an engineer is trying to store a specific document. The

Item	Issue Raised	Manager/ Engineer/ Both	Perception
	process		Company processes adopted is an issue beyond the scope of the intervention of technology utilised in this thesis.
7.6	Difficult to locate information	Both	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.
7.7	Poorly structured data/ illogical	Both	Poor structure of information can put users off using the application or facility. This is a generic problem which can be addressed through the usability domain of this research

Table 4-7: EPF Problem Areas Summarised and Analysed

The issues raised with the EPF include: -

- Employees use different terminology to describe the same document – which makes it difficult to identify when you want it

- The EPF application allows users to store documents differently within the directories in either an individual entry or an individual entry with multiple documents hidden beneath it. This makes it difficult to locate particular documents.

It is not possible to use a word search to locate terms within a set of documents. The EPF only allows one to search the title or any attached description (the latter is rarely used by employees)

Lessons Learned Log

(a) Description

The Lesson Learned Log is a mechanism used to capture the wash-up process of all projects within the Company. It is supposed to be used to capture the results of projects, not failure and success, rather the outcome, experiences and possible future changes. In practice the Log is used very little within the Christchurch site and contains only five entries.

(b) Manager Views

BC's statement raises several issues as to who is responsible for communicating that the Lesson Learnt Log exists, who should be using it, why it is there and how often the company expect people to enter data into it.

BC [BC: 13] being a technical domain expert and senior manager gives me alarming messages in his statements suggesting his lack of awareness of the use and usage of this lessons learnt log. The Lessons Learned Log must be promoted by the senior technical managers who must be ensuring (even if via other personnel) that the Log is used and re-used by the Company otherwise it is of little value to the business.

[BC: 13] "There have been attempts at doing this, for example in one of the business areas CCIS on one of their servers there is a lessons learnt log, but I am not sure how many people are aware of it, or how often it is accessed, or up-to-date it is"

In the Reflective Practitioner chapter of this thesis I have discussed in detail my own researcher's perspective of the Lessons Learned Log.

(c) Engineer Views

When questioned at the interviews several engineers were unaware that the Lessons Learned Log even existed let alone actually using such a facility [CL: 10; EL: 6; LL: 15; WS: 7; MD: 7; WJ: 16] (Table 4-8)

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
8.1	Lack of use of the log	Both	The log may not be used due to item 2 below. If employees are unaware of its existence then they are unlikely to use it. There are also many other social factors which may prevent employees from using this tool e.g. they may be viewed as failures
8.2	Lack of awareness of log	Both	This is an issue for communication as is outside of the scope of this thesis.

Table 4-8: Lessons Learned Log Problem Areas Summarised and Analysed

TES

(a) Description

TES is an application used by all employees to record their time against their project codes. Project codes are provided by all projects when they are set up and given out to specific employees who are completing tasks for that project.

(b) Manager Views

There was no mention made of the TES application as a problem area for the Manager population interviewed. This is likely to be the case because TES is unlikely to be at the top of their list as something of considerable importance.

(c) Engineer Views

ST [ST: 25] states his opinion on the fact that TES is another interface that is not very usable and a pretty clumsy tool.

It is seen as time-consuming [CL: 7; LL: 14]. The TES tool is seen as slow and frustrating and not particularly user-friendly [LL: 14; WS: 9; MD: 9; JD: 3]. Others suggest that the tool is full of bugs and therefore is open to errors [WS: 8; JD: 16]. Other comments include: from a physical aspect some printers are unable to print from the application [JD: 3]; the fact that the new TES system was deployed without enough proper training or instructions [RW: 16; LL: 14]; and, that a reminder should be sent around to get employees to fill out their timesheets effectively [RW: 17] but this does not resolve the other issues that are raised above. The booking method is criticised as well as the tool for entering the data required [MS: 16; MR: 7]. Sometimes projects or employees fail to provide adequate booking codes in time for the individual to book their time through the tool [RW: 17; MR: 7]. Other projects have far too many booking codes at a considerable level of abstraction, which makes it difficult for employees to book to the correct one [MS: 16; MR 7] (Table 4-9).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
9.1	Poor usability	Engineer	Usability is an issue raised across several applications discussed in this research. This issue will be given serious investigation during the pilot phase of the thesis.
9.2	Time-consuming	Engineer	Time-consuming applications require re-visiting through the Company officials responsible for them. The generic aspect of time-consuming applications will be investigated further through this research
9.3	Bug-ridden, open to errors	Engineer	The issue of functional errors and bugs are more likely to be raised by engineers as they work in this area of software the majority of the time. They are expected to produce code without bugs and they expect to use code without bugs and errors
9.4	Printer configuration wrong	Engineer	This is an IT Support issue which has been communicated to that group
9.5	No proper training provided	Engineer	This is an Training issue which has been communicated to that group
9.6	Booking code process is inadequate	Engineer	The whole process requires re-visiting and evaluating by the Company but is outside the scope of this thesis.

Table 4-9: TES Problem Areas Summarised and Analysed

Estimating Metrics

(a) Description

Software estimation is a hard and complex task, usually carried out by engineers and managers. Often software estimates are eventually found to have been far too optimistic (insufficient resources or optimistic timescales), often by as much as 100% or more (Verner & Tate, 1992). In addition market forces can add pressure to reduce an estimate that is already too low (Gaffney, 1997).

The purpose of an estimate is to provide a believable assessment, usually showing an understanding of the tasks to be undertaken and backed by the evidence to show the most realistic future outcome (Srinivasan, & Fisher, 1995). In software estimating we are attempting to predict the size, effort, phase schedule, elapsed duration and critical computer resources required to develop a software component, be it a single module or the complete project development, to within an acceptable tolerance of the actual effort that will be incurred. If estimates are good then the Company benefits from the knowledge and belief that the business will be able to meet the customer's requirements to plan and budget. The customer becomes a satisfied returning customer if the estimates become a reality. Good estimates enable the company to ascertain whether it is a good competitive decision to bid for specific contracts.

The estimation process should be based upon a scientific and systematic application of comparative analysis (McCabe, 1976). All estimation processes are concerned with making analogies to past experiences through the traceable application of knowledge obtained from a variety of sources (Low & Jeffrey, 1990).

(b) Manager Views

In the two excerpts from BC's interview [BC: 11; BC: 12] he cites the fact that in his view the Company is continuously reinventing the wheel where metrics and estimates are concerned. He is concerned that the Company is not learning from its past experience in this area.BJ brought up the issue that estimating could be done very badly in the first place [BJ: 15]. He raised a specific instance of where this had occurred previously but there was no indication as to whether the issue was recorded so that others might learn from it

Here ST [ST: 5 – ST: 21] expresses concern from a management perspective over the whole process of gathering metrics; how the results are obtained and he even doubts the value of such estimates. ST is a senior manager within the software product development of the Company which gives rise to concerns over his perception of estimation.

[ST: 5] "Productivity, we collect metrics coming out of the various developments. I'm somewhat sceptical about those......". [ST: 18] "I think in particular with software, but also with design phases and hardware it is very difficult to assess where you are....." [ST: 19] "At the end of the day it is almost art it is almost a feel, in the sense of how nearly finished is it......" [ST: 20] "It is very hard to put values on some of those things..... [ST: 21] "how do you measure software in the first place?".

ST argues that estimates can be extremely subjective [ST: 22] depending on who is conducting the estimation. ST [ST: 22] believes there is a difference in what a line of code is, depending on the programming language being used. However, ST does not mention using an estimation peer reviewing process such as Wide Band Delphi in order to counteract at least some of that estimate. Wide Band Delphi was used on several of my own projects in the software estimation process and worked better than an individual 'expert' view in isolation.

Earned Value Analysis (EVA) is a common management mechanism used to measure and report the progress of a project and the performance against a baseline cost and schedule. The manager usually splits the project down using a work breakdown structure to create a baseline plan that is regularly examined and updated with progress. From this it is possible to derive a set of metrics to analyse and monitor items such as project cost, completeness and schedule performance. It is also possible to forecast completion dates and the future costs to some extent. By using EVA the Company project managers are examining trends and identifying problems in the early stages of the metric analysis thereby getting the opportunity of resolving the problems before they escalate. In my personal experience with the Sampson Project I found that the EVA tool being used produced very unusual results for several months. Each time I investigated this with the staff developing the results we identified issues affecting the process we used in extracting the raw data as being incorrect. The macros used within the EVA tool produced incorrect results and poorly planned processes, which had not captured a true reflection of the baseline plan. These issues were all resolvable but the inaccuracies caused incorrect trends to be identified in some cases. However, it is also correct that the EVA results did continue to identify real issues as well and caused the managers to further examine some particular areas of concern.

To use EVA metrics requires a good understanding of the detail of what is happening at a team level on a project. The EVA can only point to issues which may be a problem but those problems could be known and may be being managed but taking some time to resolve. The results need a very subjective management interpretation. For example, key tasks may be behind schedule others on schedule but due to priority and inter-linking of tasks the date these tasks do not balance up but instead produce a massive extension to the time needed to complete a project.

ST [ST: 6] may have been able to recognise key issues for the development of his main project – X if metrics had been collected. Metrics of the amount of time spent on the design phase or the requirements phase would have identified the fact that there was a high cost in these two areas. Metrics on the number of lines of code and a comparison with the three point estimate that I created for the interface development may have helped me to monitor the progress made other than by the methods I hade created at the time. It also would have helped to identify the correct estimate values for other areas of Project X. In my view the figures presented for the TTT element of Project X were completely inaccurate and substantially over-estimated. The customer also noticed this after the project details had been sent to him and he commented strongly as to his disagreement with these estimates.

(c) Engineer Views

The Estimating Metrics Intranet site has failed to be updated for several years since the owner left the Company, neither has it retained management or company support in any concerted way [WJ: 13]. This situation has led to useless information being available [WJ: 13]. If this is a true representation of what happens in the Company then how can the Company ever expect to get this right in the future? [JD: 18].

Past records of estimating metrics are far too coarse to apply to future projects [JD: 18] and not enough records and proper analysis have been done in the past [JD: 18].

Estimating metrics has been quite a time-consuming task for some engineers [WJ: 14]. More automated solutions could prove beneficial to obtaining useful information.

Although an estimating process exists, employees fail to use it [WSZ: 6; WSZ: 41]. The estimating initiative within the Company has failed for several reasons. Firstly the Company does not give its full backing but purely lip service to an estimation process {WSZ: 7; WSZ: 8]. When vital decisions need to be made initiatives are the first to be abandoned and support withdrawn by the senior managers [WSZ: 8].

'But there is a huge gap between the information that is available and applying that information in some meaningful way. Everybody knows how they should be doing estimating but nobody really is' [WSZ: 41].

WSZ states that finding out what estimation process a project has been using is the hardest part of his job [WSZ: 10]. Getting the information of what has been done, how it was done, who did it and what was their experience is pretty much unavailable to WSZ [WSZ: 11]. This information is unavailable to WSZ or to other projects – the communication does not exist – neither can that project or other projects learn from their experience [WSZ: 12]. In fact WSZ discovered whilst carrying out his job, that every time a new project started a bid they started a new estimation process from scratch [WSZ: 13]. WSZ also found out that estimation is rarely a continuous process throughout a project's lifetime [WSZ: 14]. How can the business learn therefore? [WSZ: 15]. The whole process of estimation and coming up with an estimate is in the heads of the engineers asked to perform this task [WSZ: 16]. Very little of the process, engineers' assumptions etc. are recorded anywhere [WSZ: 16]. The knowledge about that estimate and how it was arrived at gets lost once questions are asked by WSZ with the managers and senior managers of the project [WSZ: 17]. Managers are even unable to isolate and distinguish those on their own project with the skills, experience and expertise in the area of estimation [WSZ: 18].

WSZ has concluded from his own work over an eighteen month period that there is a cultural issue in projects not wanting to share information between themselves, not just about estimating but other issues too [WSZ: 19]. The projects can be defensive and enclosed and they refuse to allow their information to flow outside of their project [WSZ: 20; WSZ: 40] (Table 4-10)

"But that is difficult for 2 reasons, projects are busy and projects are very insular and protective of what they have got"[WSZ: 40].

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
10.1	Company not learning from past mistakes	Manager	This is likely to be due to items 1, 2 and 4 above.
10.2	Poorly maintained estimation process website and poor company backing of process	Engineer	This is another area where the information needs to be available and up-to-date and is not. The process is seen to have little Company support and therefore is less likely to be taken seriously by those asked to do the estimates.
10.3	Poor past estimation recording	Engineer	This suggests that the past records are of no value to the new projects and thus the process is failing to bring improvement to the new

Item	Issue Raised	Manager/ Engineer/ Both	Perception
			Company projects
10.4	Time-consuming for engineers	Engineer	This is a specific case where the Company should be providing adequate guidance to the employees. The process requires further investigation by the Company to ensure an appropriate and effective implementation.
10.5	Estimation process not used, not valued	Both	This could be due to items 1 and 2 above.

Table 4-10: Estimating Metrics Problem Areas Summarised and Analysed

Private Venture (PV)

(a) Description

Private Venture funding is money utilised by the Company to undertake research and development. This can be new product ranges, enhancing current product lines, improving processes, investigating new technology and its impact for the Company (Figure 4-17; Figure 4-19; Figure 4-18). The Company budgets for a certain amount of PV funding each year. Then the Company looks through the list of potential projects and decides the priorities and spending allowed, together with the scope of the work to be done. PV work is very important to the Company in order to keep its products up-to-date, enhanced and for developing future business. Projects are supposed to back PV work undertaken by their staff, allowing them time to devote to this. In practice this does not happen.

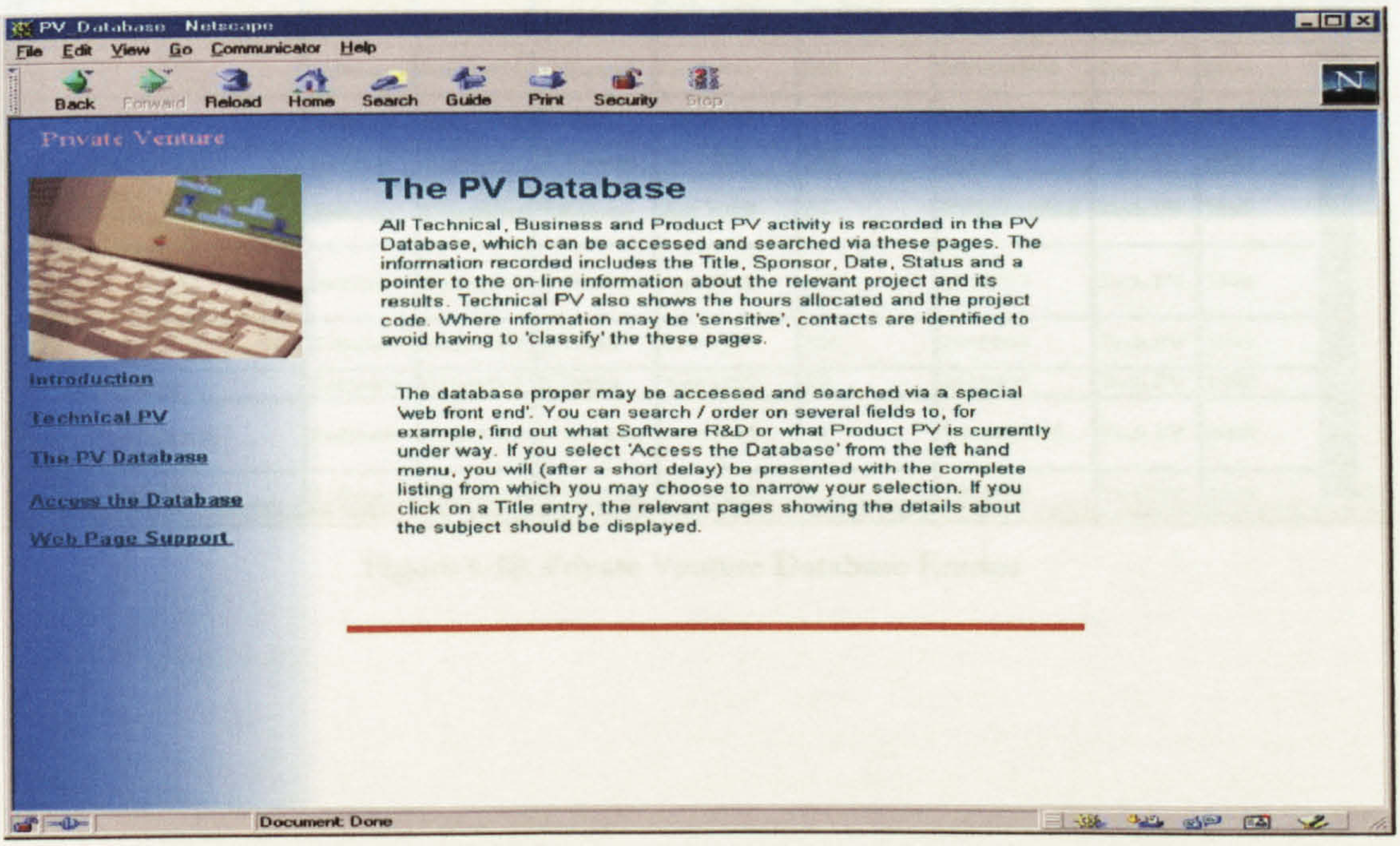


Figure 4-17: BAE SYSTEMS Private Venture Database Homepage

(b) Manager Views

BC [BC: 14] is concerned that another important information source, the Private Venture (PV) data is not widely known, nor communicated.

[BC: 14] "Also other information. Each of the business areas is responsible for PV, CCIS particularly when we were two divisions on this site, there would be very little communication between what was called Defence Systems Division and what was called Tactical Communications Division. We wouldn't necessarily know what PV activities were being done in one or the other or even in different business areas within the same division. So again we could improve that situation by using something like the web and at least we have got something set up now which is the basis for providing details of what PV is going on, what reports we have produced etc. but again we can use the web for that"

The whole area of the Private Venture work at the level BC is discussing was researched in by the analysis of my own PV Report developed when I first joined the Company. These results are described elsewhere in cycle 2 of my thesis and go into far more detail. BC suggests the use of the web to keep an updated view of what PV reports are being written and what research work is being done. However, although the PV site does exist it is not currently up-to-date (Table 4-11).

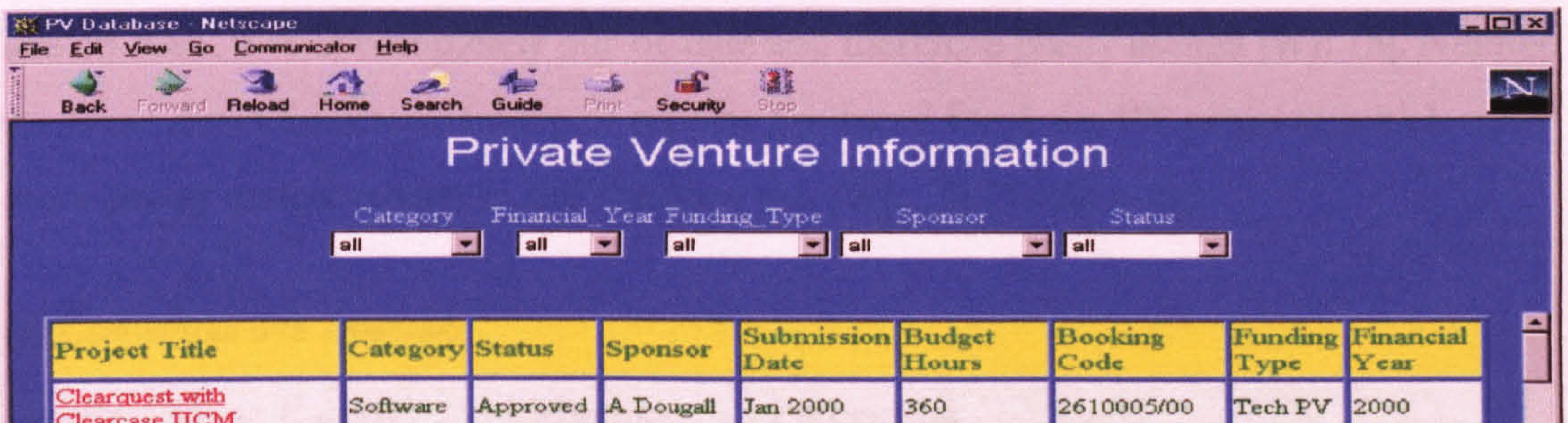


Figure 4-18: Private Venture Database Entries

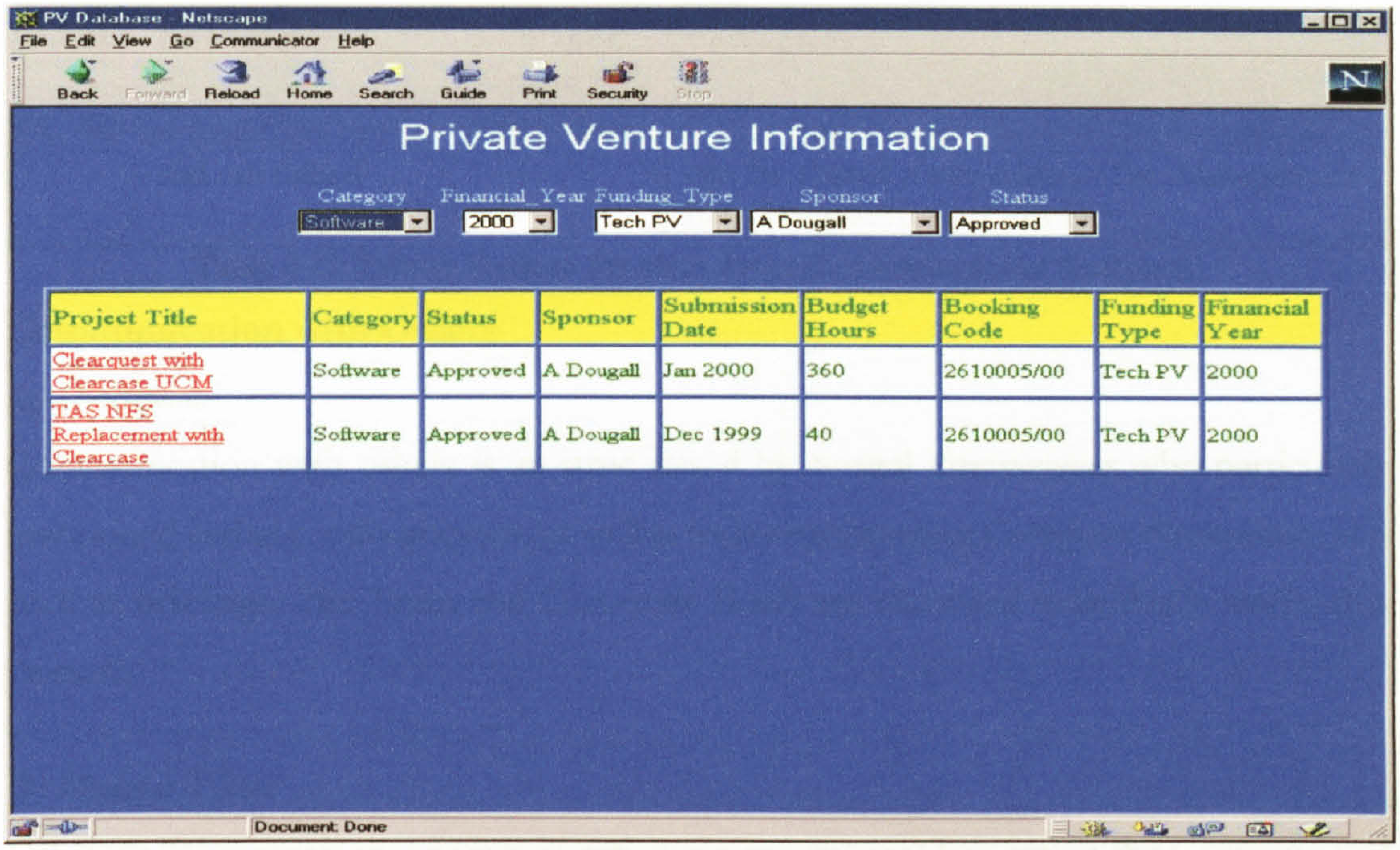


Figure 4-19: Private Venture Database Filtering Option

(c) Engineer Views

LM states that although it is a worthwhile area for the Company, private venture funding is very limited [LM: 5].

PV trials are very useful to the Company and to local projects however, the PV database site on the CWW is completely out-of-date and therefore pretty useless [WJ: 15]. Neither are these direct links to software or reports produced for those PV projects, which make them pretty useless entries in the database too [WJ: 15] (Table 4-11).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
11.1	Poorly communicated	Manager	The whole issue of communication is now recorded and being dealt with via a communications strategy through the Company
11.2	Limited funding	Engineer	The Company may need to revisit the amount of funding available and the true results of the work that has been carried out by the Company. At the moment no proper evaluation of the value of the PV work has been done – this may be dealt with further by this research.
11.3	Out-of-date information	Engineer	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.
11.4	Website(s) information poor	Engineer	In particular the work carried out needs to be linked into the website so that the information

Item	Issue Raised	Manager/ Engineer/ Both	Perception
	and not linked		can be shared more widely. The Management have been notified of this fact.

Table 4-11: Private Venture Problem Areas Summarised and Analysed

Communication with Others

(a) Description

Communication with others is an issue raised by several interviewees who particularly mentioned verbal communication as well as issues surrounding Company communication such as briefings. The Team and Corporate Briefs are discussed individually within this research.

(b) Manager Views

DR [DR: 26] suggests that communication is a general problem within the Company and he suggests that communication needs to be planned into the activities taking place in the Company. He suggests that the Company is still failing to communicate.

[DR: 26] "But as engineers, we, the community here, are engineers so they tend to be not here to communicate, we are not strong in communication skills but in technical things. So the ethos that everyone has does not lend itself to communication and communication is always a blind spot and we don't give it enough attention. One of the people on the SEPG actually investigated communication in all its guises and showed that you really need to plan and invest in communication to do it properly, to make it happen, it can't just happen in an ad hoc way. But we continually fail in recognising the importance of it and plan for it. Whilst we continue to fail to plan for communication properly we will continue to fail to communicate"

Other issues raised as problems with the information flows in the Company include the downward flow of information between BC a senior manager and his own boss, a senior director [BC: 16]. BC also has the opinion that he and his peers feel that they do not know or have a view of the Company picture [BC: 16]. BC [BC: 17] explains why certain members of the group are worried about not getting particular information. BC states that "they don't have visibility of the whole picture, whatever the picture is" – this suggests that the group believe they should have access to the information about the whole picture. HD [HD: 10; HD: 11; HD: 12] also backs BC [BC: 18] in the view that he is not getting the information he expects from his superior about the Company. Their view may contradict a business perspective of this self same issue. The business could be disseminating information on criteria it believes appropriate on a 'need to know' basis. I would also like to add that in my view communication is a two-way channel so if this group believes they should have access to more information then they need to take responsibility for requesting further information in the first place – thus giving the business an opportunity to respond. BC states [BC: 16] that there was a different mechanism for getting the kind of information the group wanted in the past, but that has changed and BC believes there is a gap in the communication. In response to this comment I would add that if BC and the group feel this is the case then the Company needs to be made aware of this issue in order to resolve it.

HD: 11 " no I think we're not too well informed on that topic at all".

BC [BC: 17, BC: 18) is also supported by the interview of BJ but in this latter case BJ wants the bigger picture of the Company strategy [BJ: 4]. The issues raised by BJ [BJ: 4; BJ: 5) predominantly discuss the over-arching Company strategy and trying to develop his own strategy for his division based on this strategy. Because the Company is in an unstable change due to the merger it is difficult to see what the Senior Directors are planning because the rest of the business has little visibility of this. BJ should have a superior to direct his questions at in order to get the answers he seeks. However, BJ states [BJ: 14] that his superior is not providing that information. BJ [BJ: 14] also points out that his superior may not have all the answers – in this case BJ may need to press his superior to find out who has and get those answers from that other person. When asked "How about communications of information that you need from, say, your bosses, do you feel that you get the information that you need?" BJ replied:

[BJ: 14] "I work directly for PC, and no I don't. Something I mentioned earlier, which is this sort of flow down of information from Corporate. Obviously, PC looks downwards at me and my fellow heads of projects and upwards into Defence Systems Group and to be fair, we are in a state of great transition at the moment, obviously, it's stating the blindingly obvious really isn't it. And therefore the assumption that PC knows all the answers to all the questions it's patently nonsense he doesn't! He is actually pretty good at communicating what he does know down he is always very willing to go and have a chat, I do think he prefers the face to face, and I do too, I much prefer that sort of relationship with the boss".

BJ is open and honest in his view that he feels he is not getting all the information he would like to get from his superior. However, in this case BJ is stating that his own boss does not necessarily know everything in the first place, therefore how can his boss pass it on?

Further issues relating to communication were raised in other interviews whereby the communication failure was deemed to rest on the individual managers themselves. The suggestion is that the managers sometimes don't even communicate very well with each other.

[DR: 8] "There are other communications, which I am more disappointed with. The corporate level of communication I think is quite good but we fail in our own jobs to communicate with each other very well"

DR [DR: 9; DR: 10] gives me reason to believe that one senior manager finds that his peers are poor communicators. DR [DR: 10] recognises his own responsibility in this but presents his views that the channels do not exist and he does not have the time or effort to open these channels himself. But this leaves the problem unresolved and this is unsatisfactory for the business as a whole. As a starting point someone who can resolve the problem needs to be made aware of it. DR [DR: 12] identifies the issue that the right people, specifically motivated staff, need to create and maintain these channels of communication. In [DR: 13] DR states that if these people with commitment to this work can't establish the channels then this will fail.

DR [DR: 14] equates this problem to two specific areas, first management and secondly, people. By identifying management as partially responsible for setting up these channels of communication there needs to be some analysis of the purposes of the channels and who should be involved in creating them. Also what information is expected by the receivers? Also is there likely to be any deviation from the Company perspective of what information they want carried and how should it be disseminated throughout the Company? All these are unanswered questions at the time of writing. DR [DR: 15] continues to explore this issue, suggesting that there should be owners of the issue arising from the communications. I believe DR is correct in this interpretation but to do this work the staff concerned need the backing of the Company at a higher level and to have a remit which defines the boundary of their responsibility or this will not work very well. In DR's next statement [DR: 15; DR: 16] he reiterates the fact that responsibility for the continuing impetus of the communication medium remains with the person running it.

DR [DR: 17] explains the difficulty of running communications meetings based on his own personal experiences. DR is correct in his views that individuals are all different and respond differently to different mechanisms of communications. DR also indicates that he found it difficult to match the style of his meeting to the needs of his audience and that the issue was not really resolved. In my own experience it is difficult to manage meetings, some people find it easier to manage than others. There are also courses in relationship management and meeting management, which can assist managers like DR to develop better skills in this area. DR is also correct in saying that the right method to deal with communication is not necessarily a meeting (Table 4-12).

(c) Engineer Views

TA has no problems communicating with his immediate superiors, however those one-step higher are less accessible [TA: 5; OJ: 6]. LL on the other hand requires further interaction with the boss, which has not been happening [LL: 9]. MR communicates upward to his superior but often feels isolated and needs more communication than he is getting [MR: 5]. Whereas RW has too many interruptions by his boss, preventing him from doing his daily job [RW: 12].

SN states that the company communication is one-way down to the engineers [SN: 7]. It is felt that the engineers do not have the proper mechanism in place to communicate upwards properly or whether it will be heard higher up the chain [SN: 8] (Table 4-12).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
12.1	Poor communication throughout Company	Manager	This view should be monitored through the Employee Opinion Survey. This was suggested and carried out.
12.2	Poor communication of Company strategy, holistic view of the Company	Manager	The kind of information communicated and the levels need to be measured through the Employee Opinion Survey. This was suggested and carried out.
12.3	One-way communication down to engineers	Engineer	This view should be monitored through the Employee Opinion Survey. This was suggested and carried out.
12.4	Poor information from direct line manager	Both	This is a personal issue which employees need to discuss with their bosses

Table 4-12: Communication Problem Areas Summarised and Analysed

Culture

(a) Description

The whole aspect of Company culture was raised in a few of the Engineer interviews and in order to capture these views for the Company they are included here. Company culture is a large issue that requires a great deal of investigation and for this reason the comments are recorded from the transcripts and the issues are summarised. But this aspect will not be investigated further as the technology of software agents will not be able to address this in any meaningful way.

(b) Manager Views

Other aspects of communication relate to the fact that some managers believe the capability exists within the Company to solve problem but that the problems do not get resolved. AT [AT: 1] suggests that this relates to the poor communication within the Company. AT has spent many years in the Company and in his experience things have still not improved in this area. AT cites an example of this from his own experiences of a three-year program [AT: 2]. AT also explains in more detail what was happening in his opinion [AT: 3; AT: 4] (Table 4-13).

AT relates the problems to the culture and philosophy of the Company [AT: 5], he also states that he feels that the Company is naturally non-communicative [AT: 6]. AT goes even further in his views that the Company is deliberately hiding things from the staff and that this is true throughout the layers of the Company [AT: 7 - AT: 11] . If this view is a correct one then there is likely to be difficulty in implementing new ways of doing things that will affect this culture. In order to share knowledge, for example, the culture needs to be open and honest or it will fail miserably and people will lose faith in the process (Tiwana, 2000; Dixon, 2000).

[AT: 9] "we start off our projects with a cloud of secrecy over them"

[AT: 10] " Because they cannot be open, because if you open them you find that it doesn't all stack together"

[AT: 11] "We have won this job because we put in a winning price" but people forget to say and we cut out all those bits that should have been in there but we better not tell Joe Bloggs that his bit's been cut out or else he won't do it and we are going to need him to do it really"

AT expresses his views that members of staff are not given the whole picture when they start a project so to a certain extent it may be doomed to failure before it has started (AT: 12 – AT: 14]. I can relate to the views in point [AT: 13] on my latest project although I don't know that the project is doomed to fail. However, the project does not have all the requirements from the customer sorted out, yet it has begun work in the areas it feels happy to work on. But by not seeing the system as a whole and working on isolated parts the system may not be integrated and the project may fail. Also team leaders in trying to be seen as successful have not passed all of the information I require to me as their manager for fear of being seen as a failure [AT: 14]. This may be personal or may be related to the culture of the Company as TA suggests – I do not know for certain.

[AT: 12] "So we have this culture that people are often faced with being given failure on a plate when they start off"

[AT: 13] "So the last thing anybody wants to do is to tell the truth, like 'I'm sorry I am not on schedule' because they never are so they've failed from day one in essence"

[AT: 14] "One of the problems is we don't have what's called an honesty culture: people won't tell you how they're doing really"

I also agree that some members of staff I have worked with or closely with fall into the description that [AT: 15] provides. Some members of staff have not sought assistance or help when they have obviously needed it. Others are proud engineers who want to be seen as experts and strong engineers so they won't ask for help in case they lose face. I have also worked with engineers and managers who do not communicate the problems they face and it is only when it goes so far wrong that it can't be corrected that the truth comes out. In my role within the Company I have tried to maintain as honest a situation as possible and tried to encourage the staff to let me know ahead of time if there are problems. This does work better but I have also now experienced the other end of the spectrum where a member of staff is reporting to me on every little aspect of his problems, which is not an efficient use of his time or my time. I am learning to balance this activity. I have also learned that by proclaiming that all problems are joint problems, and that we are all in the project as one team, assists with breaking down the barriers. I take as much responsibility for errors and mistakes as those making them. This builds better and stronger relationships with my teams.

Some of the reasons for a failure to communicate are not subversive and AT acknowledges that in his comments at [AT: 19] when he says that it may be related to the fact that there is a lot of information and it can be difficult to decide or have the time to communicate certain aspects. AT also recognises that some of this secrecy may be to do with the engineering profession as a culture in its own right [AT: 32] for example, being a more introverted role due to the need to concentrate the brain effort on the complexity of problems. Employees may not need to communicate as much as in other professions [AT: 36]. Employees may prefer to keep ideas to themselves in order to remain valuable to the company too [AT: 36].

(c) Engineer Views

CL comments quite openly that the Company only pays lip service to the vision statement that "people are our greatest asset" [CL: 9]. This is backed by the very pertinent response held by JD:

"The company culture is an expensive lip service to an urban myth. Some validity is that we are not quite Victorian but there is a lot of running around looking for a new magic wand to wave. There is a fundamental contradiction between the global aspirations of the business, as shown by its constant mergers, acquisitions and disposal of business units, and its declared valuing of people ..... Underneath we are the same elitist, sexist, cliquish, if-your-face-fits bunch of back-stabbing, status-driven, 'from a business point-of-view I must not let morality interfere' bunch as before, okay!! But I firmly believe in the cultural aspirations which our directors are praiseworthily trying to bring to fruition and look forward to the time when the workforce will embrace them fully to the benefit of the business as a whole" [JD: 19]

There are several views on the culture issues surrounding the company that were raised in these interviews. WSZ adds weight to the views of JD above: -

"I find the environment here draining. I find it difficult to work with. I find it frustrating, the bureaucracy, the paperwork and so many things that the company seems to need to make it function but they add so little value to what people are trying to do, they stifle creativity, imagination, and any sort of dynamic response to your work"[WSZ: 52].

EL believes that the Company culture is too relaxed and many people get way with doing very little [EL: 9]. EL thinks that this is because the Company does not have cutting edge or commercial software, which needs to be delivered in a commercial market [EL: 9] (Table 4-13).

TA feels that the Company does not value its longer service employees at the expense of employing new ones [TA: 10]. TA believes that newcomers get a better deal on joining the Company than those already employed by it [TA: 10]. However, TA is of the opinion that new recruits are less skilled than those who have a longer service history with the Company [TA: 10].

LL states that there is too much negativity from the long-service employees [LL: 19] and these people don't like change [LL: 20]. LL feels the Company is old-fashioned in its approach [LL: 17]. MR feels that some employees maintain a false superiority of knowledge in his domain without the required expertise [MR: 8].

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
13.1	Secrecy culture	Manager	This is a strong expression of an engineer's view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.
13.2	Company pays lip service to its proclaimed culture	Engineer	The culture and values are freely available and visible through the Company literature and key websites. Unfortunately some engineer's feel that the Company says one thing and does another.
13.3	Company is full of elitist, sexist, cliquish, if your face fits, back-stabbing, status driven individuals	Engineer	This is a strong expression of an engineer's view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.
13.4	Company is bureaucratic and frustrating	Engineer	This is a strong expression of an engineer's view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.
13.5	Culture too relaxed	Engineer	This is a strong expression of an engineer's view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.
13.6	Little loyalty to long-term employees	Engineer	This is a strong expression of an engineer's view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.
13.7	General negativity	Engineer	This is a strong expression of an engineer's view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.

Table 4-13: Culture Problem Areas Summarised and Analysed

Best Practice

(a) Description

The idea behind best practice is that Companies encourage their employees to give visibility to the rest of the Company when something they have done or are doing is successful (See Figure 4-20, Figure 4-21). This should enable other employees to read about it and then adopt it themselves thus creating some tangible value to the Company itself (Tiwana, 2000). Once again, just making the information available may not be enough to inspire other employees to utilise it. A change in the Company culture may encourage best practice usage (Tiwana, 2000).

Best Practice is often identified only in a positive manner in that it can only be best practice if it is a success. But success can come from learning from mistakes too and is often retained more vividly (Dixon, 2000; Corbin et al., 1999). BAE SYSTEMS has several Best Practice intranet sites available and a lessons-learned log (Figure 4-22, Figure 4-23, Figure 4-24 and Figure 4-25). In reality these should all be amalgamated into one, as there should be a central source of best practice for the whole Company (Figure 4-26 and Figure 4-27). A central source that allowed mistakes to form part of the successes of the future should be encouraged. Often there are no guidelines for employees as to what is 'best' and therefore they are unable to determine whether what they are doing is a best practice contribution or not (Brown, 1999; Dixon, 2000).

The following extracts from the interview data take these points further and highlight difficulties and issues within BAESYSTEMS.

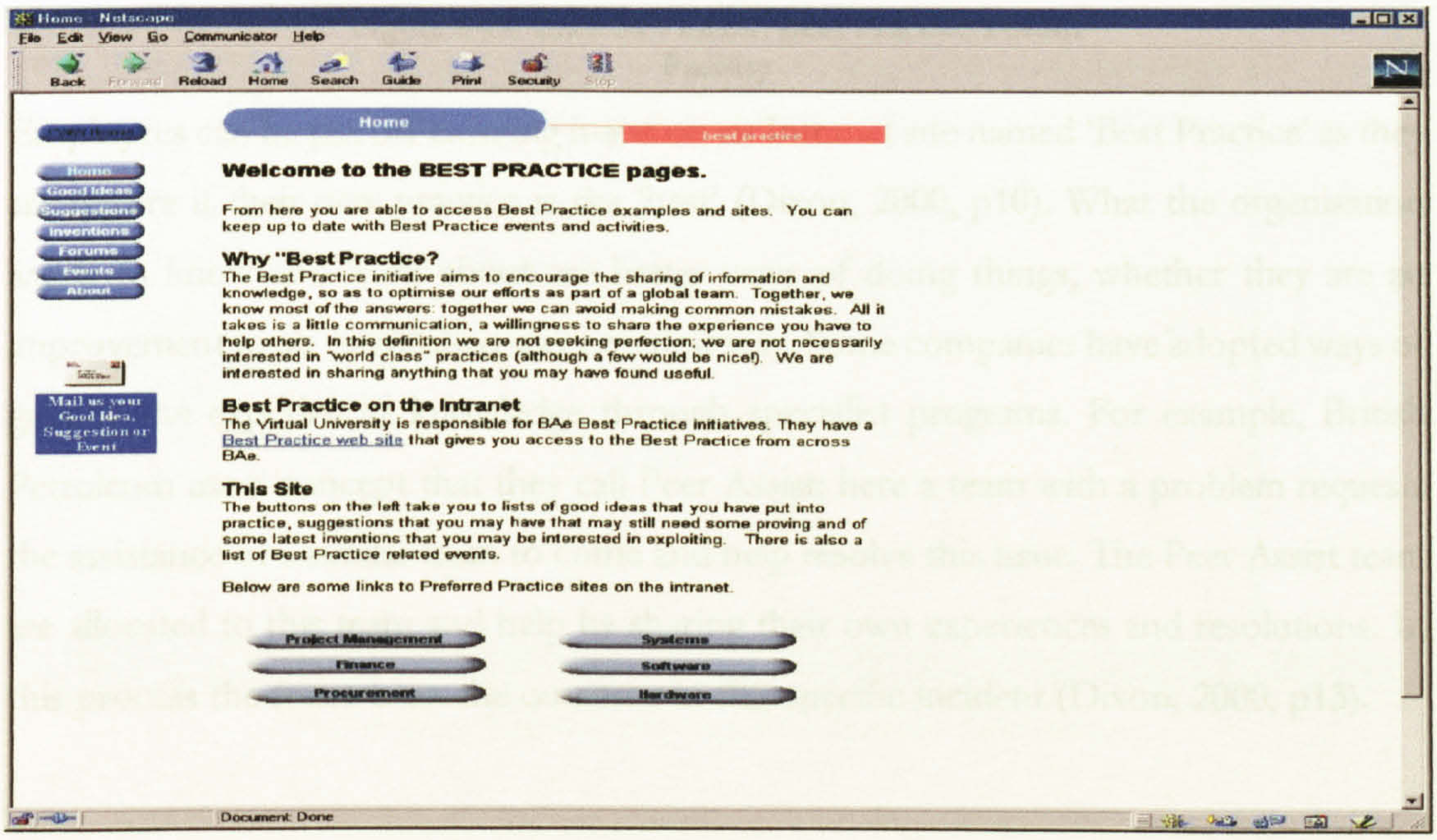


Figure 4-20: BAE SYSTEMS Best Practice Homepage

(b) Manager Views

In [DR: 27] DR explains the way that dry and dull documentation develops into the various standards on site and how these rarely get used and are ignored. This way of working is not really a good use of time, knowledge and expertise within the Company – so Best Practice rose from the ashes as the new way forward for the Company. Having looked at the Christchurch Best Practice site there are currently 14 entries and I would argue that of these only 4 are really true Best Practice and could be used elsewhere within the Company.

RD in [RD: 10] his response states that he is meant to be leading the way in re-using the Best Practice available but he feels that he is not succeeding.

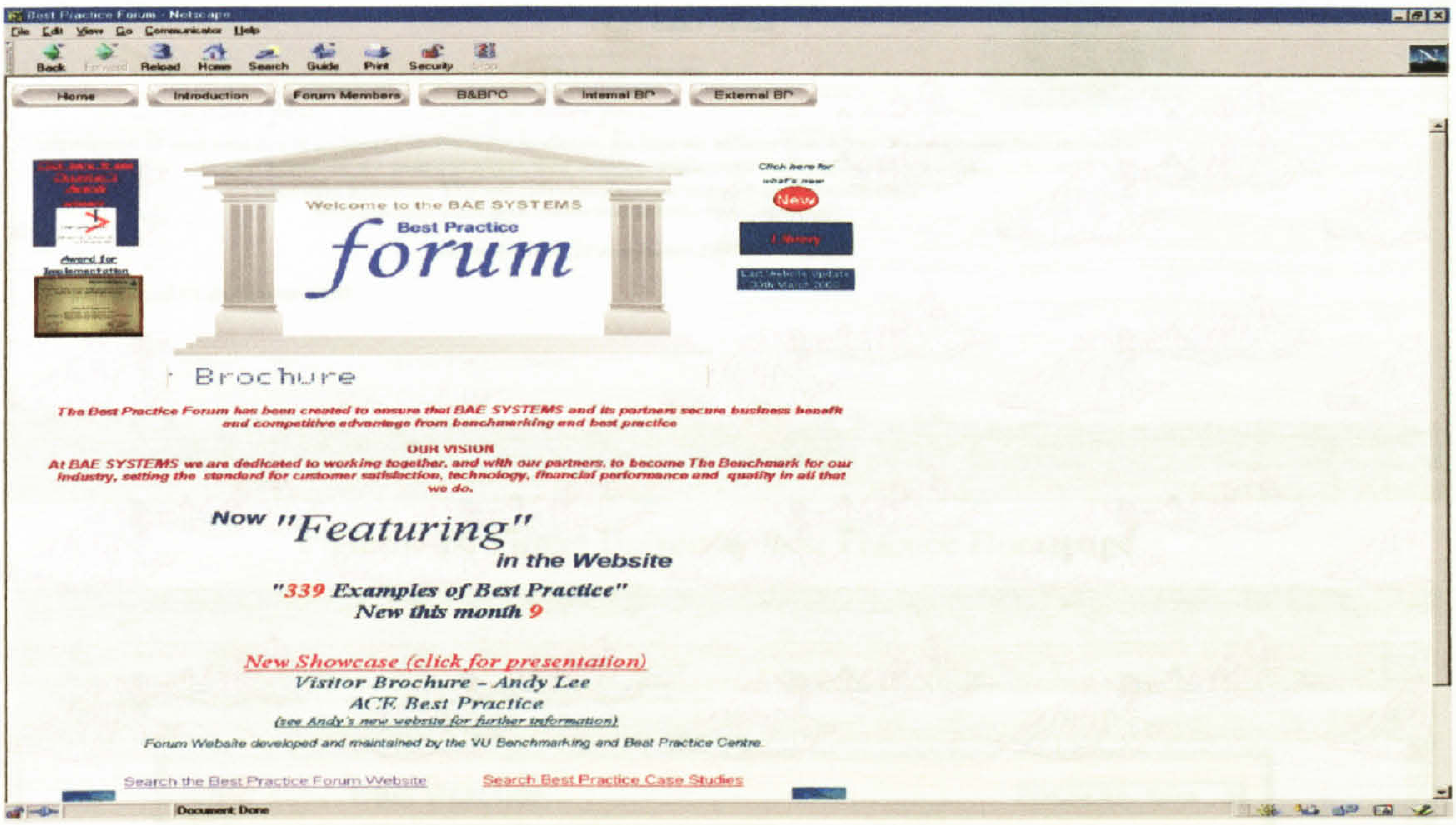


Figure 4-21: BAE SYSTEMS Best Practice Forum Facility

Employees can be put off entering items on an Intranet site named 'Best Practice' as they are unsure if their new practice is the 'best' (Dixon, 2000, p10). What the organisation wants to know and learn about are better ways of doing things, whether they are an improvement to an established way or a new way. Some companies have adopted ways of gaining the experiential knowledge through specialist programs. For example, British Petroleum use a concept that they call Peer Assist: here a team with a problem requests the assistance of a similar team to come and help resolve this issue. The Peer Assist team are allocated to this team and help by sharing their own experiences and resolutions. In this process the focus is on the outcome in this specific incident (Dixon, 2000, p13).

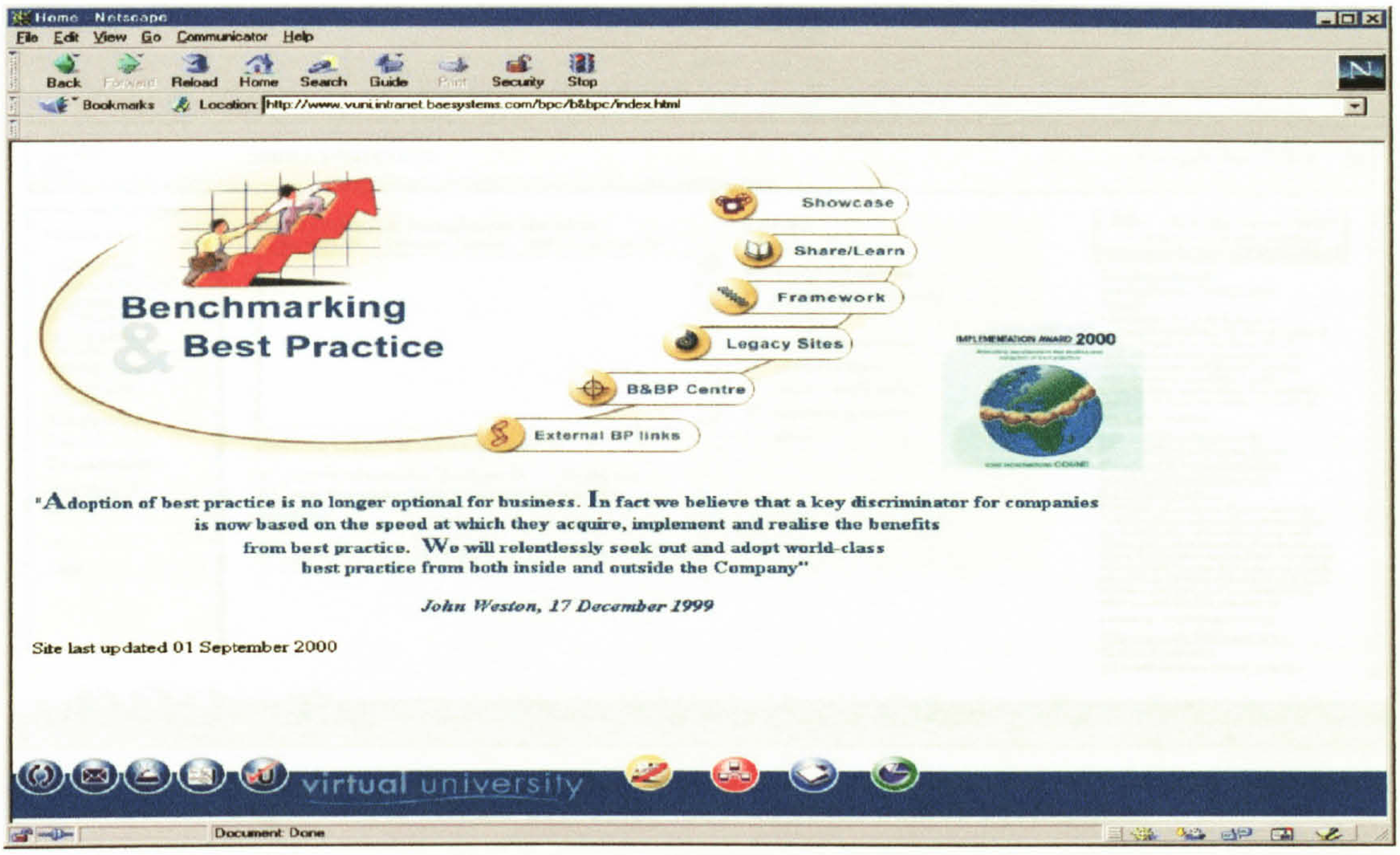


Figure 4-22: Virtual University Best Practice Homepage

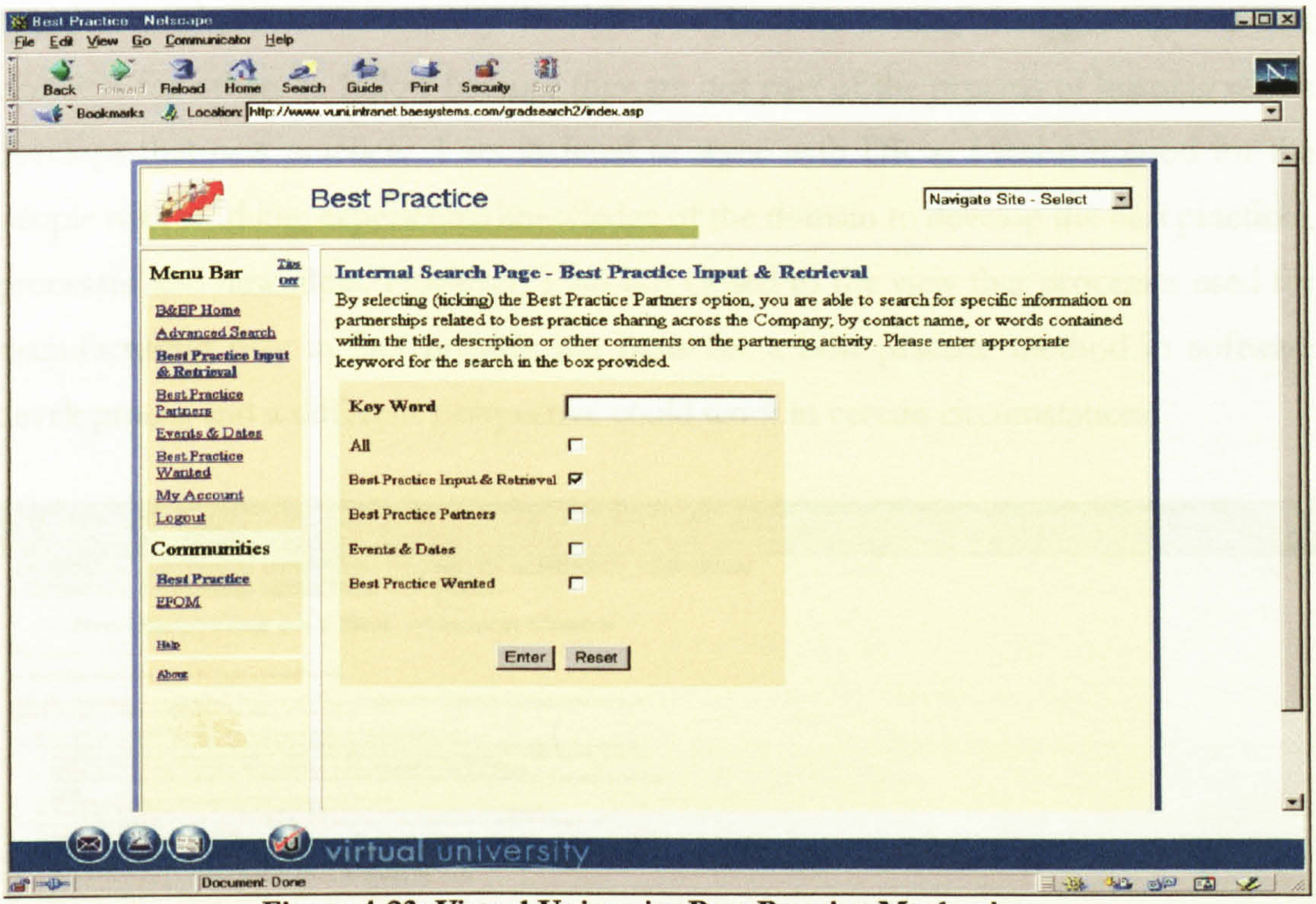


Figure 4-23: Virtual University Best Practice Mechanism

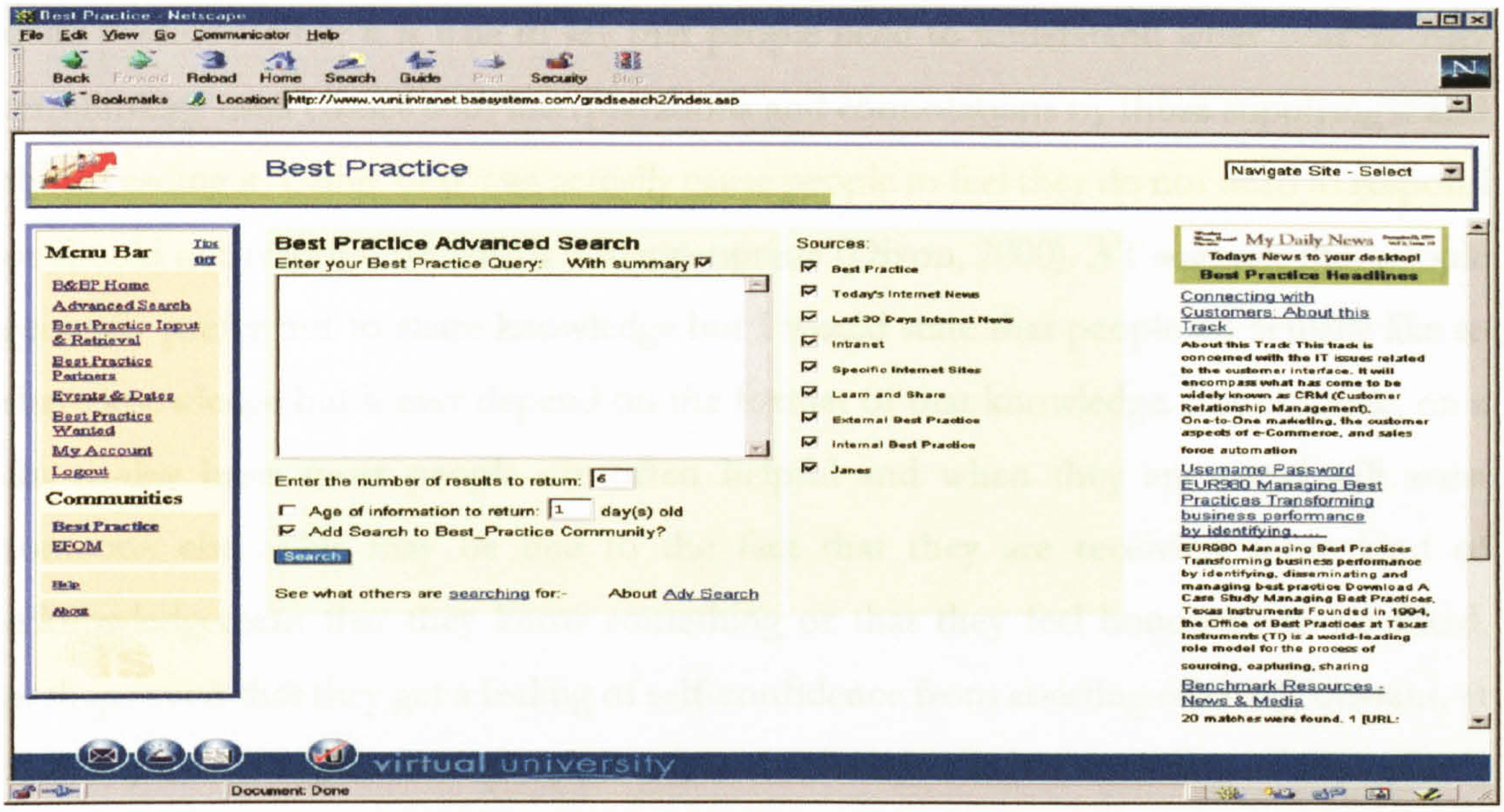


Figure 4-24: Virtual University Best Practice Search Mechanism

Next DR [DR: 28] suggests that people who are not connected with the processes and practices used are not necessarily the right people to be writing or suggesting new best practices for others to follow because they are not part of the process of learning which develops that new practice. I am inclined to agree with DR as I feel it is good for the people with working, experiential knowledge of the domain to develop the best practices, processes and new ideas. However, I am not closed to the view that processes used for manufacturing may in fact provide the basis for a best practice method in software development and a different perspective could work in certain circumstances.

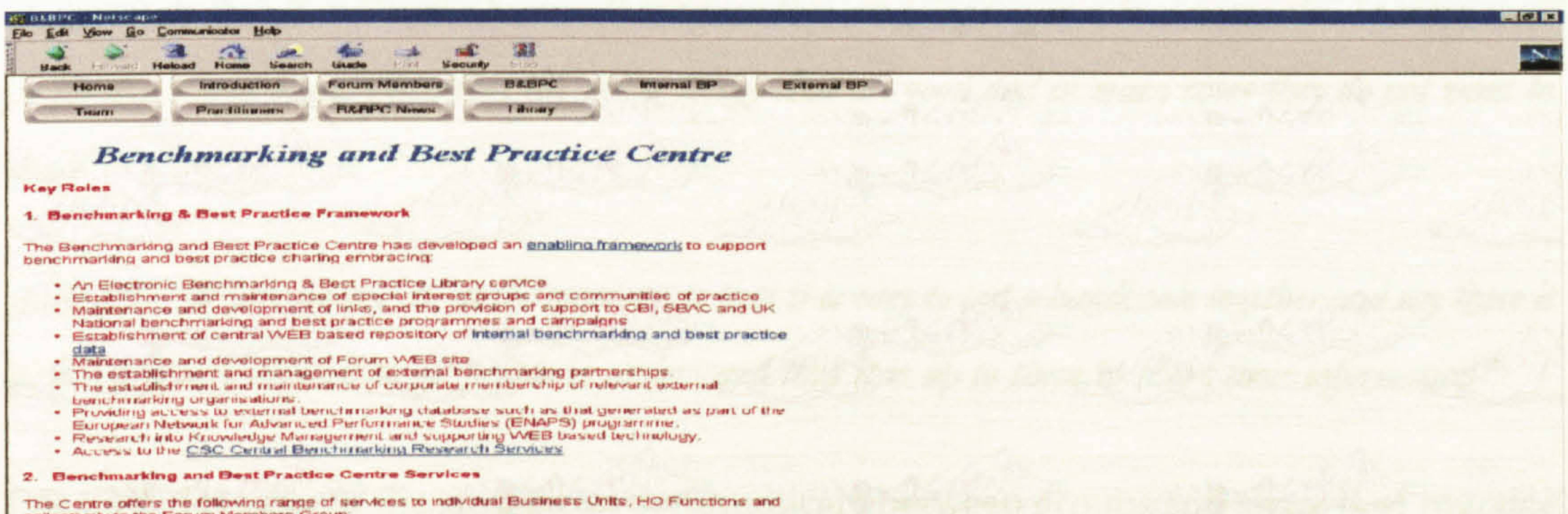


Figure 4-25: BAE SYSTEMS Best Practice Centre

AT suggests [AT: 26] the main reasons that the Best Practices will not work are: (1) people will not generally want to share their knowledge in this manner on a web site for anyone else to use, (2) the Company culture is non-communicative; and (3) people do not know what Best Practice really is so they wouldn't know it if they saw it. These views are quite pessimistic but it is true to say that people need to understand what 'best' is. Any terminology used comes with interpretations and connotations by those supplying it and those reading it. Using 'best' can actually cause people to feel they do not need to respond or should not respond because it is inappropriate (Dixon, 2000). AT suggests that people generally prefer not to share knowledge but I would state that people do actually like to share knowledge but it may depend on the format of that knowledge. For example, on a day-to-day basis most people are often helpful and when they are asked will assist someone else. This may be due to the fact that they are receiving some kind of acknowledgement that they know something or that they feel honoured to be asked, perhaps even that they get a feeling of self-confidence from assisting others (Constant, et al. 1994). Issues which cause people to close themselves off from assisting or helping with other people's problems, can be (1) a time management issue; (2) mistrust – because they have been treated inappropriately or been taken advantage of; (3) some people struggle with personal relationship issues and so lack the ability to deal with others when requested. In each of these examples there are suitable solutions: (1) they can often point people to an alternative source of assistance, or re-schedule their priorities; (2) new trusting relationships can be built, or the benefits to the provider in sharing knowledge can be explained; (3) people can be given coaching and training to overcome this issue.

[AT:26] "I fully support the Best Practice activities unfortunately they are going to fail. I think they are going to fail because we do have this lack of communication type of culture so people won't want to communicate their Best Practice because that means they are going to give it to someone else. In many cases people don't even know when they are doing things that are good and in many cases they do not want to share"

[DR: 29] "Where we are at, at the moment, is that it is easy to put a handbook together and say there it is, but it is very difficult to get people to understand that it is up to them to share their information"

DR [DR: 11] talks of the struggle to communicate between groups and share best practice with each other. DR suggests that there is a lack of proper commitment to this kind of sharing of information and the lack of support provided to see it through. DR also intimates that there is a lack of good communication in the process too which hinders progress.

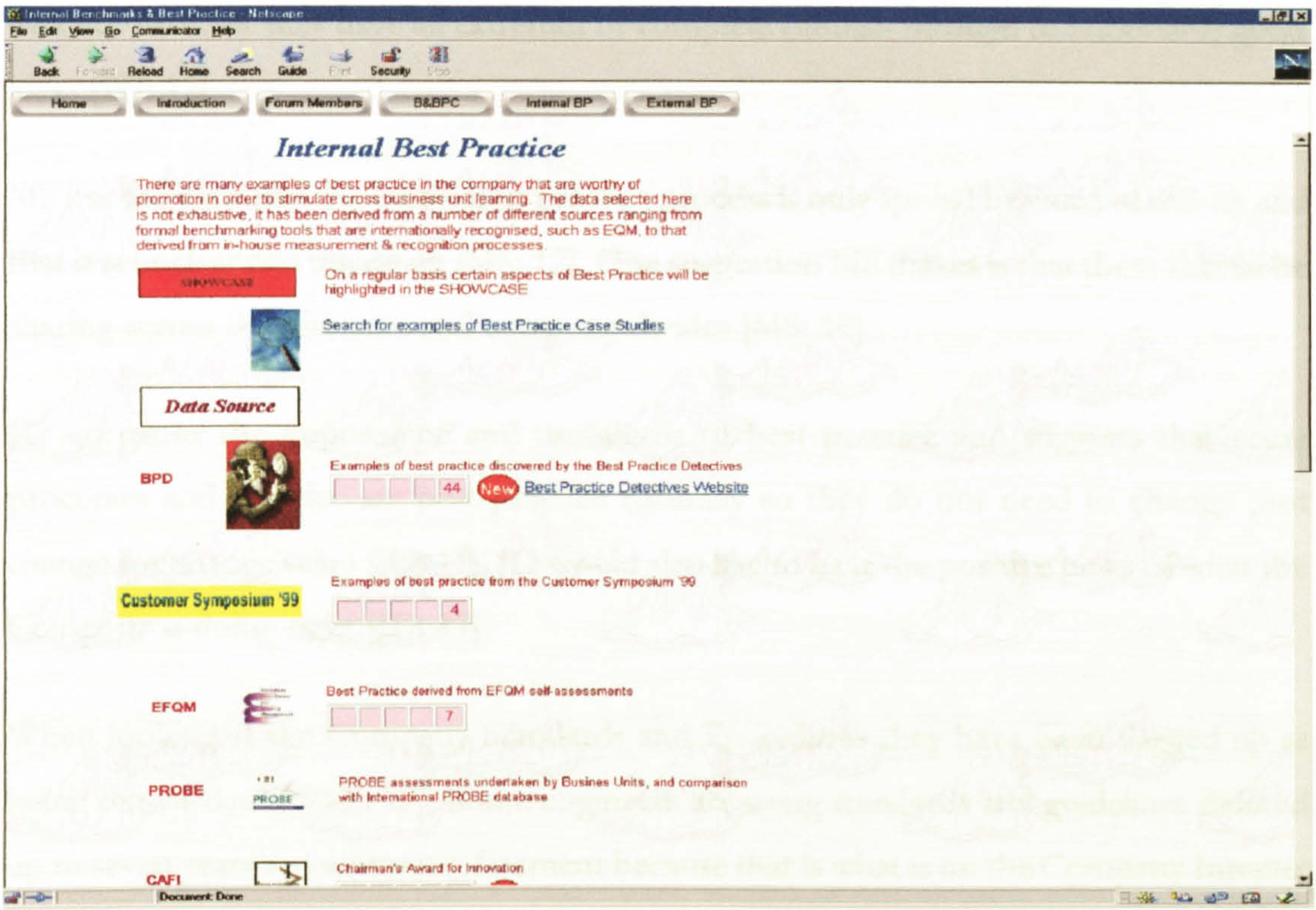


Figure 4-26: Example Internal Best Practice

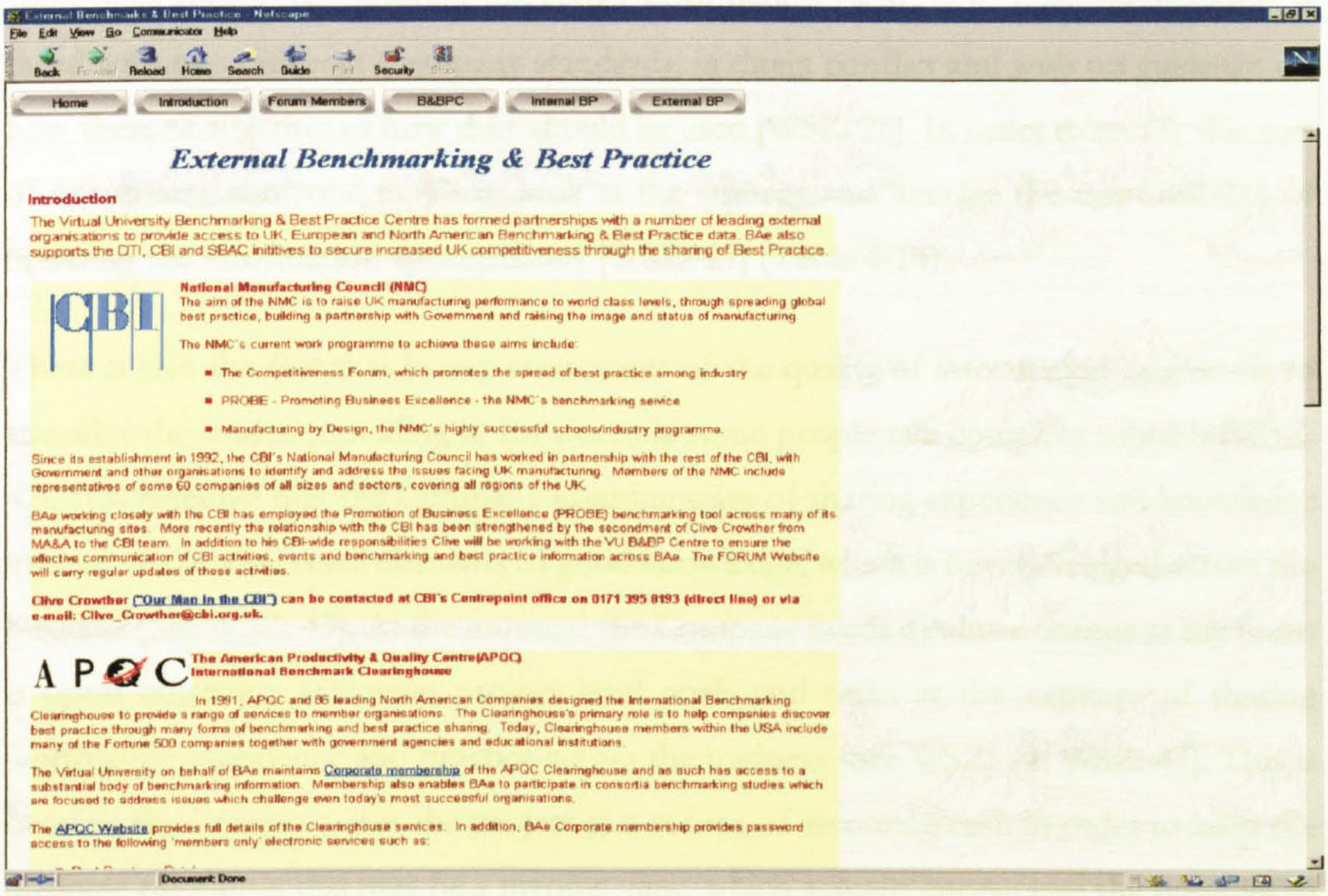


Figure 4-27: Example External Best Practice

(c) Engineer Views

SN suggests that Best Practice is another good idea, which has failed to be implemented at the engineering level of the Company [SN: 15; See also: MS: 11; MS: 12]. Best practice needs to be encouraged around the Company [WJ: 12]. At the moment the so-called Best

Practice Intranet sites have all extremes of complete rubbish through to reasonably good ideas [WJ: 12].

MS has the view that the whole best practice process is only spread by word of mouth and that it is unclear and uncertain [MS: 12]. One suggestion MS makes is that there should be sharing across the divisions and company divides [MS: 12].

JD questions the importance and usefulness of best practice and suggests that some processes and practice are best practice naturally so they do not need to change (not change for change sake) [JD: 17]. JD would also like to hear the positive news of what the Company is doing right [JD: 17].

When looking at the Company Standards and Procedures they have been flagged up as being out-of-date [WSZ: 22]. Some engineers are using standards and guidelines defined up to seven years ago without refinement because that is what is on the Company Intranet [WSZ: 24]. Then when there are new standards, procedures and guidelines introduced on some sites they in fact conflict the earlier information [WSZ: 25]. Then the engineer is faced with two different Company standards, in direct conflict and with no guidance on how these sit together or how they should be used [WSZ: 26]. In order to rectify this sort of occurrence someone needs to look at the strategy and manage the responsibility of updating the information appropriately [WSZ: 27] (Table 4-14)

There is also the fact that in any assessment of the quality of information one needs to consider the source providing it, for example some people talk complete rubbish [WSZ: 42]. It is essential that the Company examine ways of sharing experience and knowledge instead of allowing small elements of good knowledge, which is never divulged across the business [See WSZ: 43]. At the moment the Company needs a culture change as the focus is upon engineers achieving project level goals and tasks at the expense of sharing worthwhile experience and practice across the business [See WSZ: 44; WSZ: 47]. This is because the Company sees the project as a source of incoming cash in order to keep the business running – this may be a myopic view, which actually encourages the business to work less effectively and less efficiently.

"A lot of the problem is not about locating the knowledge we have but applying the knowledge that already exists. The gap between knowing and doing is quite a big one in this company" [WSZ: 47].

The whole view on process from a Company perspective appears to be that a process shows someone how to do something. But if blindly followed with no reasoning or analysis of particular situations people do not learn the principles and can be quite sceptical about the benefits of the process [See WSZ: 45]. Without continuous improvement a process can become extinct. The Company needs to re-evaluate processes adopted and make changes as necessary. See WSZ's comments below: -

"*I believe people in this company want easy answers, they want one process to solve all their problems so that they don't have to think, so that they don't have to solve problems but that's not going to happen. It shouldn't happen because then everyone would be working doing something that's never going to change in a dynamic environment and you'll soon be left behind*" [WSZ: 46].

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
14.1	The Best Practice ideas are not being re-used in the Company	Both	If some best practice is good then the Company needs to communicate it and link people to those who used it in the first place.
14.2	People fail to enter anything on the sites	Both	Employees may need encouragement and motivation to do this. Perhaps guidelines should be presented to aid people too. There are many sociological reasons why people fail to share information.

Table 4-14: Best Practice Problem Areas Summarised and Analysed

Expert Groups

(a) Description

The Company has identified a number of experts within the divisions. These individuals have been given the title 'Domain Experts' and this group is used across all the projects on the Christchurch site. These people within the group were identified by several means including the number of years service they have in a particular domain, or because they wanted to attain a technical role which was more senior. The company has a career path for those wishing to become a domain expert. These individuals also promote and assist with Technology Group meetings. These meetings take place in an ad hoc manner but always during the lunchtime period on the site – never in working time.

(b) Manager Views

The statement made by DR [DR: 21] implies that there are no common sources of expertise within the Company. DR also states that there is a lack of visibility of such experts so it's difficult for employees to know whom to ask. This is an issue that requires resolution. There are a fairly small number of employees in a group known as 'Domain

Experts' and these are mainly more senior members of staff with expertise in larger technological areas like Tactical Communications or Networks. There are no lists of contacts neither on the Christchurch site nor, to my knowledge, any lists of contacts at other sites that are experts in one area or another. The Technology Groups were meant to facilitate the meeting of such experts and a place where ideas could be exchanged. In reality some of the groups rarely meet, others have been disbanded since the division of the Company into its respective divide ready for the BAE SYSTEMS/AMS merger and split of the business. In my early months with the Company I attended two Technology Groups and found they had little direction or vision as to why they existed let alone any exchange of knowledge and experiences. At that time I felt no one was driving the group with any motivation and determination towards some goals. I would have liked to see some facilitation of the meetings such that the group were driving their own outcomes from it. This aspect is only one aspect of the expertise within the Company, the other is that a list of contacts who have a set level of skills should be made available throughout the Company for short and long-term needs in the business. Some people just need to ask an expert how to set up a file, or how to operate a particular product or similar and there appears to be no point of contact to do this sort of thing. Also with the recent changes in the way the Company has been divided up most people on one or other side of the division are not prepared to share information unless it is paid for in both time and effort by the person requiring the assistance.

Another extremely relevant point raised by DR [DR: 22] is the fact that the managers do not know the expertise of their own staff. Networks of knowledge normally develop through social circles and employees finding out for themselves who the experts are. My experience is that these groups seem to form at an engineering level when related to technical issues. This is a reality across the Company in my own experience; I have seen several people declared as being some sort of expert when in fact they have to ask other members of staff because they do not know. I have also experienced the fact that some members of staff have incredibly more expertise than others but they are totally unrecognised in their field by managers in their project. It is true that by working with people we can get to know their expertise and specialist knowledge but there are many ways the Company can overcome this issue. This issue will be addressed in more detail later in this thesis.

(c) Engineer Views

LM suggests that these groups need focus in project areas [LM: 3]. Some see the current technology groups as being of little value to them [WJ: 9]. It is also suggested by LM that the technology groups get stale if there is no commercial drive [LM: 3; WG: 22] (Table 4-15)

TA believes that the Technology Groups are a good forum however; the business does not appear to support these very well [TA: 7; SN: 12]. SN suggests that the engineering community should have support for attending these during working hours rather than in their lunch times or after work [SN: 12]. SN continues by suggesting that if in working time the engineers will only go if they have a keen interest in the subject. SN also states that the Company should encourage the engineers to develop their knowledge in technology [SN: 12]. This kind of thinking is along the lines of creating communities of practice (Dixon, 2000; Tiwana, 2000; Gladstone, 2000; Wenger, 2001). The Company should encourage the engineering community to learn, grow, and develop but also to form networks and share that knowledge within the Company.

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
15.1	No common sources of expertise within the Company	Manager	Managers and other engineers need to be able to contact and raise issues with the appropriate experts within the Company
15.2	Lack of visibility of the experts	Manager	Managers and other engineers need to be able to contact and raise issues with the appropriate experts within the Company
15.3	No contact mechanisms for experts	Manager	Managers and other engineers need to be able to contact and raise issues with the appropriate experts within the Company.
15.4	Managers fail to recognise and determine the expertise of their own staff	Manager	This is a fundamental failing throughout the company. If this continues then staff will become disillusioned, they will not be adequately rewarded and will be likely to leave.
15.5	Technology groups have little value	Engineer	If engineers see little value in their own technology groups then the groups need to be re-evaluated and the engineering community needs to be able to express its opinion of what it expects from such groups to the higher management.
15.6	Technology groups poorly supported by the Company	Engineer	Poor motivation and company backing will hinder the sharing of knowledge and expertise throughout the Company (Constant et. al. 1993)

Table 4-15: Expert Groups Problem Areas Summarised and Analysed

Skills Database

(a) Description

The Skills Database was developed in 1998 to hold the details of employees' skills across the Company for resourcing and training purposes. It contained generic fields in the areas of academic qualifications, professional achievements, training courses, work experience and other experience. The attributes associated with each database entry included: the date of the award/achievement/course; the awarding body/organisation/supplier/institution; the level/grade/scope; the title; the role/post/responsibility; the duration and a description.

(b) Manager Views

Having entered my own details into the Skills Database in early 1999, I found it took me about six hours to fill it out and to navigate a very unwieldy interface. I agree with RD's comments in his view of the front end (i.e. the interface). I also found that the levels were unclear and in assessing whether I had achieved a certain level it was not distinguished whether this could consist of academic experience, some academic and some practical experience, or purely practical experience of the skill. Also because the skill levels were hard to distinguish I felt that I entered my skills with my subjective discrimination and biases that may have been totally different from another co-worker with the same level of expertise filling out the Skills Database. Also speaking to other people in my department and project, most people had felt it was too complicated and difficult to fill in. One common theme from the interviews with managers is expressed here by DR [DR: 23]: -

DR: 23 "The skills database was rolled out some time ago and it did not work very well because the front end on it, the means by which people put their information in was not easy yes. People tried it out and found it to be quite tortuous and difficult and time consuming so they gave up on it"

There are many aspects that could have been introduced to the Skills Database, which would have enhanced its usefulness. For example, there are no references to the personal and relational skills of the employee. There are no Belbin or similar categorisation, which would be useful to a manager searching the database. Neither are there any cross-references to the employee's career aspirations and desires or to their Personal Development Plans and SMART objectives and no reference to their Staff Dialogues either. Also there was no view as to who should be updating the Skills Database and how the entries were to be validated once entered by the employee.

ST [ST: 30] suggests that the skills database cannot collectively store all kinds of information together e.g. the social factors. I would argue that the database could be a source of current data on an individual's skills as a starting point from which other knowledge should be added through social interaction. It is unlikely that a skills database would be the sole tool on which to appoint a new recruit and that an interview and references would be added to that information in order to make an appropriate selection. This Company skills database did, however, lack a great deal of other useful sources of information, which may also have added to its value to those using and contributing to it.

[ST: 30] 'Not least whether these people get along and mesh as a team. That being one of the values of using an existing team because you know how well or otherwise that they work. And you can't capture all of that on the skills database"

In some cases the Skills Database was not even filled out by whole sections of the Christchurch site and DR [DR: 24] states that some managers did not sponsor it. DR as a manager himself found that he did not fill it out and gave up on it [CB did not use it either CB: 16]. In this case the half attempt to complete the database is of very little value to the business and based on my earlier comments on the validity of the entries makes it very questionable. On looking at the raw data I noticed that one employee had entered that he had a degree in 'Nose picking' and this was not invalidated on entry or removed over eighteen months later.

Another valid issue raised by DR [DR: 24] is the ownership and availability of the information on the Skills Database. If the database is accessible by all members of staff then problems arise with regard to privacy and especially when people are given pay rises or grade rewards. Others may look at the personal information and raise problems or issues if they are not getting the same kinds of rewards as staff with the same qualifications and experience. RD also mentions the fact that he believes the company does not have an honest and open culture yet.

HD [HD: 6; See also CB: 17] shows that there is an inadequate level of skill description in the Skills Database and very specific skills concerning specific software packages or tools are not captured. This is also verified in HD's statement [HD: 8]. It would complicate the interface even more and make it an even longer task for employees to fill it in if a further level was added. This is a problem that needs to be addressed in some way in order for the Skills Database to be of value to the business more specifically.

Continual updating of the Skills Database, like other Company databases, is another issue. HD [HD: 7] raises this factor. The situation HD describes is the reality of the situation in October 2000 since the database has not been updated by those who filled it in during 1998-9 and those that did not fill it in at all have still not completed that task either. This makes the Skills Database a disused and obsolete storage of out-of-date knowledge and information. HD [HD: 9] recognises that individual's may object to their data being available and may be concerned about who has permission to see that data. This may be an issue which employees feel is important as information on pay scale, grade or salary as well as education and experience could cause infighting amongst staff as jealousies may develop.

(c) Engineer Views

The past attempts to create a skills database have been particularly unsuccessful [WJ: 11]. Such a database could be useful but is influenced by these previous unacceptable attempts to create a good tool [MD: 8; See also: MS: 14; WJ: 11]. However, the data in it needs to be maintained [EL: 7; WSZ: 22; WSZ: 23] and perhaps there should be an automated updating facility associated with any such database [TA: 9]. MS is surprised by the lack of commitment by the management to develop a good skills database [MS: 15].

'When you are talking about perhaps a 1000 engineers just having a database of information at a level that everybody's at the experience they've got the types of project they have worked on is an administrative nightmare just keeping that information fresh' [WSZ: 22].

"And despite this company having a huge administration infrastructure the information in the records that it holds is frequently out-of-date because people don't really take responsibilities" [WSZ: 23]

Another aspect that requires attention is that employees should be encouraged to buy into it as something of benefit to them not just for the management [WJ: 11]. There should also be links to the training an employee requires and the data in the skills database [WJ: 11] (Table 4-16)

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
16.1	No verification	Manager	The data requires verification e.g. based on qualifications – see certificates. This is a lot of work to get a proper baseline.
16.2	Grading structure subjective	Both	There were no clear guidelines of what constituted a particular level of expertise. There should be a time scale or educational or both equivalent for each level.
16.3	Lack of full skills coverage	Manager	The skills listed needs re-visiting as some areas were too detailed and others too high level. Some others were not included at all.
16.4	Poor interface usability	Both	Interface unwieldy and difficult to track where a user is in the program. Long convoluted process to fill in just one single skill. Poor design.
16.5	No link to other aspects of career development	Both	A comprehensive view would contain this information and a link to other documentation.
16.6	Ownership and visibility of information	Both	Confidentiality is important. Levels and types of access were not determined
16.7	Poorly defined skills	Both	Lack of clear guidance in some cases regarding exactly what is meant.
16.8	No buy in by employees and no positive company support	Both	There was a lack of completed individual skills data throughout the trials. The Company managers were not actively encouraging employees to fill it in.
16.9	Data maintenance	Both	Who will keep the data up-to-date once it is at a baseline? The method for doing this needs to be easy to achieve and not as time-consuming as the original database was.

Table 4-16: Skills Database Problem Areas Summarised and Analysed

Other Sources of Information Discussed

Communication and Team Briefs

(a) Description

These are usually communications in an explicit format that get passed on to all employees. They are normally used to brief all staff about issues such as mergers, acquisitions, closures, redundancies, new senior management and senior appointments in the business.

(b) Manager Views

RD raises the issue that he does not think this works very well [RD: 1] and he adds that it takes a lot of his time since he receives so many [RD: 2]. This suggests that the mechanism for passing on the information is not working as efficiently as it could and perhaps this needs to be examined by the Company. More recently some of these briefs have been flowed out by e-mails [CB: 1; CB: 3]. However, from my own perspective this is not working very well as I get the same brief via three different members of staff. This gives me a problem as these e-mails normally carry attachments and they overload my e-mail facilities. As a manager who needs to deal with more important issues e-mail overload is an issue for my being able to work effectively.

Another aspect RD raises [RD: 3] is the fact that the briefs do not come with priorities or distinguishing markers to help him filter them effectively and therefore use his time efficiently. I have had same problem whilst working on the Sampson project whereby I receive e-mails relating to the Cowes site facilities or football match or similar but I work in Christchurch. My project belongs to the Cowes division of the Company but I am not interested in everything that happens at Cowes as I do not work there on a permanent basis. If this comes by e-mail then it should be filtered or flagged to be effective.

RD [RD: 4] is overloaded with the data he is sent and this gives rise to inefficiency in his time spent reading it. If he misses things that he should have passed on then his subordinates are not happy he hasn't passed them on. But on the other hand he has too much data to deal with [RD: 5]. RD [RD: 5] is obviously unhappy with the current mechanisms for dealing with this data. Also because of the time spent trying to deal with the communication and team briefs RD is not able to do other aspects of his job as well as he would like [RD: 6; RD: 9].

RD states in his interview that he is expected to know at a higher level what is happening in the steering groups but that the data that he is given is pretty poor [RD; 11]. RD [RD: 12] also does not find the time to read all the material he gets sent day by day and finds he had to skim read whatever he could. RD [RD: 12] feels that this does not give him the quality time to be effective in his role. RD also states that he has a human filter to read his e-mails [RD: 13] and incoming literature whilst out of the office in order to cut down the amount he has to read effectively. However, I would think that this may not be as effective as sorting it himself and important pieces of information can still get missed.

(c) Engineer Views

The two types of briefs: corporate and local get different views by the engineering community. Engineers suggest that both briefs types are too long [CL: 5; WJ: 8; JD: 11] and can be boring or dull [EL: 4; WS: 6; SN: 9; SN: 11]. These briefs are seen as not being very useful [SN: 10; MS: 7; WJ: 8] and can be frustrating [MS: 7].

Engineers suggest that the corporate briefs seem so far removed from their actual day-to-day roles that they are of less value [CL: 5; LL: 11; MD: 5; MR: 6; OJ: 7; JD: 12]. Corporate briefs are viewed as giving a false view and being unrealistic by LL [LL: 12; JD: 12]. LL would like to hear a truthful view of the corporate situation [LL: 12; JD: 12]. They are also seen as a one-way communication to the engineers [MS: 8].

Local briefs are viewed as more relevant and informative [CL: 5; MD: 4; MR: 6]. But some see these as adding very little value suggesting that the information be available on the Intranet for employees to access if they want instead [TA: 6; SN: 11] (Table 4-17)

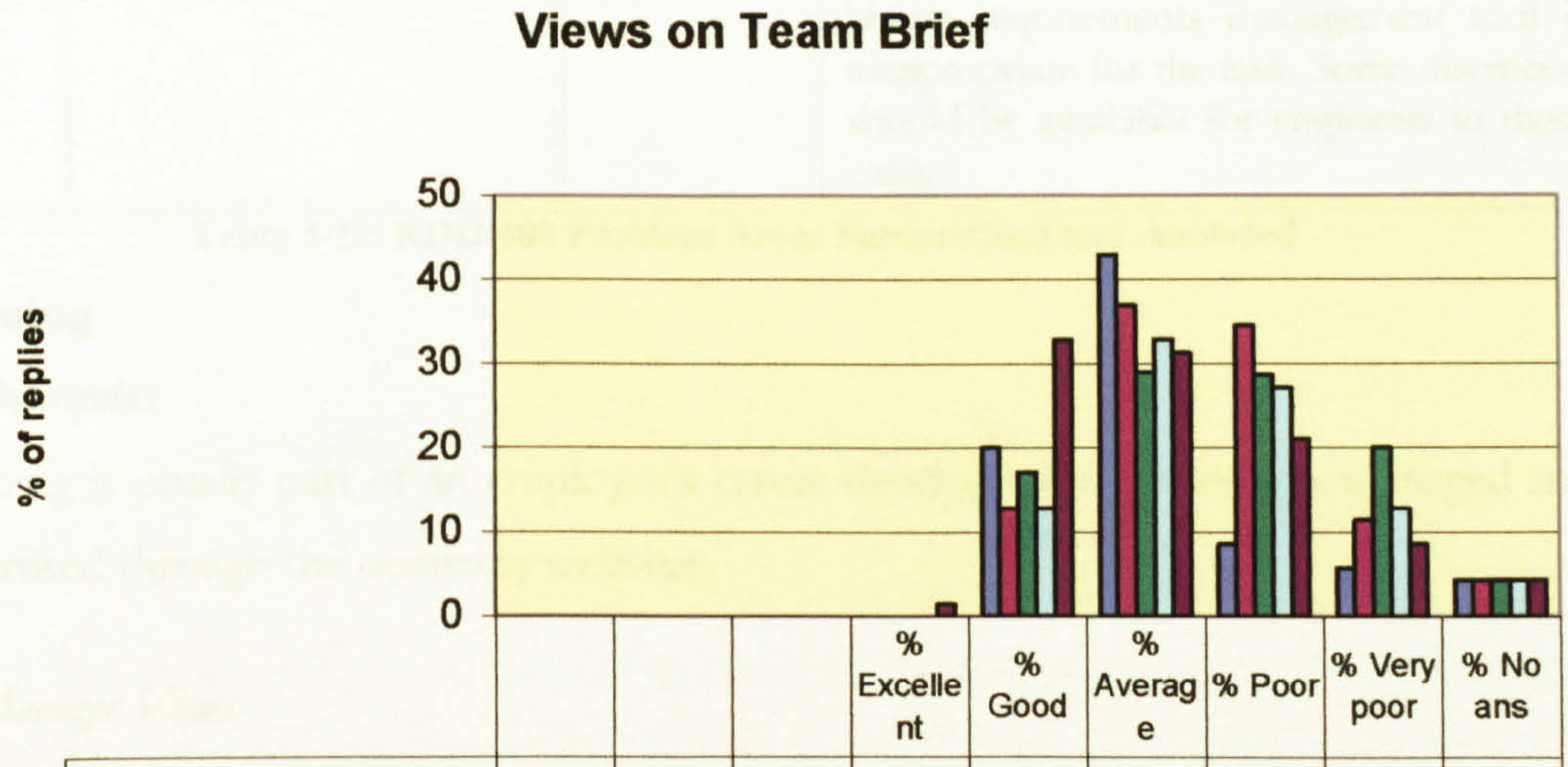
"I find it easier to get the information I want from those lower down the tree. Even with the project constraints. As I go up the chain I find the information is harder to get and becomes more vague and woolly and generally more useless…."[WSZ: 49].

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
17.1	Difficulty in filtering what needs to be announced for particular audiences	Manager	Subjective level of what individuals think is important to hear – can be difficult to get the balance right.
17.2	Too much information coming down to the manager in the first place	Manager	Managers don't want huge great documents to decipher, filter and disseminate. They don't have a lot of time to dedicate to these tasks. They just want to see what is relevant to their group and read that.
17.3	Briefs take far too long	Engineer	Subjective level of what individuals think. Should be tested in opinion surveys
17.4	They are boring	Engineer	Subjective level of what individuals think. Should be tested in opinion surveys
17.5	They are not valued	Engineer	Subjective level of what individuals think. Should be tested in opinion surveys

Table 4-17: Team and Corporate Brief Problem Areas Summarised and Analysed

The 2001 Employee Opinion Survey indicated the following areas (Figure 4-28). The results here show that more people are happy (20%) with the timing and frequency than unhappy (14.3%) and the main opinion is that in the average group (42.9%). This would suggest that the frequency about right. However, when we look at the content of these briefs there is a distinct view that the content is not good or right since 47.9% are unhappy with the content which is far greater than those happy with the content (12.9%) or even giving an average view (37%). This is an issue that needs to be addressed and agrees strongly with the content of the interview data above. The same trend exists for the opinions of the quality of the information in the team brief (i.e. 48.6% unhappy, 29% average and 17.1% happy). This is also raised in the interview data and requires further investigation and a resolution. Exactly the same trend is visible for the relevance of the team brief to the employee and is likely to be related to the quality and the content factors already addressed by the survey (12.9% are happy with the relevance, 32.9% average acceptance and 40% are unhappy with it). Once again this issue was raised in the interviews too. Finally the presentation of the team brief gets a reasonable split of scores with 34.3% satisfied, 31% giving an average score at 29.7%, roughly a three-way split. This aspect is not so much of an issue that needs resolving immediately. It may be possible to allow the different employee views to allow the delivery of the brief in a different manner for each. This would need further investigation in order to see what options could be considered.



	% Excellent	% Good	% Average	% Poor	% Very poor	% No ans
a) Frequency/ timing	0.0	20.0	42.9	8.6	5.7	4.3
b) Content	0.0	12.9	37.0	34.5	11.4	4.3
c) Quality of info	0.0	17.1	29.0	28.6	20.0	4.3
d) Relevance/ Usefulness	0.0	12.9	32.9	27.1	12.9	4.3
e) Delivery/ presentation	1.4	32.9	31.3	21.1	8.6	4.3

Rating

Figure 4-28: BAESYSTEMS Employee Survey 2001 Team Brief Results

RDD 100

(a) Description

This is a Requirements Management tool used as a Company standard tool and it is mandated throughout the Christchurch site.

(b) Manager Views

Managers raised no issues on this subject.

(c) Engineer Views

Some engineers' feel that they have been forced into using company-standardised tools (Such as RDD-100) that did not fit the particular project they work on [RS: 8; RS: 9]. It was argued that this was political not technical [RS: 10] (Table 4-18)

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
18.1	Imposed toolsets can be a problem	Engineer	Not all tools are suitable for all cases. Sometimes the uniqueness of a project or the level of a project may mean a full blown requirements management tool is inappropriate for the task. Some discretion should be available for engineers in these cases.

Table 4-18: RDD-100 Problem Areas Summarised and Analysed

Training

(a) Description

Training is usually part of an employee's career development. Training is managed and advertised through the company websites.

(b) Manager Views

Managers raised no issues on this subject.

(c) Engineer Views

One engineer found that training advertised on the CWW was no longer available [RS: 1] and has not been available for a year [RS: 2]. However, it was clear that this training was a requirement yet the Company was not meeting it. Also, the training department was fairly limited in stock in some areas [WG: 13; WG: 14] (Table 4-19)

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
19.1	The data on the training websites were out-of-date	Engineer	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.
19.2	There is a limited stock in the training department	Engineer	This aspect has been reported to the Training Department for them to deal with.

Table 4-19: Training Problem Areas Summarised and Analysed

Company Standards and Documents

(a) Description

The Company has a website dedicated to the Military, International and specific internal Company Standards for documentation, software and hardware. This site gives employees access to the templates they need and the standards they need to follow whilst undertaking work for the Company.

(b) Manager Views

Managers raised no issues on this subject.

(c) Engineer Views

LM finds it difficult to identify the latest Company Standard or procedure at any point in time [LM: 6].

LL states that they feel that these standards and procedures are often outdated and so he does not use them [LL: 16].

CL on the other hand realises the usefulness of having company standards but states that the company has too many and a lot are out-of-date [CL: 8]. The implication here is that these standards are of little use unless these issues are remedied (Table 4-20).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
20.1	Out-of-date data	Engineer	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.
20.2	Finding the right information	Engineer	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.

Table 4-20: Company Standards Problem Areas Summarised and Analysed

Role Description and Scope of Job

(a) Description

Most companies have a set of defined roles and associated tasks and responsibilities accompanying them. The Company only has a subset of this information and this is not used when assigning roles to individuals.

(b) Manager Views

Managers raised no issues on this subject.

(c) Engineer Views

The interview data states that most employees do not have a proper written role description or terms of reference [CL: 11; EL 10; EL: 11; TA: 11; LL: 20; WS: 10; MD: 12; SN: 16; MS: 17; MR: 9; OJ: 8; WJ: 19]. LM confirms that he has no written role description or responsibilities for his position but does have some views on his own role and responsibilities [LM: 6; See also: LL: 20; WS: 10; MD: 12; SN: 16]. EL intimated that he would like guidance in this area [EL: 10; SN: 16; MR: 9] and appropriate training [EL: 11; EL: 12]. EL believes that the Company is reluctant to provide that training [EL: 12; EL: 13]. TA states that he finds having no proper written terms of reference for his role is a problem [TA: 11; OJ: 8]. SN expresses a similar view by stating that without having a proper role his career path ahead is uncertain [SN: 17].

Another view brought out in the interviews is the fact that staff change roles frequently and the job they were working on is left high and dry [WSZ: 34; WSZ: 35].

To get a better picture of the problems involved in the Company not providing a proper role and responsibilities description I use the follow accounts of two engineers' interviews.

Example 1:

WG suggests that there was a lack of clarity between himself and his line manager as to his role [WG: 2; WG: 11]. When WG asked for a clear written role description he was informed it did not exist [WG: 6; WG: 12]. This situation gave rise to problems in WG knowing what was expected of him short-term and long-term [WG: 7]. WG therefore made assumptions about his duties and responsibilities [WG: 8]. WG had a preference to know his change of role earlier than he did in practice allowing him to prepare and understand the role [WG: 9]. He also suggested that mentoring in such a new role may have helped on hindsight [WG: 10].

Example 2:

WSZ stated that upon joining the Company he received very little direction and his brief was extremely simple [WSZ: 1]. The role and responsibilities were never really tied down [[WSZ: 2]. His superior never expanded on the original one-liner statement of the role even though WSZ has been back and asked for both direction and further clarification [WSZ: 3]. WSZ felt the description was pretty intangible from the outset [WSZ: 3]. WSZ's boss did not want to clarify or direct WSZ in this role [WSZ: 4]. The only direction given provided WSZ with an unacceptable outcome [WSZ: 5]. WSZ feels isolated in this role and feels that a team structure and freedom of feedback from within that team would help the Company to resolve the issues that form part of his role [WSZ: 50]. WSZ thinks that feedback and exchanging views would help him to clarify his views, gain confidence and do a better job [WSZ: 50] (Table 4-21)

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
21.1	No proper role and responsibilities available	Engineer	This makes the employee's life a little difficult when trying to develop a career path; or being unable to determine what is or is not within his responsibility; or being able to get adequate training for that role in areas in which he is deficient.

Table 4-21: Role Description Problem Areas Summarised and Analysed

SAP

(a) Description

SAP is a database application that lies at the centre of some of the main infrastructure within the Company. It is used to store training information, when people attend any form of training, details of qualifications and other such activities. It was also used at the core of the development of the original Skills Database.

(b) Manager Views

BJ [BJ: 2] also discussed the use of another database product used on site, SAP, which is used to extract the costs used on projects, resources booking to various elements of that project and the like. BJ is concerned that in his role he feels that he needs to know a more up-to-the- minute picture of spending because he wants to isolate problems earlier on in a project than waiting until a month has passed by. SAP is the tool used to monitor the spending on a project and it allows the users to see what each resource on their project is doing on a weekly basis. SAP is only up-to-date if the Managers' resources fill out their Weekly Timesheets regularly, this should be at the end of each week but from experience I have seen it out-of-date by as much as four weeks. In order to be valuable to a project the SAP required data must be up-to- date; if it is not, this will affect the Managers' view of the project and the calculations for Earned Value Analysis.

(c) Engineer Views

SAP is a laborious and not very instinctive tool [MS: 13; RW: 18; RW: 22]. It can also be long-winded, time-consuming and has poor usability [RW: 18; RW: 19; RW: 22]. It is also easy to forget the methods of getting and putting the data into SAP even after training [RW: 19]. SAP can also contain incorrect or misleading information [RW: 20; RW: 21]. But SAP does contain important information, which could be used more effectively [MS: 13] (Table 4-22).

(d) Comparison and Summary

Item	Issue Raised	Manager/ Engineer/ Both	Perception
22.1	Data is often out-of-date	Manager	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.
22.2	Poor usability	Engineer	Usability is an issue raised across several applications discussed in this research. This issue will be given serious investigation during the pilot phase of the thesis.
22.3	Incorrect/ misleading information in it	Engineer	Data is only good if entered correctly. Human errors need to be captured and corrected to make any tool useful.

Table 4-22: SAP Problem Areas Summarised and Analysed

Analysis overview

This section deals with the analysis of the data collected during this first research cycle and as such there are some important points relating to the validity and reliability of this data that include:-

(a) Every interview was carried out in the same room, with the same equipment and same environment

(b) The same single question was asked at the beginning of every interview without change

(c) No leading questions or further questioning was undertaken throughout the interviews in order to allow the participants to say as much or as little as they liked about whatever aspects they felt were important.

(d) Because it was stated throughout the process of data collection that all names would remain anonymous and confidential, and that the data would not be used for any other purpose than to assist the research, this delimited the necessity for interviewees to provide heavily biased data as they gain nothing.

(e) The staff interviewed are all either professional managers or engineers within BAE SYSTEMS Ltd.

(f) By interviewing thirty candidates in proportional representation, and extracting the key problems raised using NVivo there is a reduction in the amount of bias

These points have clarified the substance of the data collected and analysed during this phase. As a result this cycle has successfully identified twenty-two sources of information required by managers and/or engineers to carry out their current jobs: -

1. Resource Planning Module
2. QUEST
3. Newsgroups
4. Company Wide Web (including search engine technology)
5. World Wide Web
6. E-mail
7. Electronic Project File
8. Lessons Learned Log
9. Timesheet Entry System
10. Estimating Metrics
11. Private Venture
12. Communication with Others

13. Culture
14. Best Practice
15. Expert (Technology) Groups
16. Skills Database
17. SAP
18. RDD-100 tool set
19. Team briefs
20. Training
21. Company Standards and documentation
22. Role description and scope of job

Each of the areas identified raised different views and perspectives of the problems encountered by either a Manager, or an Engineer or both. These problems are captured at the end of each section in the previous chapter in order to identify key concerns. The clustering process used in NVivo, together with the output results, is stored in Appendix E of this thesis. The key clusters were formed once some searches of the data were carried out using NVivo and these are captured in Table 4-23. Each set (A-G) is a node in NVivo and contains the problem areas identified in column two – the detail of these examples can be traced to other sets that have been discussed earlier in this chapter and are cross-referenced to the specific table numbering in column three.

ID	Generic Identified Problem Areas (themes)	Table ID and Item No
A	Data is out-of-date. Inaccurate data due to lack of data maintenance.	2: 3; 4: 4; 10: 2; 11: 3; 16: 9; 19: 1; 20: 1; 22: 1
B	Time-consuming process. Not enough time to find information due to time constraints. Long-winded, time-consuming processes.	1: 2; 3: 5; 4: 8; 5: 2; 6: 6; 7: 7; 7: 5; 9: 2; 10: 4; 16: 9
C	Usability Issues. Tool is not intuitive. Poor user interface. Tool not easy to use. Poorly displayed material.	1: 3; 2: 2; 4: 5; 7: 1; 9: 1; 11: 4; 16: 4; 22: 2
D	Difficult to find/locate information or data. Poorly structured data/information. Not easily navigable. Illogical structure of information/data.	1: 4; 3: 2; 3: 1; 4: 3; 4: 7; 4: 8; 7: 6; 7: 7; 7: 3; 11: 4; 20: 2
E	Too much information/data. No filtering available. Information overload.	4: 1; 17: 2; 21: 1
F	Lack of visibility of experts/expertise. No commonly identified experts/expertise.	15: 1; 15: 2; 15: 3; 15: 4
G	Misleading or incorrect data.	4: 6; 2: 3; 1: 6; 9: 3; 16: 7; 16: 1; 16: 9; 17: 1; 22: 3

Table 4-23: Generic Problem Areas Raised from Cycle 1

NVivo is a powerful qualitative analysis tool and was used to code various nodes and each one was used for a number of searches in order to create sets of data for use when analysing and drawing conclusions from the findings of these sets of data. There is a detailed explanation of the use of NVivo and the type of analysis carried out in Appendix E.

4.4 Summary

This chapter has brought together a considerable amount of interview data, which has been used to identify problems faced in the information systems and applications adopted by the Company. In the overview analysis these problems have been generalised into specific problem areas using NVivo. In examining the tables in Appendix E the next step of the research will reflect upon this cycle and then examine how to move on into cycle two. In the next chapter consideration is given to the potential of technology in resolving the issues that were raised in this cycle.

WHERE ARE WE NOW AND WHERE ARE WE GOING?

5.1 Introduction

This cycle takes the findings in cycle one and identifies the problem areas that could be resolved using software agents. This technology is described and given consideration at this stage in order to delimit the areas of further research for this cycle. The chapter continues from the cycle one findings as a starting point. References are also made and other pertinent secondary data introduced into this research. Another aspect of this chapter is the analysis of the particular words used in the first cycle of the research. These have been categorised as positive, negative or neutral and were carried out using coding techniques in the NVivo tool as well as statistical analysis using SPSS (Version 10).

This is then followed by explicit investigation into three areas of extended research, which are then discussed in the light of their suitability for the pilot study involving software agents in cycle three. The areas given consideration arose from the evaluation made in this chapter. The three areas of further investigation are presented in their own right and are (1) private venture (i.e. managing knowledge assets) (2) e-mail and (3) resource management.

5.2 The Scope of the Technology

The whole realm of software agents is at the forefront of the technical literature at this time and the claims of the usage and the capability of this emerging technology makes them an area for consideration for this thesis. The literature provides much in terms of the potential for software agents, however it provides fewer examples of true exploitation of this functionality. In examining the scope and literature at this point I explore the possibility of software agents for the resolution of some of the key problem areas discovered in cycle one. Therefore this section deals with an exploration of the literature surrounding software intelligent agents as well as examining the available definitions before drawing upon this material for application to this research cycle.

5.2.1 The Origin of Software Agents

Artificial intelligence (AI) has had many definitions over the many years the term was coined (Russell & Norvig, 1995) and Ramsay (1996). There are several capabilities (See Table 5-1) associated with intelligent behaviour:

Many of the past attempts of technology to substantially perform all of these capabilities are failures. Even in today's ever increasing technically capable market there are only partial breakthroughs in meeting these intelligent behaviours. However, there has been a real growth in the availability of software which can offer a much more intelligent system than past attempts.

ID	Capability /Characteristic	Reference(s)
1	Learning or understanding from experience	Cope (1998); Garratt, (1987); Hedberg, (1981);
2	Making sense of ambiguous or contradictory messages	Anjewierden & Weilemaker, (1992);
3	Responding quickly and successfully to a new situation	Barron, (1993);
4	Using reasoning to solve problems and direct actions effectively	Russell & Norvig, (1995);
5	Dealing with complex situations	McKenna, (1999);
6	Understanding and inferring in ordinary, rational ways	John, (1995);
7	Applying knowledge to manipulate the environment	Cope (1998); Turban , et. al. (1999);
8	Recognising the relative importance of different elements in a situation	Devlin, (1999)

Table 5-1: Capabilities Associated with Intelligent Behaviour

Knowledge is used in AI systems because knowledge provided by experts in a situation can be collected, organised and reused by the system in what is known as a knowledge base. Here, for example, information can be interpreted and understood, thereby converting it into knowledge that can be used.

According to Kaplan (1984) AI can provide organisations with commercial advantage because of the permanence of AI – since employees can take their knowledge with them once they leave an organisation, whereas if captured in an AI system it holds permanence. AI also offers easy duplication and dissemination, which is a scalability issue across both local and global organisations (Genesereth & Nilsson, 1987). Thirdly, it can be less expensive e.g. it may be more cost effective to let the AI system do a repetitive job than employ a human being. AI is also very consistent and thorough, for example it doesn't have emotional ups and downs and perform badly some days (Fikes & Nilsson, 1971; Georgeff & Lansky, 1987). It can also be documented enabling all of the AI system decisions to be recorded and documented for future analysis (Russell & Norvig, 1995). This all sounds well and good, but what about the disadvantages as compared with the use of human intelligence? Firstly, people are creative whereas systems are pretty much uninspired mechanisms, which do not think 'outside of the box'. Secondly, humans acquire knowledge but AI systems must have all of that knowledge available or input into them. However, there have been more and more breakthroughs in the reasoning elements of AI systems over approximately the last three years. Humans use direct natural sensory perception of their environment; whereas AI systems must use sensors and interpret that indirectly first. People use their natural ability to gain awareness of how things fit together, e.g. spatial awareness, relationships between items etc. but this is quite a complex characteristic for AI systems to develop. Humans can use a wider appreciation of the context of information and data and apply their reasoning to it and enable application of that knowledge to some other situation.

AI technology is used in many types of systems and applications, for example, expert systems, robotics (Etzioni, 1993), fuzzy logic systems, natural language processing (Turban, et al., 1999; Fass & Cercone, 1992), neural networks (Kasabov, 1993; Wang, 1994; Haykin, 1994), software agents (Genesereth & Ketchpel, 1994; Nwana, 1996; Bradshaw, 1997) and virtual reality (Turban et al., 1999). Not all of these areas require discussion in this thesis, as the area of agent technology is the one utilised as part of the solution. The main areas of AI covered by this thesis are expert systems (Harmon & Sawyer, 1990), fuzzy logic (Burkhardt & Bonissone, 1992; Cox. 1992; Cox. 1994; Wiig, 1997b) and robotics. Expert systems are artificial intelligence systems that attempt to imitate human experts. Due to the knowledge and information capability of these systems they are often most successful in narrow or refined areas of expertise (Harmon & Sawyer, 1990). The prerequisites for creating such a system include extrapolating the knowledge from the experts and inputting it to the system (Eriksson, 1996). Then any other individual with a specific question in this domain can use the system to help him with that problem or decision. The system normally contains an inference engine (Harmon & Sawyer, 1990; Stroulia & Goel, 1994; Turban & Aronson, 2001) and often enables the logic for the decision to be made available to the user. If several sets of expert information are added to the system then this may result in a clearer set of guidelines for the user and can provide a more reasoned decision. This performance can prove better than seeking the advice of one human expert in isolation.

5.3 Software Agent Technology

Roots of AI are in psycholinguistics, sociolinguistics, computational linguistics, adaptive systems, cognitive psychology, philosophy, philosophy of language, logic, robotics, image processing, pattern recognition, management, mathematics, statistics, operations research, management information systems and biology (Cercone & McCalla, 1984; Tuthill, 1990).

The main root of software agent technology lies particularly in the background of robotics. A robot is an electromechanical device that can be programmed (Turban et al., 1999; Russell & Norvig, 1995). Robots are normally used to automate manual tasks in order to improve productivity. Not all robots use AI technology. Robots with AI capabilities normally have more functionality than being programmed to do a task. For example, they have sensors which are used to collect data from their environment, which is used to perform other activities based on how that data is interpreted. Software agents are sometimes termed softbots, because they are not electromechanical devices but perform tasks like a hardware robot. Early research in the area of softbots investigated and used knowledge from the robotics research (Etzioni & Weld, 1994).

The term 'agent' was developed in mid-1950 where it was envisaged that a system would be able to give and get responses in a human format (Kay 1984). This system would complete tasks set by interacting with a human, as necessary, but with the anticipation that once it learned something it wouldn't need to ask again for the identified task completion (Kay 1984).

Although the obvious range of agent technology has vastly increased, with it has come a lack of clarity as to what a software agent really is. In some cases the terminology has been applied to top selling commercial products claiming the ability of learning by software, which underneath is little more than a rule-based truth table. Here repetitive tasks carried out by the User of a computer package can be automated (Boy 1991, Maes 1997) but this is not true agent technology. The definitions and characteristics of software agents will now be discussed in more detail here.

5.4 A definition

There are many definitions of software agents and knowledge-based systems that relate to their purpose in specific types of systems or to the perceptions of such systems. A few of the most commonly used ones in the literature are discussed here.

"Intelligent agents are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of the user's goals or desires" (IBM Agent, White paper)

In this definition the whole concept of 'user's desires' gives me difficulty in that those reading such a definition may have a high expectation of what a software intelligent agent could achieve for them. In fact the technology is not fully mature and can give users only an abstraction of their 'desires'. Knowledge representation is a way of expressing the real world through some representation (Wiig, 1994b) of it and at the moment it is not possible to develop a true expression of the real world through agent technology alone. I can quite easily accept that agents can carry out operations on a human-beings part, however it does not offer the holistic view of decision-making offered by a human brain.

Software intelligent agents can also act with some degree of independence but in this case humans can be reticent to utilise them without trusting those decisions being made on their behalf (Brustoloni 1991).

"Autonomous agents are systems capable of autonomous, purposeful action in the real world" (Franklin 1995, pp.265)

In this definition the focus is on the autonomy of agents and it is correct to state that this is possible. However, as discussed in other areas of this chapter, the fact that agents can offer far more capability and autonomy is not necessarily the factor of greatest importance to a user. This aspect is important to me in the development of the demonstrator and will be given some attention. But I do feel that an agent doing all the work behind the scenes may not be the most appropriate and accepted mechanism from a user's point of view. Users like to be involved and communicated to by the application in order to feel that they are a part of what is being done (Nielsen, 1993).

"Software agents are programs that emerge in dialogues and negotiate and co-ordinate transfer of information" (Coen, 1994).

Software intelligent agents are capable of communication (Bradshaw, 1997; Baumann et al 1997; Finin et al., 1994) and co-ordination (Ciancarini & Rossi, 1997; Jennings, 1993) when transferring information. However, contrary to Coens' (1994) statement, I believe that agents do not have to communicate or negotiate to perform automated tasks for a user. Once again the focus here is upon one aspect of software agent capability. Agents are very good at transferring information but they can also have the greater powers of reasoning and inferring knowledge from information they have access to and this is a greater strength for some applications. Virdhagriswarans' (1998) describes agents from two perspectives: on the one hand they provide autonomous behaviour and on the other they are able to carry out domain-oriented reasoning. The autonomy issue has already been discussed above but the reasoning within a specific domain is another aspect that deserves some attention. The ability to intelligently evaluate what is happening in a domain has potential for use in software agent systems. In order to do this there are levels of 'intelligence' which are unlikely to be met, for example the full ability of human intelligence – there appeared to be no mention of any current software technology proclaiming this ability in my literature research. I believe that to be able to create a small amount of reasoning and intelligent behaviour requires a well thought out design and associated rules with which to govern the decision-making of such a system.

Importantly Smith et al (Smith et al., 1994) concentrate upon the view that agent persistence distinguishes them from simple subroutines. They also state that agents have a defined goal but they do imply that agent applications are much smaller than ordinary multifunctional applications. Advocates of the mobile and distributed multi-agent environment (Bredin et. al., 1998; Brooks, 1986; Chang & Lange, 1996; Chess et al., 1995; Coen, 1994; Haddadi, 1994) would suggest otherwise since in these domains several types of agents work together to achieve the specified task. Maes (1995) also agrees that agents have specific defined goals but also expects the agents to operate in a very complex environment where they will transform their actions dependent upon the changes taking place in that environment. Maes (1995) views imply that agents should be able in some way to sense what is going on around them. Russell and Norvig (1995) take this latter point further in that the agents not only sense what is occurring in their environment but that they can also affect that environment through what they term effectors. Hayes-Roth (Hayes-Roth 1995) takes the view that agents perceive not only the environment they are in but the changing dynamism of that environment as well. Hayes-Roth also agrees that agents affect their environment and goes further in the agents reasoning ability by advocating that agents perceive, infer and are intuitive. However, the ability of an agent to affect its environment may not be a requirement of every agent system (this is discussed later in this chapter).

Having looked at the tremendous amount of information on the definition of software agents I think that agents are software entities that can act on behalf of another to perform specific tasks to a reasonable level of execution. Agents can deduce and reason to a complex level but cannot currently attain a replication of human decision-making. They can also collaborate within groups of agents; they can collect, analyse and reason (at a pre-defined level of abstraction); they can filter and abstract information turning it into useful knowledge for the end-user. Software agents may come up with answers to questions we may have but that answer may not be the right one since human logic may not be the be-all-and-end-all and sociological factors, human instinct and intuition are not yet modelled in the software intelligent agent world.

5.5 The basic components of a software agent system

<u>A knowledge base</u> – the storage element of the agent system that contains the artificial intelligence algorithms, rules or fuzzy logic.

<u>A User interface</u> – the important element that allows interaction of the agent system with the User.

The agent(s) – the software mechanism used to locate, identify and bring information back to the User.

The Agent Architecture – the manner in which the system is designed to interoperate with the various architectural layers that makes up the system domain.

These components are a match to the definition of an expert system and to a certain extent this software agent application being developed could move into this domain. In this case the agent aspect is the equivalent of the inference engine of an expert system; the user interface is already part of both and the architecture and the knowledge base is all within the domain of the Company's infrastructure.

5.5.1 The recognised attributes of Software Agents

Several literature sources define sets of characteristics that are aimed at determining what aspects are usually found in a software agent application. See for instance Bradshaw (1997) and Caglayan & Harrison (1997) who between them isolate the following characteristics:

1. **Delegation**: the software agent carries out a task set (one or more tasks) for the user of the application (Caglayan & Harrison, 1997; Bradshaw 1997).
2. **Communications skills**: Interaction between the user and the agent in order to instruct, inform, update or provide the status of a task set (Caglayan & Harrison, 1997).
3. **Autonomy**: here direct intervention by the user is not necessary to fulfil a task set. The agent can in fact get on with the task set in the background. There are different levels of autonomy depending on the type of agent application (Caglayan & Harrison, 1997; Bradshaw 1997).
4. **Monitoring**: here the agent can monitor the environment so that it can fulfil its task set in an autonomous manner (Caglayan & Harrison, 1997).
5. **Actuation**: the agent uses its own specific actuation mechanism in order to affect its own environment so that it can operate autonomously (Caglayan & Harrison, 1997).
6. **Intelligence**: in order for the agent to operate autonomously it has to be able to examine its actions, interpret commands and respond by taking decisions (Caglayan & Harrison, 1997; Bradshaw 1997).

These characteristics are described by Caglayan & Harrison (1997) as the minimal requirements for a software agent but Bradshaw just states that these are some of the common characteristics. A great many of the applications currently on the market which purport to be software agent enabled would not meet this requirement set e.g. Microsoft Agent application. In my view this is a set that can be used to ensure that all of these characteristics have been investigated when developing a software agent application but they may not all be necessary for the specific application being developed. However, does that therefore mean that the application is not agent based? I do not think so. I think the minimal set that still defines a software agent system is the delegation feature, communication skills, autonomous behaviour (not necessarily without user interaction though) and some level of intelligence. The other characteristics could have potential depending upon the context where they are applied but do not negate a software agent application that does not have them. For example monitoring may not be necessary for an agent to complete a task intelligently on behalf of the user but could have immense potential in a network routing system requiring high levels of performance on behalf of the end-users. Secondly, actuation also refers to changing the environment around the agent and I feel that this is very specific to certain types of environment such as temperature-controlling an automated greenhouse application.

5.6 The Applicability of Software Agents

In this section the problem areas identified in cycle one are discussed in the light of the applicability of software agents to resolving these issues. Table 5-2 illustrates the extension of Table 4-23 found at the end of cycle one and shows the applicability of software agents to resolving each of the problems raised. All the issues marked with category K are potential areas for further investigation in this research. The reasoning behind the choice of applying the categories is also captured in this early part of this second cycle too. These areas will be discussed with a view to identifying a sub-set of three areas of further research that may be appropriate for the application of intelligent software agents. Software agent technology is a technique that can be used to develop a system whereby tasks can be automated intelligently giving the user the potential for a more effective completion of the tasks required (Mueller & Wooldridge, 1997).

ID	Generic Identified Problem Areas	Table ID and Item No
H	Software agents cannot resolve the issues raised. This could be people related or inherent in a particular application/tool that has its own proprietary rights etc. e.g. SAP, RDD-100 issues	1:5; 1:7; 2:1; 2:2; 2:3; 2:4; 3:3; 3:4; 3:5; 3:6; 4:2; 4:5; 4:6; 5:4; 6:2; 6:3; 6:4; 6:5; 7:2; 8:1; 8:2; 9:3; 9:4; 9:5; 9:6; 10:2; 10:3; 10:5; 11:1; 11:2; 12:1; 12:2; 12:3; 12:4; 13:1; 13:2; 13:3; 13:4; 13:5; 13:6; 13:7; 14:1; 14:2; 15:5; 15:6; 16:2; 16:8; 17:1; 17:2; 17:3; 17:4; 17:5; 18:1; 19:2; 20: 1; 20:2; 22:1;
I	Process issue that cannot be resolved by agents either immediately or in the future	1:7; 2:1; 2:4; 3:3; 3:4; 3:5; 3:6; 5:3; 6:1; 6:3; 6:4; 6:5; 7:2; 7:4; 8:1; 8:2; 9:3; 9:4; 9:5: 9:6: 10:2: 10:3: 10:5: 11:1: 11:2:

ID	Generic Identified Problem Areas	Table ID and Item No
		11:4; 12:1; 12:2; 12:3; 12:4; 13:1; 13:2; 13:3; 13:4; 13:5; 13:6; 13:7; 14:1; 14:2; 15:5; 15:6; 16:1; 16:2; 16:8; 17:1; 17:2; 17:3; 17:4; 17:5; 18:1; 19:2; 20:1; 20:2;
J	Software agents already exist for resolving such problems that can be purchased and used by the Company	3:3; 4:1; 4:4; 4:8; 5:1; 5:2; 7:3; 11:3;
K	Could potentially apply software agents to resolve this	1:1; 1:2; 1:3; 1:4; 1:6; 3:1; 4:3; 4:7; 5:1; 5:3; 6:6; 6:7; 7:1; 7:3; 7:5; 7:6; 7:7; 9:1; 9:2; 10:1; 10:14; 11:3; 15:1; 15:2; 15:3; 15:4; 16:3; 16:4; 16:5; 16:6; 16:7; 16:9; 19:1; 22:2; 22:3;

Table 5-2: Software Agent Applicability to Generic Problem Areas Raised from Cycle 1

In order to identify areas for further research several information sources have first been excluded together with adequate reasons for doing so. Examining the list of information sources the areas relating directly to human intervention and human communication have been excluded from further research. In this group, areas identified are the **team brief** and the **corporate brief**. Neither of these areas is appropriate for further investigation since the problems relate to the manner in which these are communicated and the content of them. The area of the Company **culture** is also excluded from the next phase of the research, as it is believed that it is not possible to resolve cultural issues through technological intervention. Because this is a soft sciences issue it requires changes on the part of the individuals within that culture. The area identified as **communication with others** also is a mechanism for ensuring that the employees concerned receive regular communication relating to the company changes and business developments or infrastructure changes. This is normally addressed at business presentations to the whole community and this apparently is not working as well as it could. However, this is once again unsuitable for a technical solution in the software agent field. The **Lessons Learned Log** is a good mechanism to encourage the understanding and knowledge of previous experiences in order to assist future projects in the Company. However, the publication of the log itself and a process for using it have never been completed. The content of the current log fails to provide sufficient information to assist other projects in any meaningful way and the web site is under-used. The main concerns in this area are not suitable for the application of software agents, as they are mainly process and cultural changes. Another similar area is that of **Best Practice**, where the aim is to create a suitable set of knowledge and information to help others within the organisation. In reality there are multiple Best Practice web sites, which is divisive in the business. These are purely sites competing with each other rather than a unified approach, which is co-ordinated. The Company is advocating all extremes of 'so called' best practice with no proper control or review of what is or is not acceptable. Some identified best practices are totally inappropriate and it is difficult to associate these with either 'best' or 'practice'. The problem areas are all concerned with the defining and running of an appropriate process and as such are incapable of resolution utilising software agents.

Other specific areas raised include individual tool sets for a specific purpose, for example **RDD-100**, which is used to manage software requirements. This tool offers several problems for staff, however by itself it is not possible to resolve these using software agents as any form of intervention or enhance the tool. The same reasoning is applied to the **SAP**, **QUEST** and the **TES** applications, which are for managing data in specific databases. Only one aspect of **QUEST** is added to the generic problems table above (See Table 5-2), which is the fact that data is often out-of-date. The **TES** application is also a unique application but it has cited two generic problem areas. The engineering community raised all of the TES problems, as they are the predominant users of this program. The other four problems relate to the physical application and its functional credibility and also cover inadequate training and a poor process. This latter group will not be considered for the application of agent technology as they are unable to be resolved using this medium. The SAP application tool raised three areas of concern, all of which are captured in the generic problem areas identified above (See Table 5-2). The **Electronic Project File** also falls into the category of a specific application with its associated interface, which is used for managing the project documentation. This application area raised seven problems of which four were extracted and included in the generic table (See Table 5-2). The engineering community who use the application regularly raised all of the issues. The managers only cited two issues that are the same as the engineers. This application requires a new process to provide items such as naming conventions in order to be more usable. However the use of software agents will not resolve the problem areas that are raised by this specific tool.

The WWW on the face of it may seem like a good potential area for further investigation. In Figure 5-1 the results of a survey carried out by Feher & Towell, (1997) suggest that the key area for using the WWW rank as a "source of knowledge" with the highest score of 70.21%. Although the area of the **CWW** (Intranet) and **WWW** could provide a place for an application using software intelligent agents for BAE SYSTEMS it is not one of the areas that will be researched in more detail since the main issues raised by the interviewees relate to: -

1. Finding the information they require

2. Data/information being out-of-date on the Intranet
3. No standards for displaying Company Intranet web pages
4. No clear hierarchy of documentation on the Company Intranet

In looking specifically at these problems, points three and four are not resolved by using agents but by the Company evaluating and changing the current pages available. Point one is an area where agents could solve the problem but there are plenty of software applications, both agent and non-agent based, which can resolve this issue. Also point one may be made easier if points three and four are satisfied. Finally, point two could be partially resolved by agent technology, although this is a broad field rather than resolving a specific Company problem raised by the interviews. Data or information that is out-of-date is a problem that is not confined to the WWW and the Intranet. For these reasons continued development of the research will not be carried out

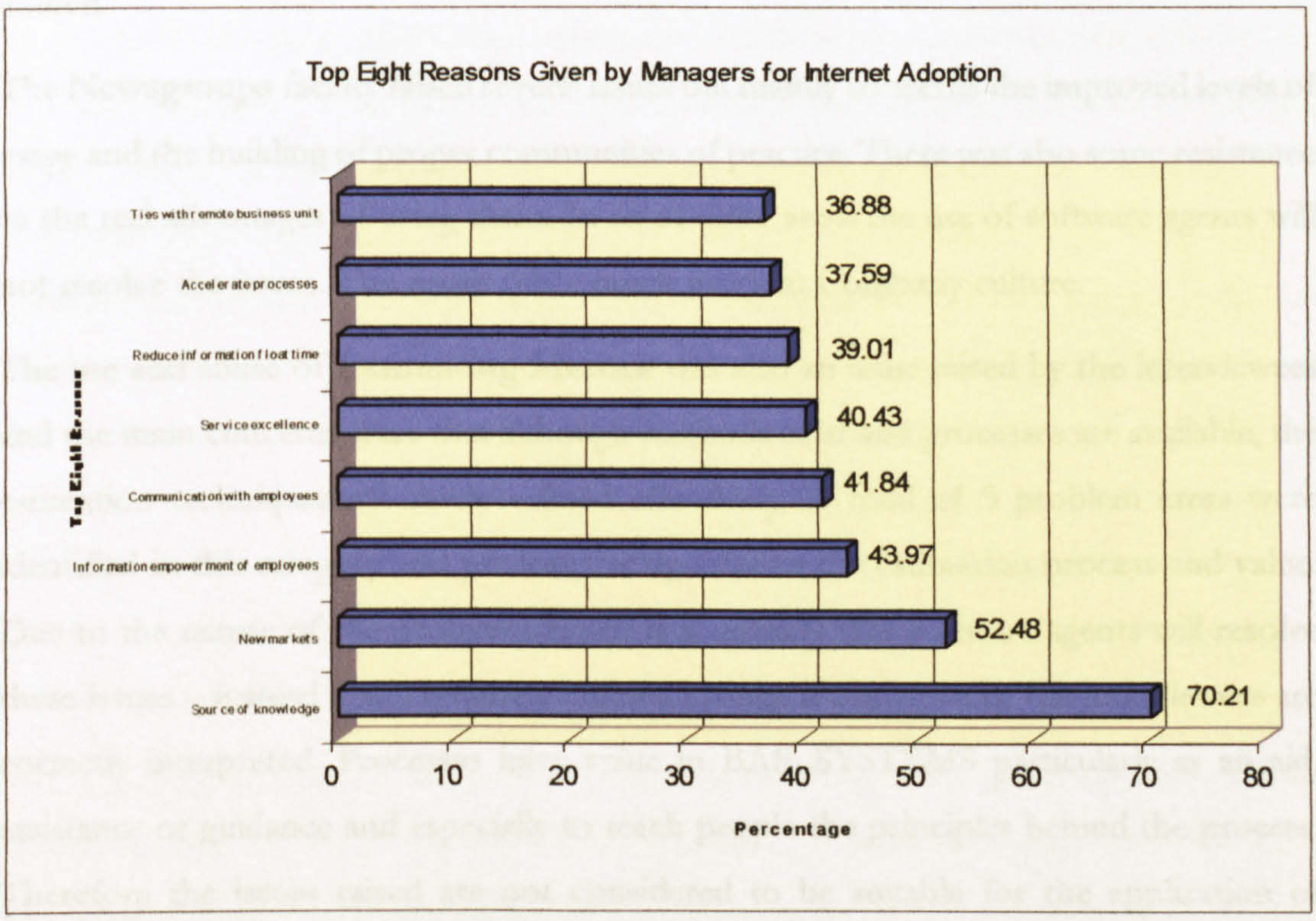


Figure 5-1: The Top Eight Reasons Given by Managers for Adopting the Internet

The **World Wide Web** has a tremendous amount of potential for intelligent software agents – particularly for searching the available material in a more succinct and efficient manner. However, a great deal of research is going on in this domain and there are many applications available to overcome the general problems such as searching the web. The issues arising from the interviews include physical connections and physical memory, which affect the service provided and these are covered through addressing the problems raised rather than applying the demonstration software to the web. From the researcher's perspective I have a preference to resolve a more integral Company issue in order to assist the Company in the management of information and knowledge. I can test this through experimentation and can reproduce the experiment later. Conversely, the World Wide Web is amorphous and growing daily and it will be difficult to test the technology in this domain. The same reasoning is applied to the **Company Wide Web**, which is in the same category. Although the software agents could be used to provide a better search facility there is little more that can be done since the main theme from the problems isolated is process related. The issues mainly relate to the process of creating suitable web pages, structuring these web pages in a manner, which makes them easily navigable, and ownership of the pages, thus promoting maintenance and updates leverage. Since creating and adopting a proper process can resolve these issues then the use of software agents is limited.

The **Newsgroups** facility raised several issues but mainly concerns the improved levels of usage and the building of proper communities of practice. There was also some resistance to the real advantages of using them. In all of these areas the use of software agents will not resolve the issues. The issues relate much more to Company culture.

The use and abuse of **Estimating Metrics** was also an issue raised by the interviewees and the main concerns were that although methods exist and processes are available, the estimation techniques are rarely utilised effectively. A total of 5 problem areas were identified in this category and predominantly refer to the estimation process and value. Due to the nature of the problems raised it is unlikely that software agents will resolve these issues – instead it will require a cultural change if the views of the interviewees are correctly interpreted. Processes have value in BAE SYSTEMS particularly as an aid, assistance or guidance and especially to teach people the principles behind the process. Therefore the issues raised are not considered to be suitable for the application of software agents and will not be considered further

The **Resource Planning Module** raised seven problem areas during the interviews (five raised by managers and two by both groups). These issues are predominantly relating to the detail of the tool itself. However, the elements that are generic (Items 1, 3-5) are captured in Table 5-2. This tool will not be specifically utilised in this cycle but the generic problems above will be continued in this research. Software agents will not resolve the unique RPM tool issues and could not replace this tool to a sufficient level to test or compare the two options within the thesis time constraints.

The **E-mail** facility raised three in six issues within the generic problem areas cited (See Table 5-2). The other aspects are unable to be resolved by the use of software agents since they are physical constraints of a sociological nature. The generic areas raised are suitable for resolution using software agents but the whole aspect of information overload, time-consuming and multiple receipts need further investigation before the use of software agents can be considered in more detail.

The area of **Private Venture** raised only four problem areas. All four areas are covered in the generic problem area table (Table 5-2). Having also been personally involved in the development of some Private Venture work and writing significantly as a reflective practitioner this area is considered to be suitable for further research. This domain includes the development of knowledge management assets and their distribution and usage within the Company. Therefore this aspect of the Private Venture will be examined in more detail within this cycle.

The **Expert Groups** cited six areas of concern and these particularly emphasised the fact that there is a lack of awareness of the expertise within the Company and who is really the expert. There are no measurements or records of expertise within the Company. The **Technology Groups** that are run within the Company fail to deliver what is expected of them and are regarded as being unsupported by management. The technology groups are meant to facilitate an expert technical community but the problems raised suggest that they are not achieving this. This aspect will receive some attention in cycle three as it is related to the technology applicability for the Company. However, most of these issues surround the social aspects of the Company and issues such as the culture and philosophy. As this is predominantly outside of the scope of the software agent technology it will be dismissed from further consideration in cycle two.

The **Training** area raised two problems. One is captured in the generic problems table above and the other is inapplicable to the area of software agents and has been communicated to the training department.

The area of **Role Description** raised one very crucial problem advocated by several of the engineering community. This problem could be an element of a software agent application and will be examined further in cycle three purely due to the fact that it is information that could be maintained and developed by agents.

The **Skills Database** raised nine problem areas, which are mostly captured in the above table. The employees interviewed are scathing of the interface and its usability, which they feel has made the application pretty poor. The database fails to achieve its purposes and has been inadequately designed. This whole aspect ties in neatly with the expert groups, role description and the RPM issues raised and could be partially addressed by the application of software agents. In this respect this cycle will further investigate the resource management aspects with some overlap into these areas. Secondly, the work in cycle three will examine the other issues of such applications to these broader domains.

NVivo was used to collate search results into nodes. Each of the terms identified in Table 5-3, Table 5-4 and Table 5-5 below was submitted into the NVivo text search engine in the identical format provided in column two. The search was to find the number of occurrences throughout the cycle one interviews (total of 30 documents). The search was requested to bring back 35 characters either side of the search phrase in order for me to see the context of the phrase in more detail. The searches returned were examined individually in order to remove irrelevant or incorrect ones according to the criteria of positive, negative or neutral e.g. if a search were carried out on the term "frustrated" for a negative response and returned " I was not very frustrated at all" this would be ignored for the occurrences recorded because the interviewee was "not" frustrated and I am trying to isolate the problems with the information.

Word searches were carried out across all documents including the interviews conducted in cycle one and the CDI Intranet. Survey The data was collected in sets so that further analysis could be carried out. The data was also imported into SPSS (version 10) in order to carry out statistical analysis.

The negative search criteria identified in Table 5-3 has a common grouping of similar issues as follows the categories **Out-of-date, Outdated** and **Not up-to-date** rank the highest with a total of forty identified occurrences within the interviews. This suggests a strong link with the data and the information being displayed as being of little value to the users and the weakest element of the systems they are using. Secondly the area of **Overloaded** and **Overload** reveal a total of thirteen occurrences, which implies that there is simply too much information and data. Next a group that references terms such as **Little relevance, Irrelevant** and **Superfluous** which accounts for another thirteen occurrences. This score is equal with the previous one and suggests that the information and data received is often of little value. The issue of the right information getting to the right individual is something that will be continued in the thesis research. Next the group **Frustrating** and **Frustrated** account for six occurrences and relate to the way the user feels about the identified information or application. It is understandable for the user to feel this way if the information is out-of-date and often irrelevant and if he is getting the wrong information. These terms are then followed by the group **Not easy to use, not**

very intuitive, **limited use**, **poor interface**, **not very user friendly** and **poor usability** which all relate to the area of what a user will see on an application or an interface. In this group there are ten occurrences and this will be addressed in this research. The final two groups relate firstly to the **time-consuming** effort, **takes time** as well as **not enough time** – which cites three occurrences and relate to the fact that if users are overloaded with information they often do not have enough time to deal with it all. Finally, the concept of **can't find**, **cannot find** and **not easy to find** account for three occurrences and relate primarily to the view that users are unable to find information through the application search facilities.

ID	Word Search	Manager Transcripts	Engineer Transcripts	Total Number of Occurrences
N1	Out-of-date	4	16	20
N2	Outdated	0	2	2
N3	Not up-to-date	1	2	3
N4	Overloaded	1	2	3
N5	Overload	2	4	6
N6	Little relevance	0	1	1
N7	Irrelevant	0	2	2
N8	Superfluous	0	1	1
N9	Frustrating	5	5	10
N10	Frustrated	5	1	6
N11	Not easy to use	0	1	1
N12	Not very intuitive	0	1	1
N13	Limited use	0	1	1
N14	Poor interface	0	0	0
N15	Not very user friendly	1	2	3
N16	Poor usability	0	0	0
N17	Time consuming	2	3	5
N18	Takes time	0	1	1
N19	Not enough time	0	0	0
N20	Can't find	1	2	3
N21	Cannot find	0	1	1
N22	Not easy to find	0	1	1
N23	Cannot locate	0	0	0
N24	Hard to find	0	3	3
N25	Difficult to find	4	5	9
N26	Impossible to find	0	0	0
N27	Old boys network	0	0	0
N28	Old boys	0	0	0
N29	Political games	0	0	0
N30	Political	2	3	5

Table 5-3: Negative Search Criteria from Interviews

When examining the differences between the Managers' and the Engineers' views there are very few discrepancies between their concerns. The Managers' top issues are in the areas of being (1) frustrated with the applications, the (2) data being out-of-date and the fact that they are both (3) overloaded with information as well as having (4) difficulty in locating the really relevant material from amongst it all. The Engineers are most concerned about the information being (1) out-of-date, secondly (2) frustrated because of this, and equally concerned about (3) finding the right information and being (4) overloaded with too much information. The differences are recorded in the correlation graph shown below which illustrates that both groups are largely in agreement about what they see as issues (See Figure 5-2 and Appendix F).

The positive search criteria are captured in Table 5-4 above and illustrate the areas, which the interview candidates identified as good when they discussed the applications they use to get the information they require. In this case although there are thirty-seven word search criteria identified the searches revealed that only twelve were found amongst all the interviews. The main areas identified in a positive manner by both Managers and Engineers are firstly the area of **up-to-date** information that cites twelve occurrences (a lot less than the out-of-date option from the negative table) together with **the latest information is available** with five occurrences. These references are mainly concerned with the information available of the CWW news pages and the top level CWW page. These pages are under the control of specific members of staff and also include an agent technology application for updating the news. This makes these two occurrences very different from the other CWW websites, which are stated as being particularly poor in the negative comments at interviews. The general terms **is very good, is better, is clear** and **is easy to understand** relate to some aspects of unique applications with the more simple interfaces. However, these interfaces are later identified as having other problems e.g. TES which is cited as easy to understand but is difficult to use. Once again the correlation, which shows little difference between the two groups, is illustrated in Figure 5-3 (See Appendix F).

ID	Word Search	Manager Transcripts	Engineer Transcripts	Total Number of Occurrences
P1	**Up-to-date**	12	22	33
P2	**The latest information available**	0	0	0
P3	**Is always up-to-date**	0	0	0
P4	**Is excellent**	5	0	5
P5	**Is clear**	1	1	1
P6	**Is concise**	0	0	0

ID	Word Search	Manager Transcripts	Engineer Transcripts	Total Number of Occurrences
P7	**Is easy to understand**	0	0	0
P8	**Is very good**	3	5	8
P9	**Is good**	11	4	15
P10	**Is relevant**	5	4	4
P11	**Is easy to use**	0	0	0
P12	**Everyone has access**	0	0	0
P13	**Is a nice simple application**	1	0	1
P14	**Time saver**	0	1	1
P15	**Time saving**	0	0	0
P16	**Is efficient**	0	0	0
P17	**Optimised**	0	0	0
P18	**Good communication**	0	4	4
P19	**Is not too bad**	0	2	2
P20	**Is a good source of information**	0	1	1
P21	**Is a good idea**	2	4	6
P22	**Is useful**	8	2	10
P23	**Is helpful**	0	0	0
P24	**Is positive**	0	0	0
P25	**Is very interesting**	0	0	0
P26	**Is beneficial**	0	0	0
P27	**Is open**	3	1	4
P28	**Are open**	0	0	0
P29	**Is honest**	0	0	0
P30	**Are honest**	0	0	0
P31	**Is better**	1	0	1
P32	**Is stronger**	0	0	0
P33	**I don't have a problem with**	0	1	1
P34	**Good culture**	0	1	1
P35	**Is very useful**	1	1	2
P36	**Quite comprehensive**	0	1	1
P37	**Essential tool**	0	1	1

Table 5-4: Positive Search Criteria from Interviews

ID	Word Search	Manager Transcripts	Engineer Transcripts	Total Number of Occurrences
NT1	**CWW**	12	59	71
NT2	**Company Wide Web**	4	3	7
NT3	**Company-Wide-Web**	0	0	0
NT4	**Intranet**	76	5	81
NT5	**Company Intranet**	0	1	1
NT6	**Resource Planning**	11	2	13
NT7	**RPM**	45	11	56
NT8	**Resourcing**	12	3	15
NT9	**Resource**	99	14	113
NT10	**Resource planning module**	3	1	4

ID	Word Search	Manager Transcripts	Engineer Transcripts	Total Number of Occurrences
NT11	**Newsgroups**	38	44	82
NT12	**Internet**	30	29	59
NT13	**WWW**	1	37	38
NT14	**World-Wide-Web**	1	1	2
NT15	**World Wide Web**	0	1	1
NT16	**TES**	3	17	20
NT17	**Timesheet entry system**	1	1	2
NT18	**Timesheet**	4	4	8
NT19	**QUEST**	6	6	12
NT20	**E-mail**	66	68	134
NT21	**Outlook**	7	4	11
NT22	**Database**	90	73	163
NT23	**Size estimation**	0	1	1
NT24	**Estimating**	3	29	32
NT25	**Metrics**	10	11	21
NT26	**Estimating metrics**	0	4	4
NT27	**Skills database**	27	16	43
NT28	**Skills**	55	25	80
NT29	**RDD**	19	0	19
NT30	**EPF**	0	16	16
NT31	**Electronic project file**	0	5	5
NT32	**Project file**	8	10	18
NT33	**Lessons learned log**	0	11	11
NT34	**PV**	17	6	23
NT35	**Private venture**	2	1	3
NT36	**Venture funding**	0	0	0
NT37	**Communications with others**	0	4	4
NT38	**Communication**	74	38	112
NT39	**Communication with my boss**	0	0	0
NT40	**Communication with my superior**	0	2	2
NT41	**Best practice**	29	16	45
NT42	**Expert group**	2	0	2
NT43	**Domain expert**	9	0	9
NT44	**Expert**	32	7	39
NT45	**Team brief**	25	37	62
NT46	**Local brief**	0	2	2
NT47	**Corporate brief**	0	10	10
NT48	**Corporate briefing**	0	0	0
NT49	**Nature of the company**	0	0	0
NT50	**Company culture**	0	3	3
NT51	**Culture**	13	14	27
NT52	**Internal politics**	0	0	0
NT53	**Telephone**	15	16	31
NT54	**PDP**	6	0	6

ID	Word Search	Manager Transcripts	Engineer Transcripts	Total Number of Occurrences
NT55	**Personal development plan**	2	0	2
NT56	**Company standards**	0	11	11
NT57	**Company regulations**	0	0	0
NT58	**Company standard documentation**	0	0	0
NT59	**Company guidelines**	0	0	0
NT60	**Company processes**	1	0	1
NT61	**Processes**	20	15	35

Table 5-5: Neutral Search Criteria from Interviews

The neutral search criteria identify sixty-one items, which were used to isolate areas of most concern or most usage by the two groups. This search identifies the main categories as (1) the **CWW**, which cites 172 together with company wide web (158), company-wide-web (135), intranet (118) and company intranet (104) – these give a grand total for this domain area as 687 occurrences. This is a key area of concern for both the Managers and the Engineers. Most of the comments surround generic problem areas but the fact that the CWW is a valuable source of material when users need to get information is clear. However, the issues raised relate to the key negative areas, which were raised earlier. The work on Intranet technology and use of software agents is an area already deeply researched. A great deal of more recent work has surrounded the 'portal' technology utilising agents. Because the CWW problems are all included in the table of generic problems raised they will be addressed. However, the CWW is too difficult to recreate for the purposes of a software agent application due to its size and complexity. To try to run a pilot on the WWW or the CWW without causing considerable upheaval to the Company is simply not practicable. It would be necessary to have copied the Company Intranet and to be able to access to a lot of the CWW environment. In this timescale it was an impossible task to achieve. Therefore the CWW will not be used further in cycle two.

The next area of concern is the **Resource Planning Module**, which with the **resourcing, resource** and **RPM** searches contains 357 references. This area is considered to be a candidate for further research and ranks second in the statistics illustrated.

References for the **Internet, WWW, world-wide-web** and **world wide web** total 156 but for the same reasons as the CWW option this area will not be examined further. The area of the WWW is already a booming subject for research and creating software agents and a reasonably high amount of software has already been developed in this area. Search engines are now often agent-based and can provide the user with more intelligent searches – but it is debatable whether these meet all of the identified criteria of software intelligent agents (identified in Chapter 6 of this research) Both the WWW and the CWW areas seem ideal as an area for the application of agent technology. For example, searching and finding what the user wants and possibly maintaining the data are both key contenders for agent applications. However, they are unsuitable in this thesis for the reasons identified above.

Next the **timesheet entry system** accumulated 88 references; the **estimation and metrics** attained 63 mentions; the **Newsgroups** scored 47; **e-mail** scored 45; the **skills database** and **electronic project file** had 21 references each; **private venture funding** was cited 14 times and finally **communication** scored 10. There is very little difference in most of these categories between the scores of Managers and Engineers. The following correlation graphs were developed using the above tables of data (See Table 5-3, Table 5-4 and Table 5-5). All three sets produced significant results. This suggests that both Managers and Engineers have related concerns about how information is both presented and distributed within the Company. The data was organised in ascending order for analysis purposes and the negative or positive direction of the correlation is irrelevant because the allocation of a number to the search criteria was arbitrary and had no relationship to the content. All statistical analysis was done using SPSS v10 (See Appendix F for output results).

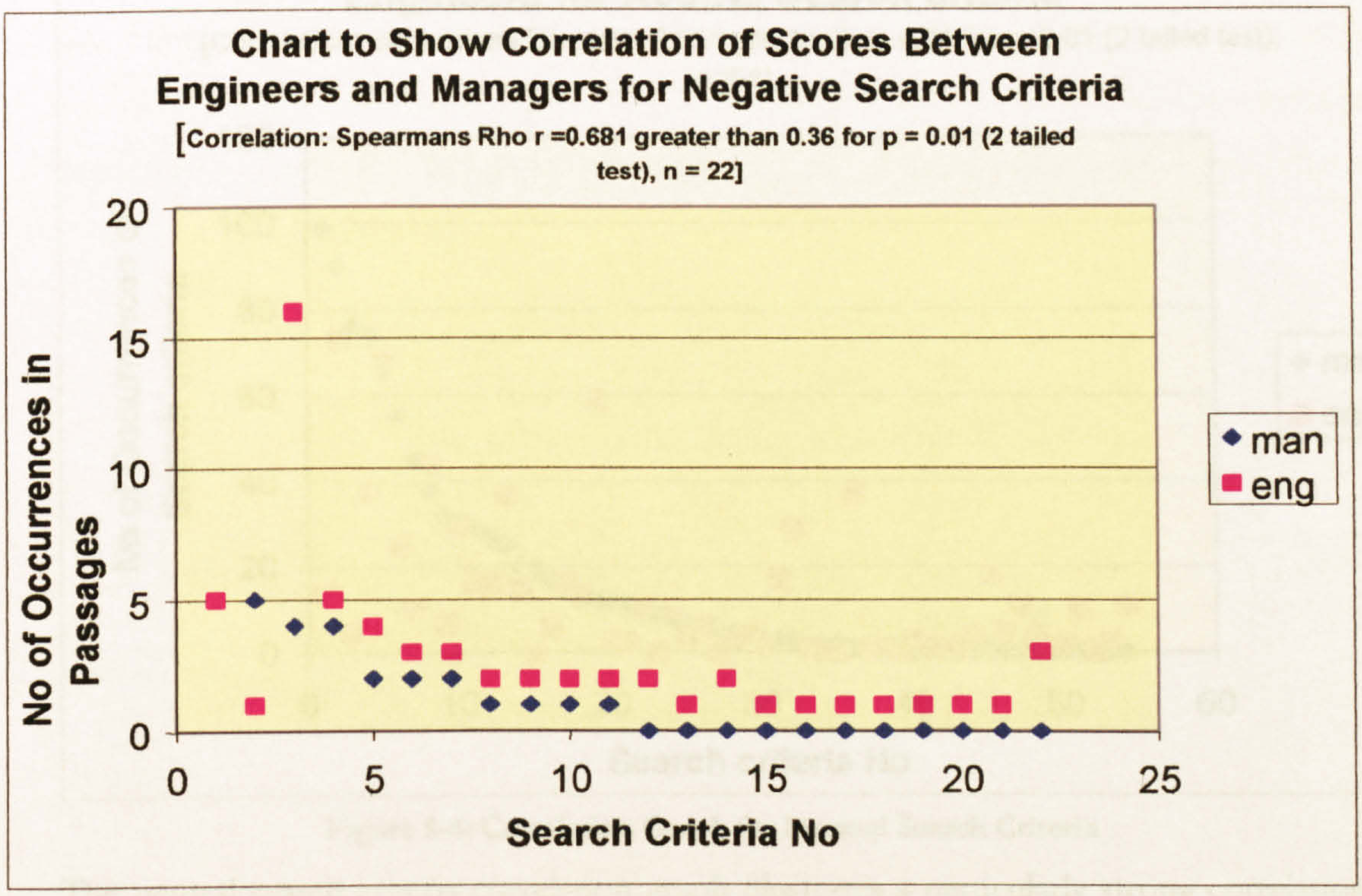


Figure 5-2: Correlation Graph for Negative Search Criteria

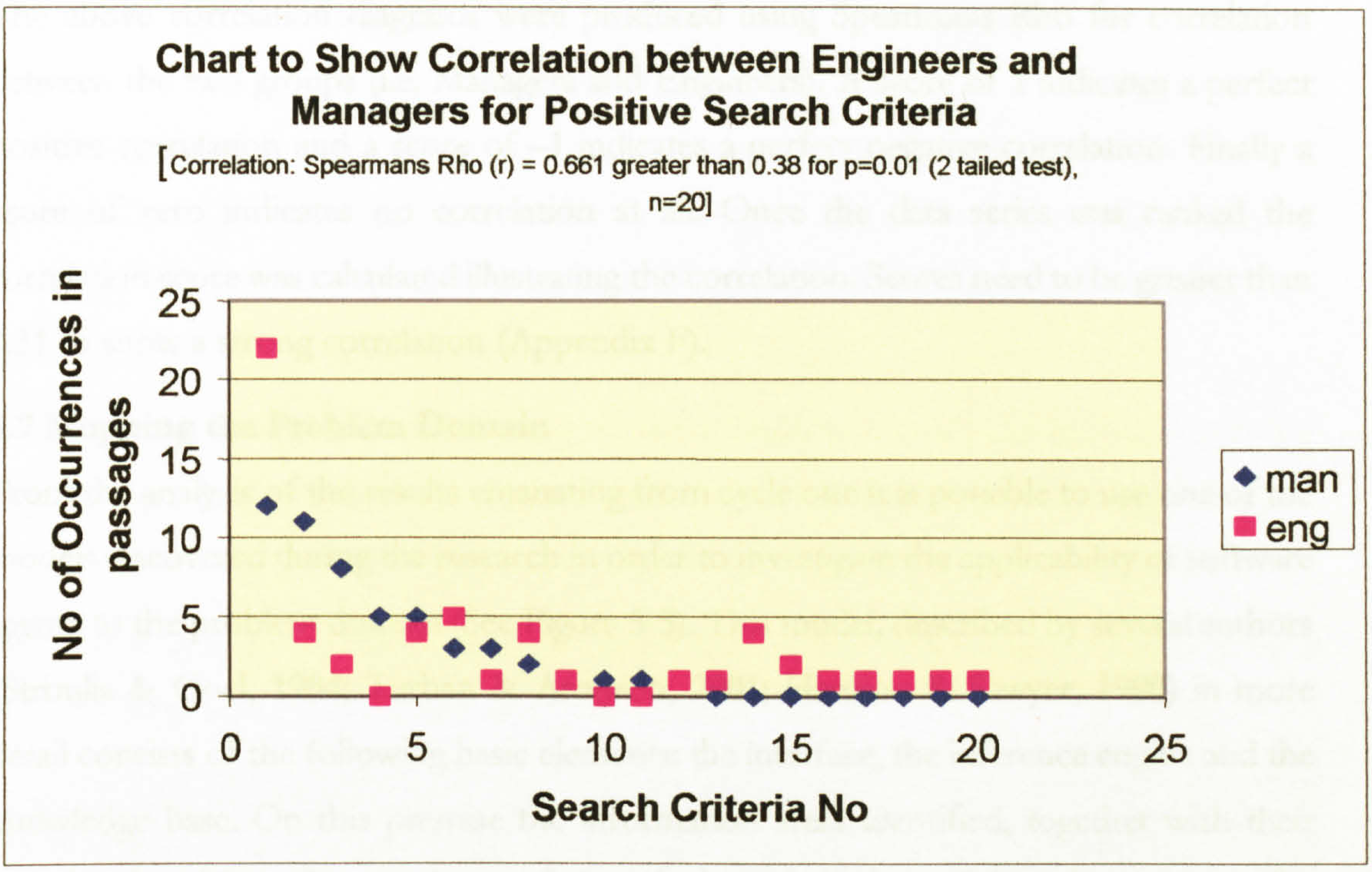


Figure 5-3: Correlation Graph for Positive Search Criteria

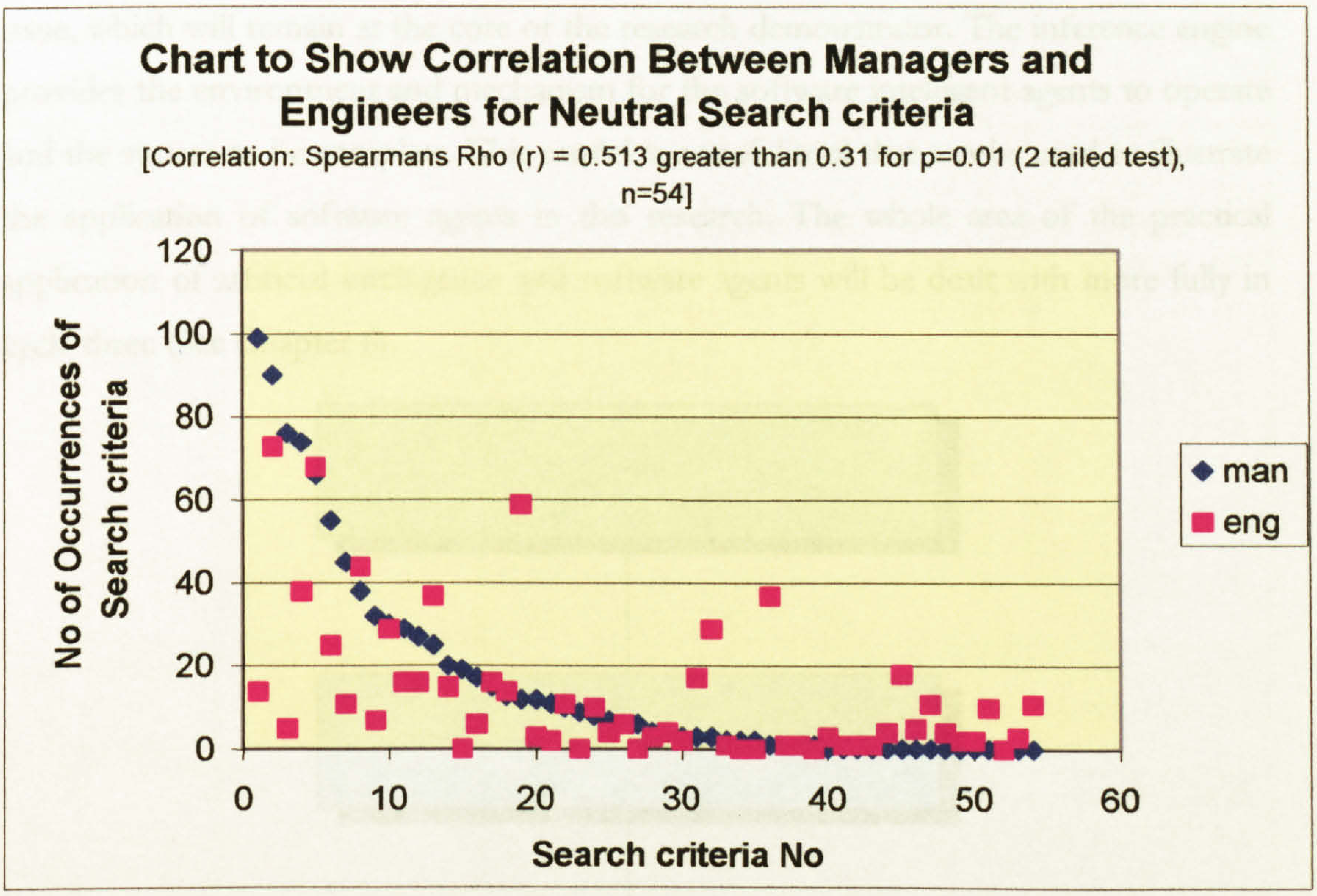


Figure 5-4: Correlation Graph for Neutral Search Criteria

The neutral search criteria correlation graph illustrates a particularly strong correlation, which suggests that both Managers and Engineers are concerned about the same areas of information within the Company (See Table 5-5, Figure 5-4 and Appendix F)

The above correlation diagrams were produced using Spearmans Rho for correlation between the two groups (i.e. Managers and Engineers). A score of 1 indicates a perfect positive correlation and a score of –1 indicates a perfect negative correlation. Finally a score of zero indicates no correlation at all. Once the data series was ranked the correlation score was calculated illustrating the correlation. Scores need to be greater than 0.31 to show a strong correlation (Appendix F).

5.7 Mapping the Problem Domain

From the analysis of the results emanating from cycle one it is possible to use one of the models discovered during the research in order to investigate the applicability of software agents to the problem domain (See Figure 5-5). This model, described by several authors (Stroulia & Goel, 1994; Turban & Aronson, 2001; Harmon & Sawyer, 1990) in more detail consists of the following basic elements: the interface, the inference engine and the knowledge base. On this premise the information areas identified, together with their associated problems from cycle one, fit into the knowledge base. Of equal importance the interface to the system gains a high priority due to the amount of issues raised concerning interfaces in cycle one and the need for users to be able to interact with the underlying application with as much ease as is possible. The usability of the interface is therefore an issue, which will remain at the core of the research demonstrator. The inference engine provides the environment and mechanism for the software intelligent agents to operate and the system to be complete. This model is a useful tool that can be used to illustrate the application of software agents in this research. The whole area of the practical application of artificial intelligence and software agents will be dealt with more fully in cycle three (See Chapter 6).

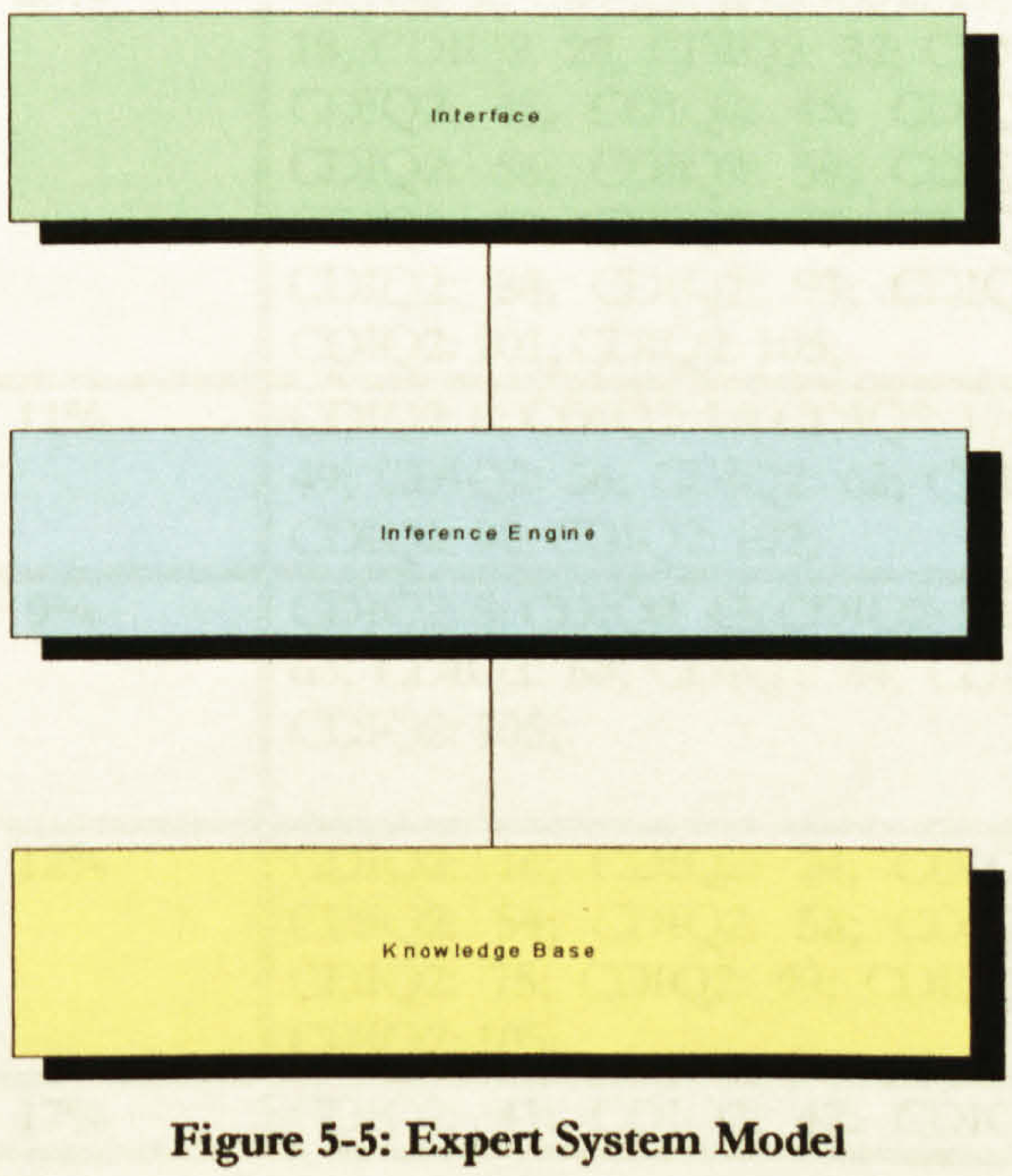


Figure 5-5: Expert System Model

5.8 Secondary Data Analysis

The data analysis in this area of the research relies upon the use of a number of CWW (Intranet) surveys that the Company has conducted over the last four years. The surveys have produced similar results to those identified within this thesis and they are presented in the following tables (See Table 5-6, Table 5-7, Table 5-8 and Table 5-9).

(a) The CWW Survey 2000 Results

These results have been analysed using NVivo in order to identify the key themes in the same manner as the earlier primary data used in cycle 1 and grouped in the same manner as the data in cycle 2 above when examining the specific word searches.

Answers relating to the CWW from Q4 of the 2000 Survey, which asked, ***"Please state a facility/area you most dislike and give a reason why?"***

Category	How many comments out of total	Reference links to transcripts
Difficulty in finding information	18%	CDIQ2: 3; CDIQ2: 6; CDIQ2: 12; CDIQ2: 19; CDIQ2: 20; CDIQ2: 29; CDIQ2: 30; CDIQ2: 33; CDIQ2: 35; CDIQ2: 47; CDIQ2: 50; CDIQ2: 52; CDIQ2: 57; CDIQ2: 61; CDIQ2: 67; CDIQ2: 74; CDIQ2: 80; CDIQ2: 81; CDIQ2: 104
Poor search engine	24%	CDIQ2: 7; CDIQ2: CDIQ2: 10; CDIQ2: 13; CDIQ2: 22; CDIQ2: 24; CDIQ2: 25; CDIQ2: 30; CDIQ2: 31; CDIQ2: 34; CDIQ2: 36; CDIQ2: 39; CDIQ2: 47; CDIQ2: 50; CDIQ2: 51; CDIQ2: 67; CDIQ2: 70; CDIQ2: 73; CDIQ2: 74; CDIQ2: 82; CDIQ2: 83; CDIQ2: 91; CDIQ2: 99; CDIQ2: 100; CDIQ2: 106;
Out-of-date information	26%	CDIQ2: 2; CDIQ2: 4; CDIQ2: 11; CDIQ2: 15; CDIQ2: 18; CDIQ2: 28; CDIQ2: 32; CDIQ2: 37; CDIQ2: 40; CDIQ2: 45; CDIQ2: 46; CDIQ2: 51; CDIQ2: 53; CDIQ2: 56; CDIQ2: 59; CDIQ2: 62; CDIQ2: 68; CDIQ2: 71; CDIQ2: 72; CDIQ2: 83; CDIQ2: 84; CDIQ2: 88; CDIQ2: 93; CDIQ2: 97; CDIQ2: 98; CDIQ2: 101; CDIQ2: 105;
Broken links. Failure to access pages	11%	CDIQ2: 8; CDIQ2: 14; CDIQ2: 17; CDIQ2: 42; CDIQ2: 49; CDIQ2: 56; CDIQ2: 62; CDIQ2: 65; CDIQ2: 85; CDIQ2: 92; CDIQ2: 102;
Poor structure/organisation of information	9%	CDIQ2: 5; CDIQ2: 43; CDIQ2: 56; CDIQ2: 62; CDIQ2: 63; CDIQ2: 68; CDIQ2: 84; CDIQ2: 86; CDIQ2: 87; CDIQ2: 105;
Poor presentation of information	12%	CDIQ2: 16; CDIQ2: 24; CDIQ2: 26; CDIQ2: 27; CDIQ2: 54; CDIQ2: 58; CDIQ2: 60; CDIQ2: 67; CDIQ2: 75; CDIQ2: 99; CDIQ2: 102; CDIQ2: 103; CDIQ2: 105;
Poor usability	17%	CDIQ2: 41; CDIQ2: 42; CDIQ2: 43; CDIQ2: 44;

Category	How many comments out of total	Reference links to transcripts
or poor interface		CDIQ2: 54; CDIQ2: 55; CDIQ2: 64; CDIQ2: 65; CDIQ2: 66; CDIQ2: 69; CDIQ2: 76; CDIQ2: 78; CDIQ2: 85; CDIQ2: 89; CDIQ2: 94; CDIQ2: 96; CDIQ2: 99; CDIQ2: 101;
Offensive/ inappropriate information/ content	7%	CDIQ2: 21; CDIQ2: 23; CDIQ2: 38; CDIQ2: 48; CDIQ2: 77; CDIQ2: 79; CDIQ2: 90;

Table 5-6: BAE SYSTEMS Year 2000 Intranet Survey Results - Dislikes Category

In the Intranet Survey 2000 results the open-ended comments section also provided feedback on the Company Intranet facilities which I have broken down into positive (See Table 5-7), negative (See Table 5-8) and neutral (See Table 5-9) comment tables: -

Category	How many comments out of total	Reference links to transcripts
Difficulty in finding information	18%	CDIQ4: 2; CDIQ4: 3; CDIQ4: 6; CDIQ4: 11; CDIQ4: 12; CDIQ4: 21; CDIQ4: 27; CDIQ4: 30;
Poor search engine	2%	CDIQ4: 9;
Out-of-date information	36%	CDIQ4: 4; CDIQ4: 5; CDIQ4: 7; CDIQ4: 8; CDIQ4: 10; CDIQ4: 15; CDIQ4: 17; CDIQ4: 19; CDIQ4: 20; CDIQ4: 23; CDIQ4: 29; CDIQ4: 31; CDIQ4: 32; CDIQ4: 35; CDIQ4: 37; CDIQ4: 38;
Broken links. Failure to access pages	4%	CDIQ4: 7; CDIQ4: 22;
Poor structure/organisation of information	16%	CDIQ4: 10; CDIQ4: 12; CDIQ4: 13; CDIQ4: 25; CDIQ4: 33; CDIQ4: 34; CDIQ4: 36;
Poor presentation of information	7%	CDIQ4: 13; CDIQ4: 24; CDIQ4: 26;
Poor usability or poor interface	9%	CDIQ4: 16; CDIQ4: 18; CDIQ4: 36; CDIQ4: 39;
Lack of information/Missing information	4%	CDIQ4: 1; CDIQ4: 9;

Table 5-7: BAE SYSTEMS Year 2000 Intranet Survey - Open-ended Comments (Negative)

Category	How many comments out of total	Reference links to transcripts
Good presentation	2%	CDIQ4: 15;

Table 5-8: BAE SYSTEMS Year 2000 Intranet Survey - open-ended Comments (Positive)

Category	How many comments out of total	Reference links to transcripts
Miscellaneous comment neither negative nor positive	2%	CDIQ4: 14;
Existence of security restrictions on CWW	2%	CDIQ4: 28;

Table 5-9: BAE SYSTEMS Year 2000 Intranet Survey - Open-ended Comments (Neutral)

(b) The CWW Survey 1998 Results

Other similar results were obtained from the 1998 CWW survey which showed similar trends. For example, in Figure 5-6 it is clear that users fail to find the information they are looking for and that if they are going to find it then it is mostly to be found within the first 5-10 minutes. But a larger proportion of users take between 10 minutes and more than 2 hours to locate the information they need. The same is true of the users' experience of finding up-to-date information on the CWW Phonebook facility, which also appears to be ineffective (See Figure 5-7)

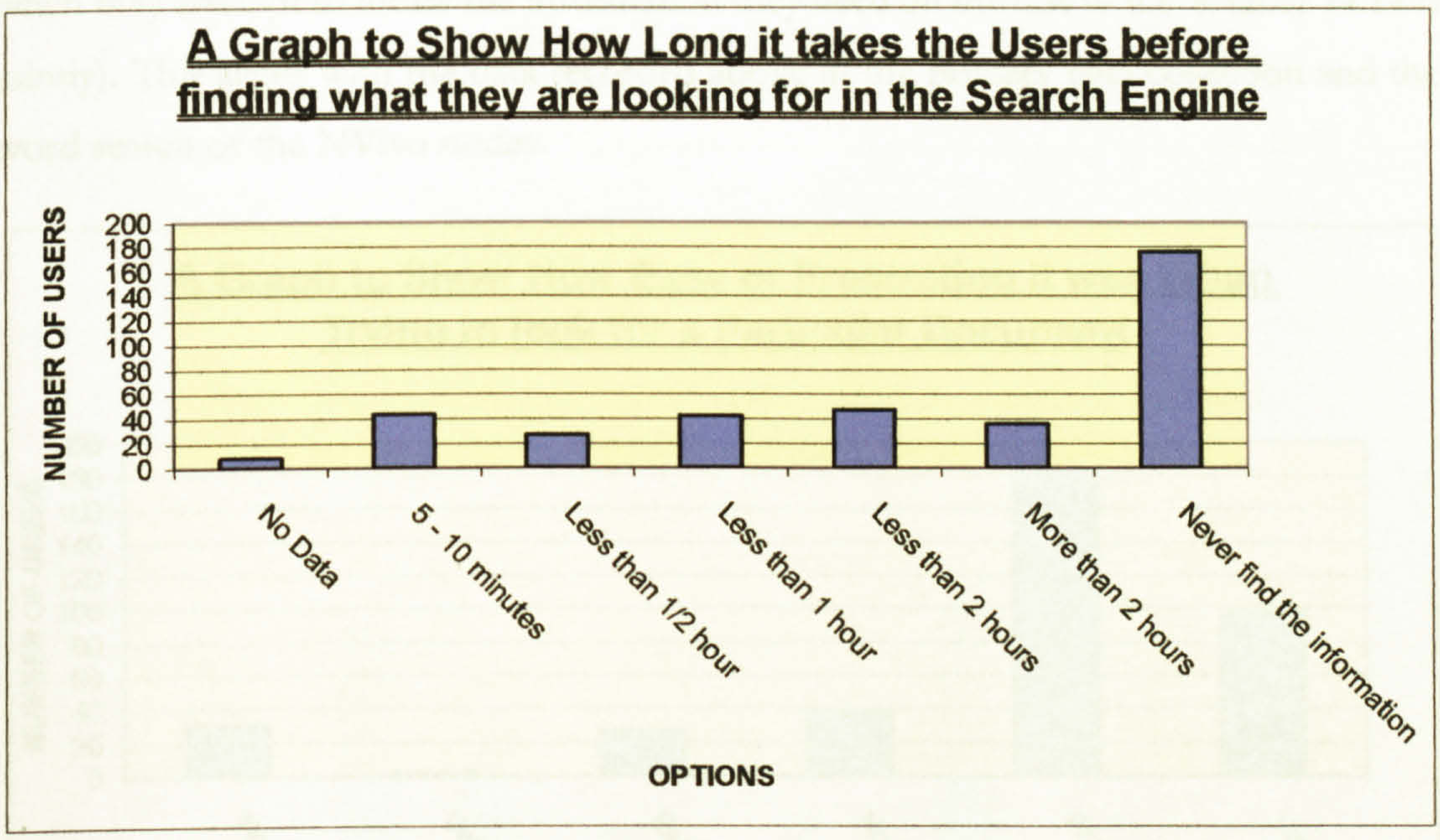


Figure 5-6: CDI Survey Showing the Time Taken to Locate Information

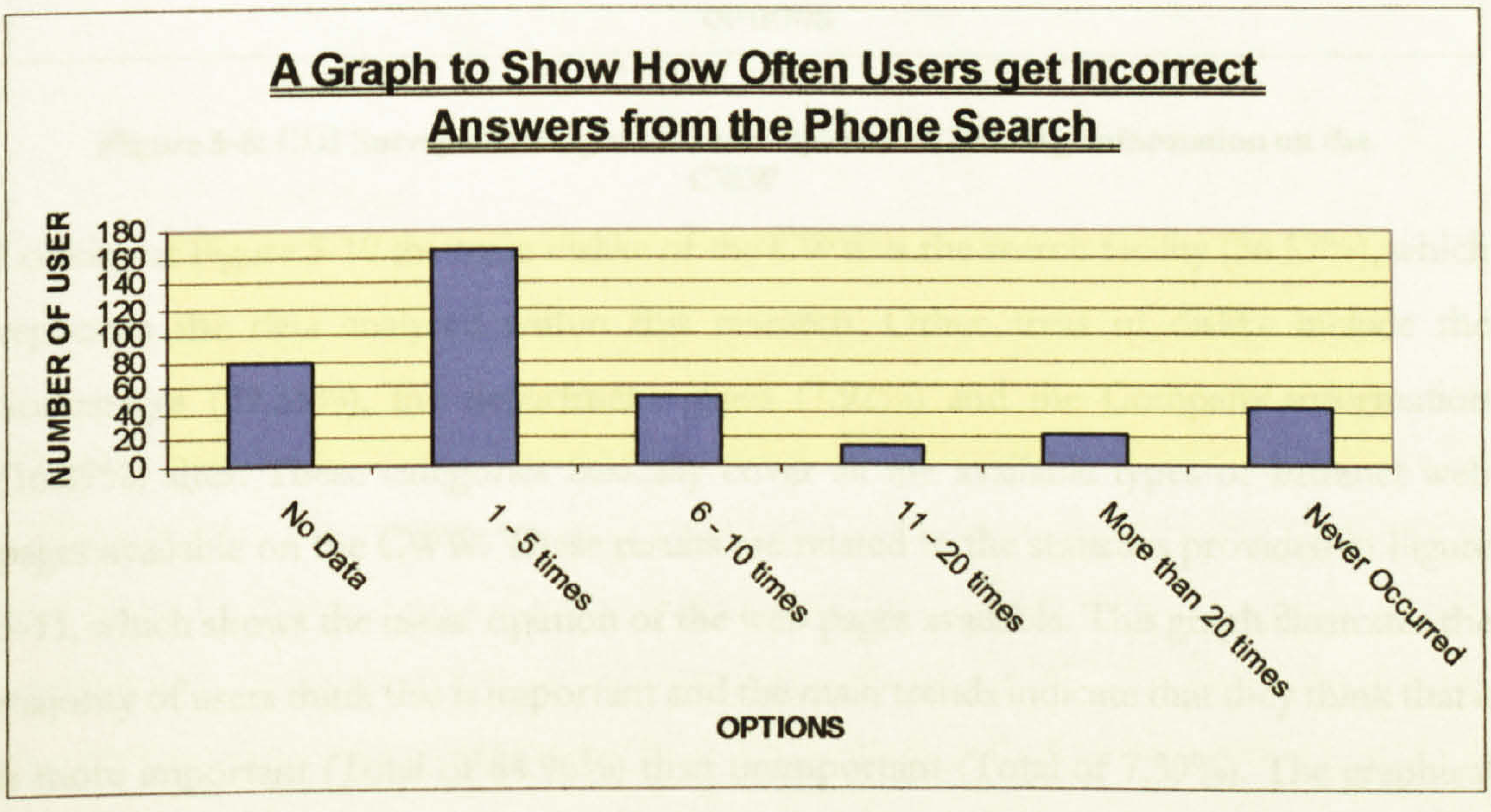


Figure 5-7: CDI Survey Showing the Number of Hits On Wrong Information in the CWW Phonebook

Figure 5-9 illustrates the main purpose for using the CWW is find general information (52.77%). There is no category for specific types of managerial or engineering and technical information within this survey. The main categories relate to administrative elements of a user's role. The remainder of 47.23% account for the other six categories and no answer category. Thus because there is such a limited choice this general information category presumably incorporates the specific managerial and technical information. Following on from this graph Figure 5-8 illustrates the statistical data, which quite clearly indicates that the users are frustrated (48.55%) or very frustrated (25.59%) when they attempt to locate the information they need on the CWW (i.e. total of 74.14% jointly). This aligns with the data recorded above in the primary data collection and the word search of the NVivo nodes.

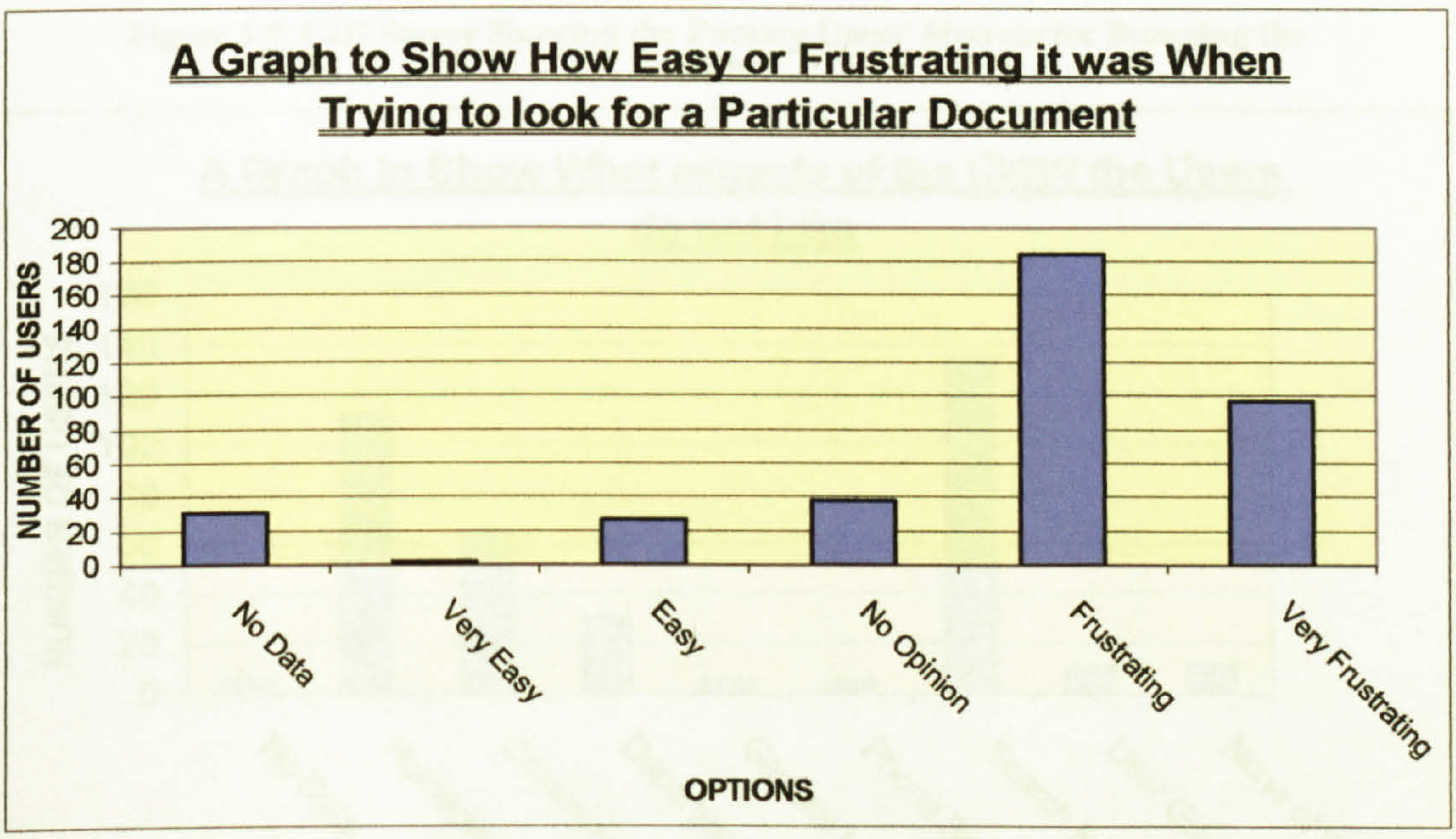


Figure 5-8: CDI Survey Showing the Users' Opinion of Finding Information on the CWW

Looking at Figure 5-10 the main dislike of the CWW is the search facility (36.37%), which replicates the data analysed within this research. Other areas of dislike include the homepages (29.55%), the department pages (7.92%) and the Company information (16.89%) sites. These categories basically cover all the available types of Intranet web pages available on the CWW. These results are related to the statistics provided in Figure 5-11, which shows the users' opinion of the web pages available. This graph illustrates the majority of users think this is important and the main trends indicate that they think that it is more important (Total of 84.96%) than unimportant (Total of 7.39%). The graphical interface to either a web page or an interface is a key issue raised by the research in this thesis. These graphs align with the results obtained through this research.

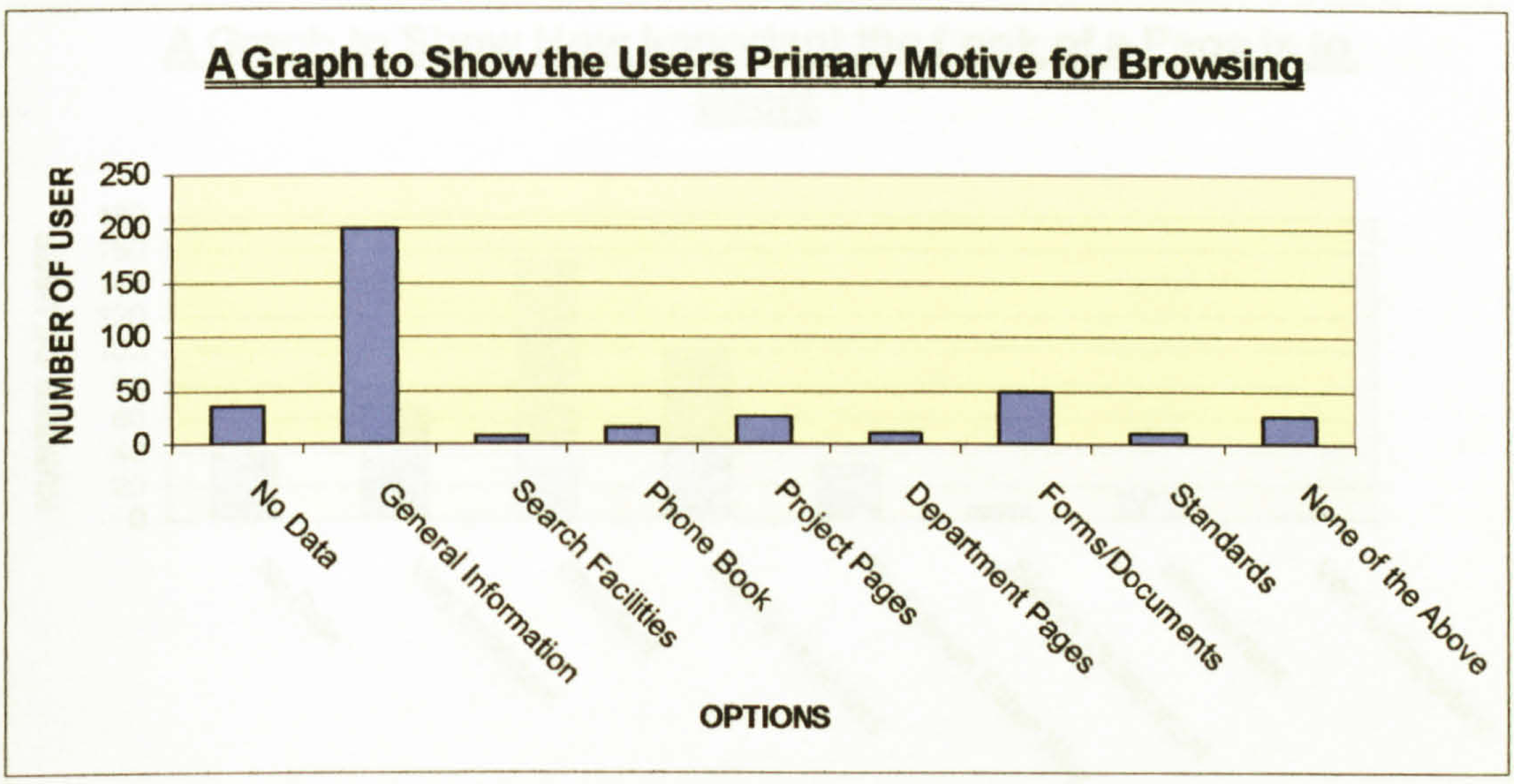


Figure 5-9: CDI Survey Showing the Primary Users' Motives for Browsing the CWW

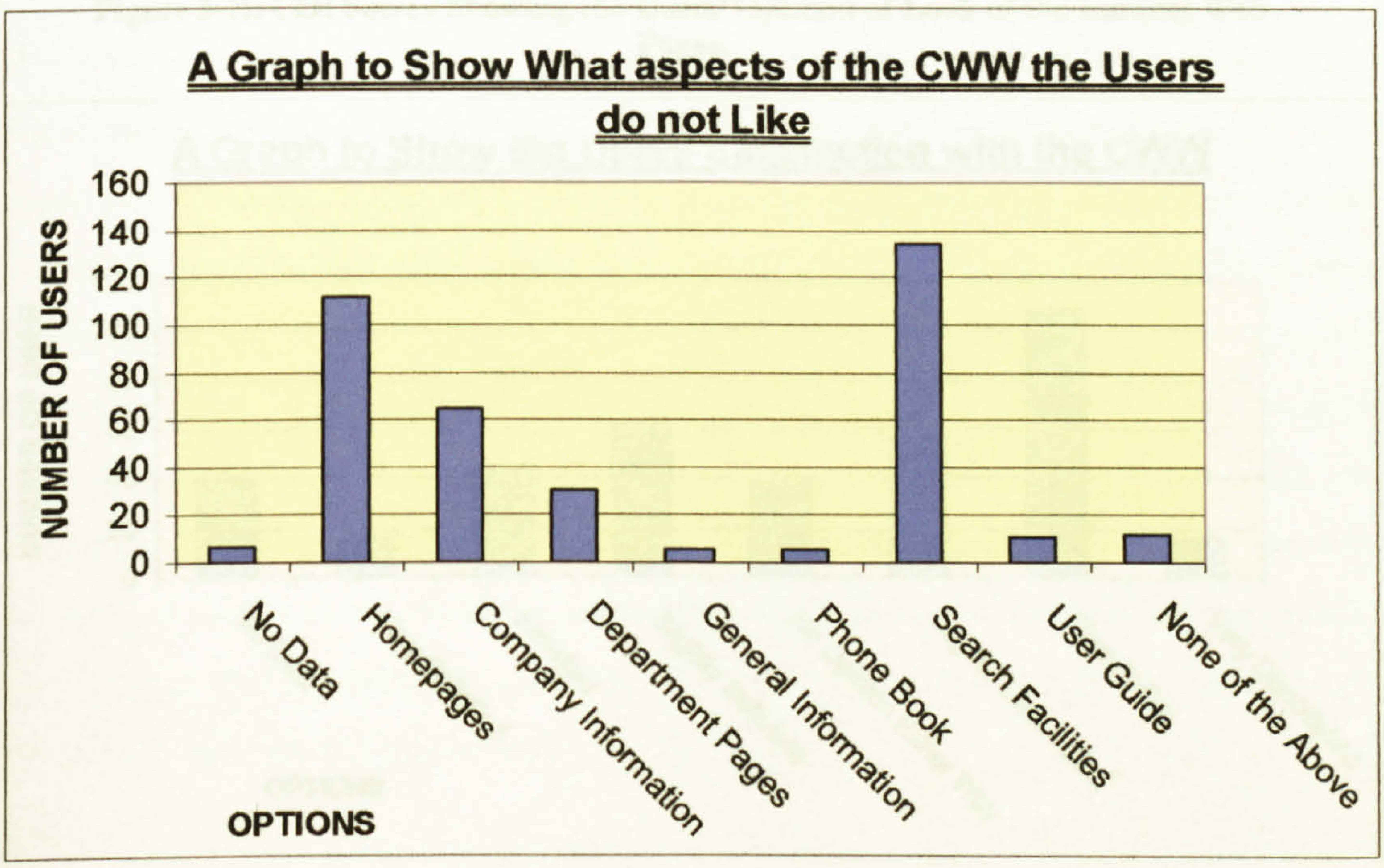


Figure 5-10: CDI Survey Showing the Users' Opinion of What they Dislike on the CWW

The final look at the CWW statistics indicates that the overall users' satisfaction with the CWW is on the dissatisfaction scale (Total of 47.7%) as opposed to the satisfied (Total of 31.93%) scale (See Figure 5-12). This is no surprise and agrees with the previous graphs representing the users' views of different aspects of the CWW. These results also correspond satisfactorily with the results of the research carried out as a major part of this thesis.

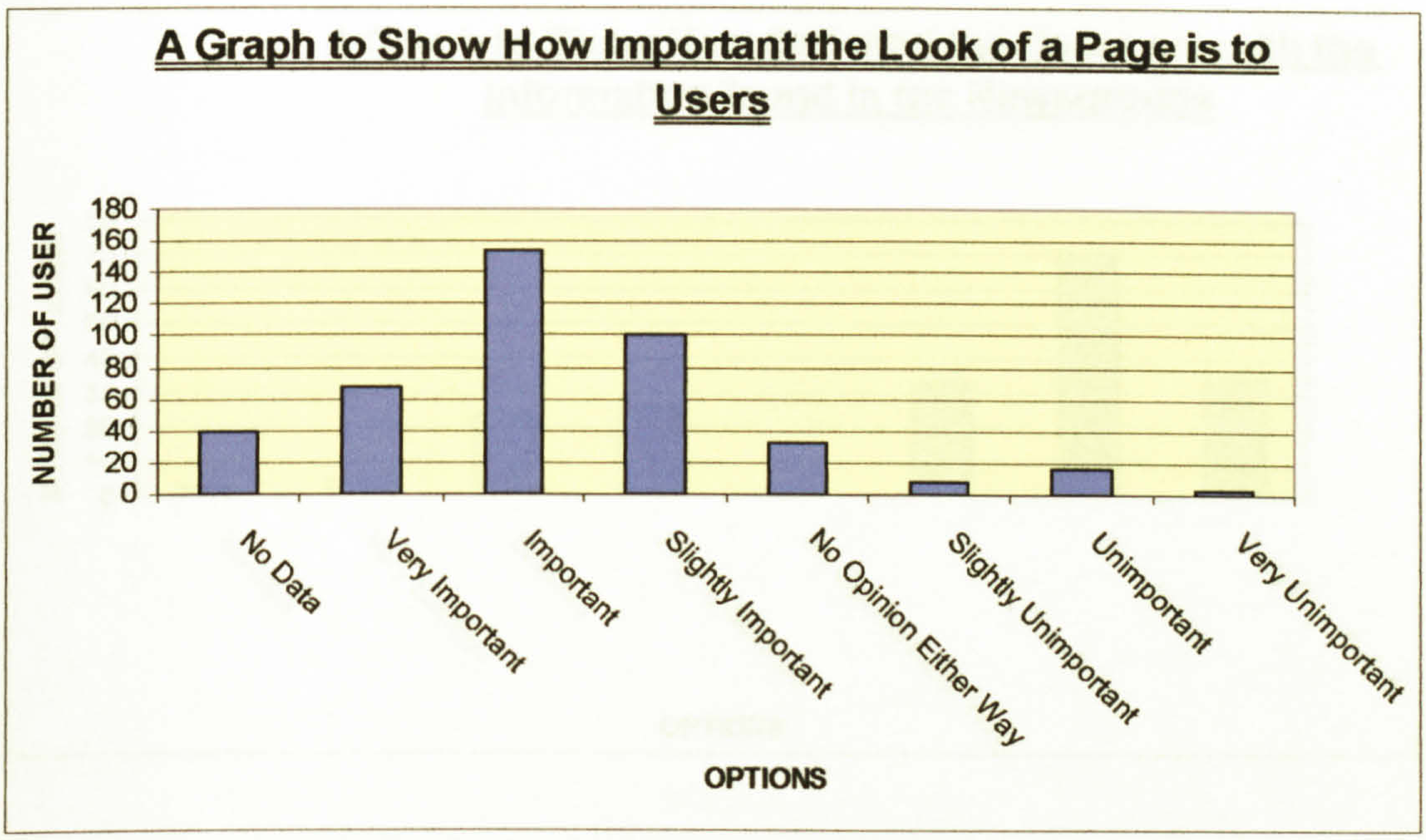


Figure 5-11: CDI Survey Showing the Users' Opinion of Look of the Intranet Web Pages

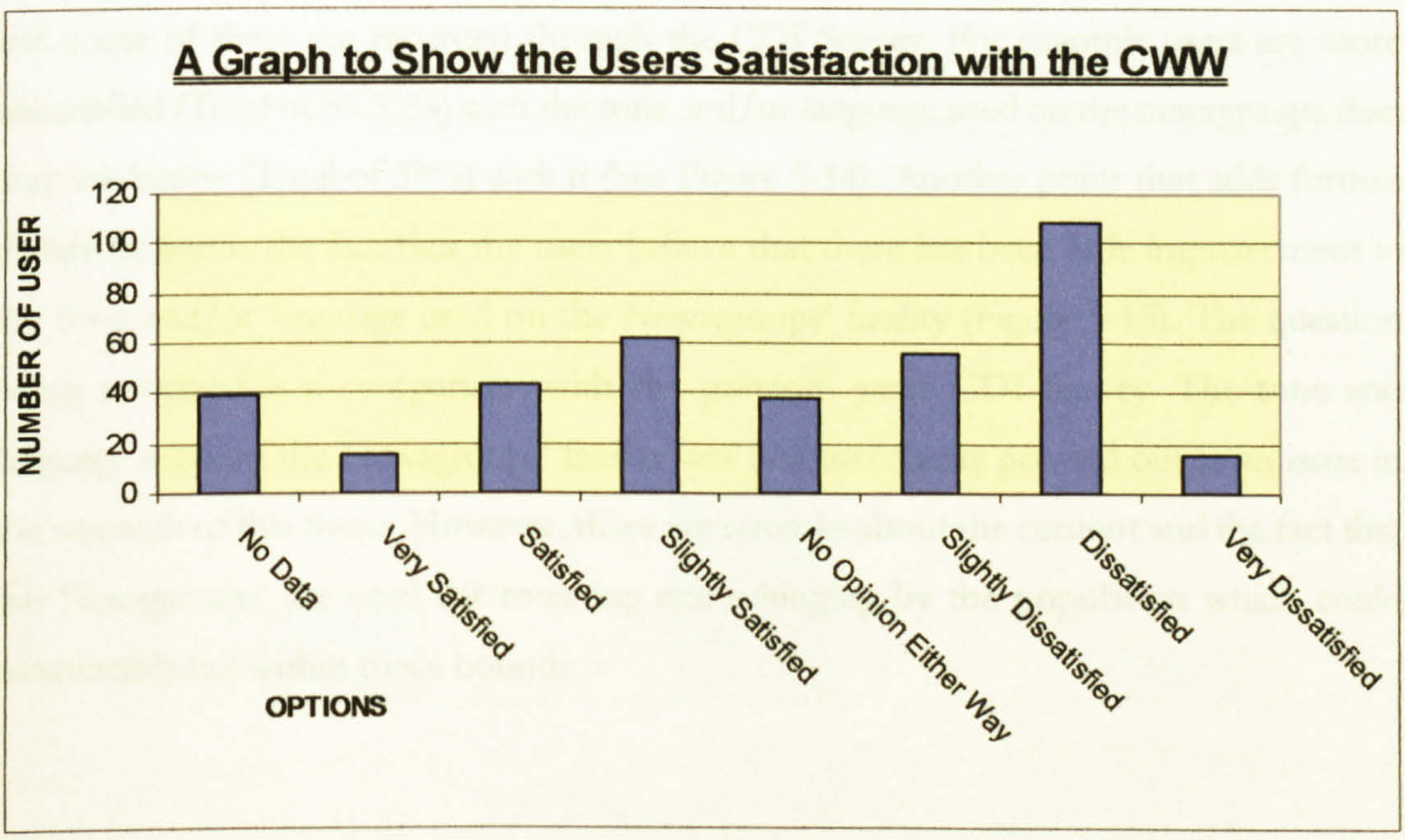


Figure 5-12: CDI Survey Showing the Users' Opinion of the CWW

The Newsgroups area received attention in the CDI Survey and the results measured here also represent an alignment with the results of the thesis research. In Figure 5-13 we see the same trends as for the CWW in that the dissatisfaction (69.54%) results are greater than the satisfaction (27.92%) results.

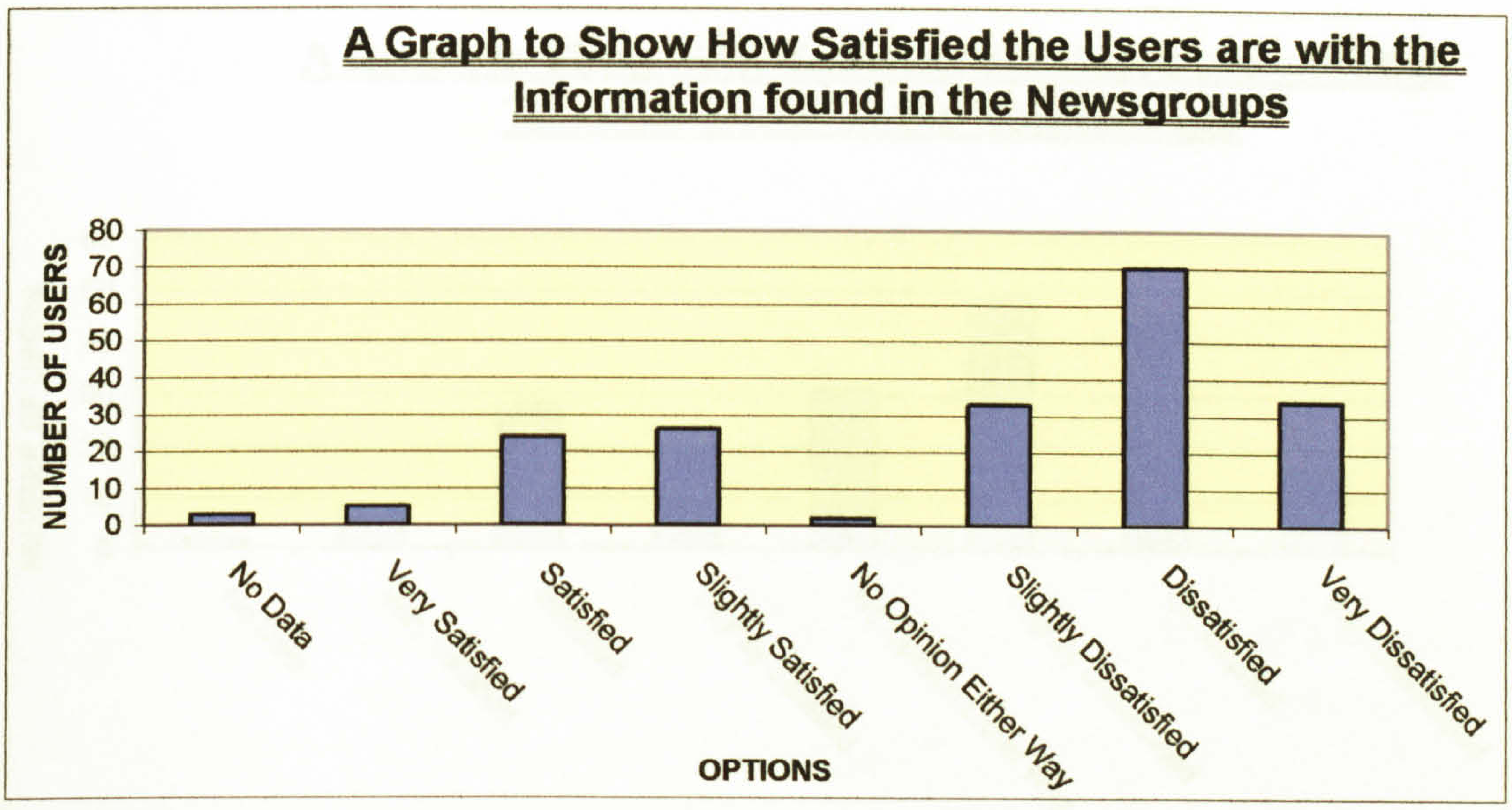


Figure 5-13: CDI Survey Results Showing the Users' Satisfaction with the Newsgroups' Facility

There are many reasons why the users may be dissatisfied with the Newsgroups' facility and some of these are recorded through the CDI Survey. For example users are more dissatisfied (Total of 55.33%) with the tone and/or language used on the newsgroups than they are happy (Total of 33%) with it (See Figure 5-14). Another point that adds further dissatisfaction is the fact that the users believe that there has been little improvement in the tone and/or language used on the Newsgroups' facility (Figure 5-15). The question being answered is a comparison with the previous years CDI Survey. The tone and language used on the Newsgroups' facility was not specifically pointed out as an issue in the research of this thesis. However, there are remarks about the content and the fact that the Newsgroups' are used for moaning and whinging by the population which could conceivably fall within these bounds.

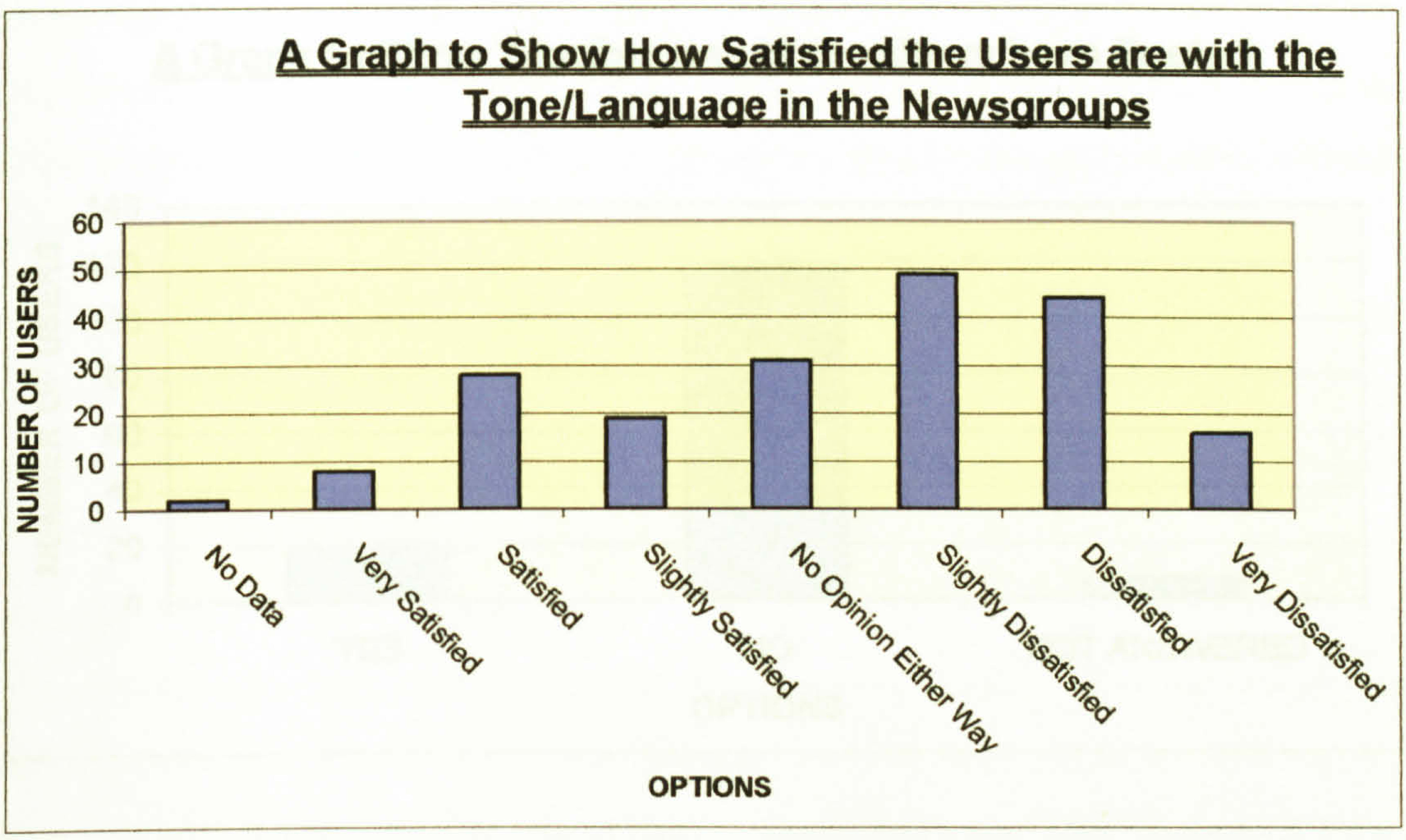


Figure 5-14: CDI Survey Results Showing the Users' Satisfaction with the Tone/Language of the Newsgroups'

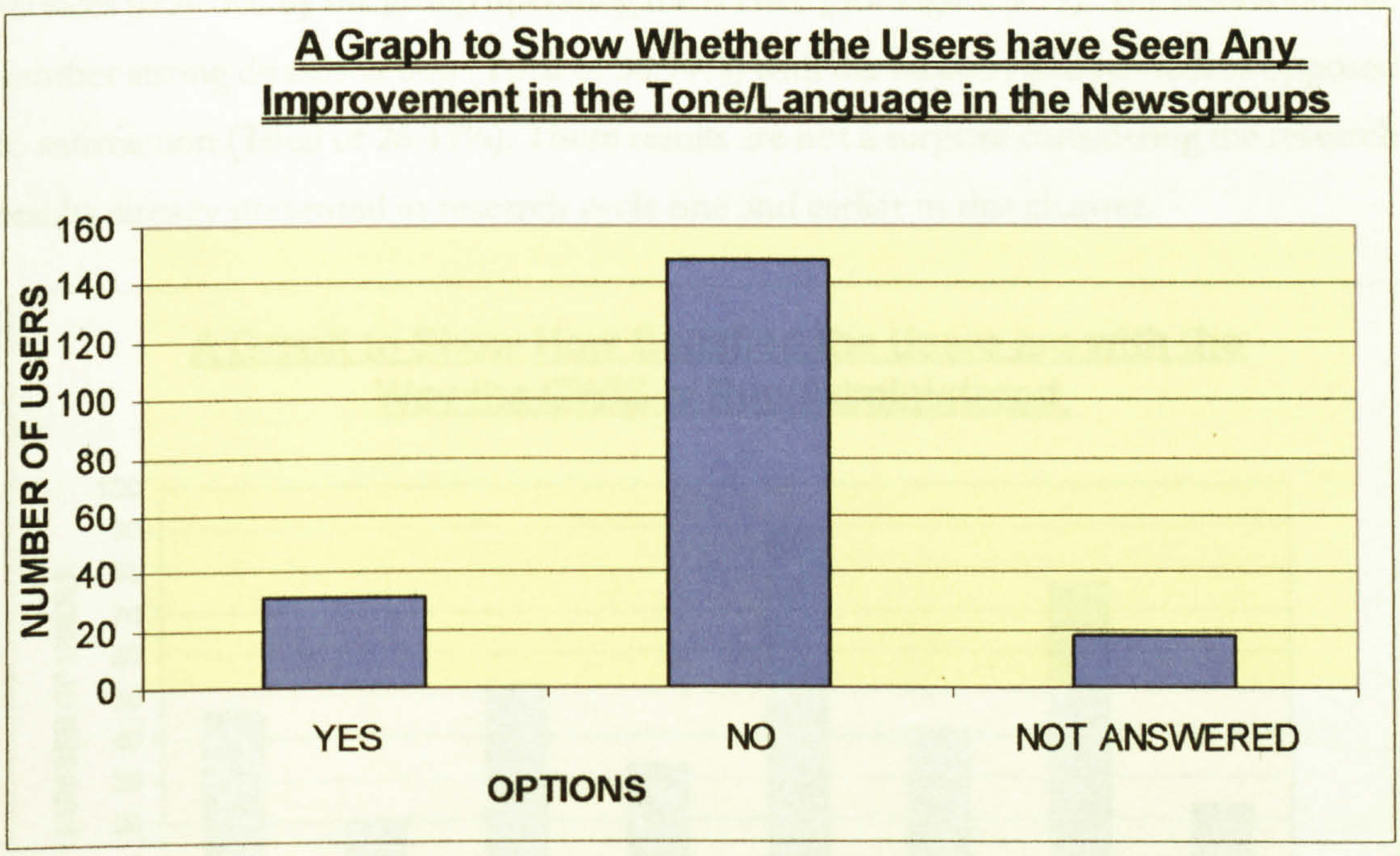


Figure 5-15: CDI Survey Results Indicating Whether Users' Have Seen Improvements in the Tone/Language Used on the Newsgroups'

The CDI Survey also indicated a lack of usage of the Newsgroups, which is another factor raised by this research and is strongly aligned with these results. In Figure 5-16 there is a strong tendency towards not using the newsgroups.

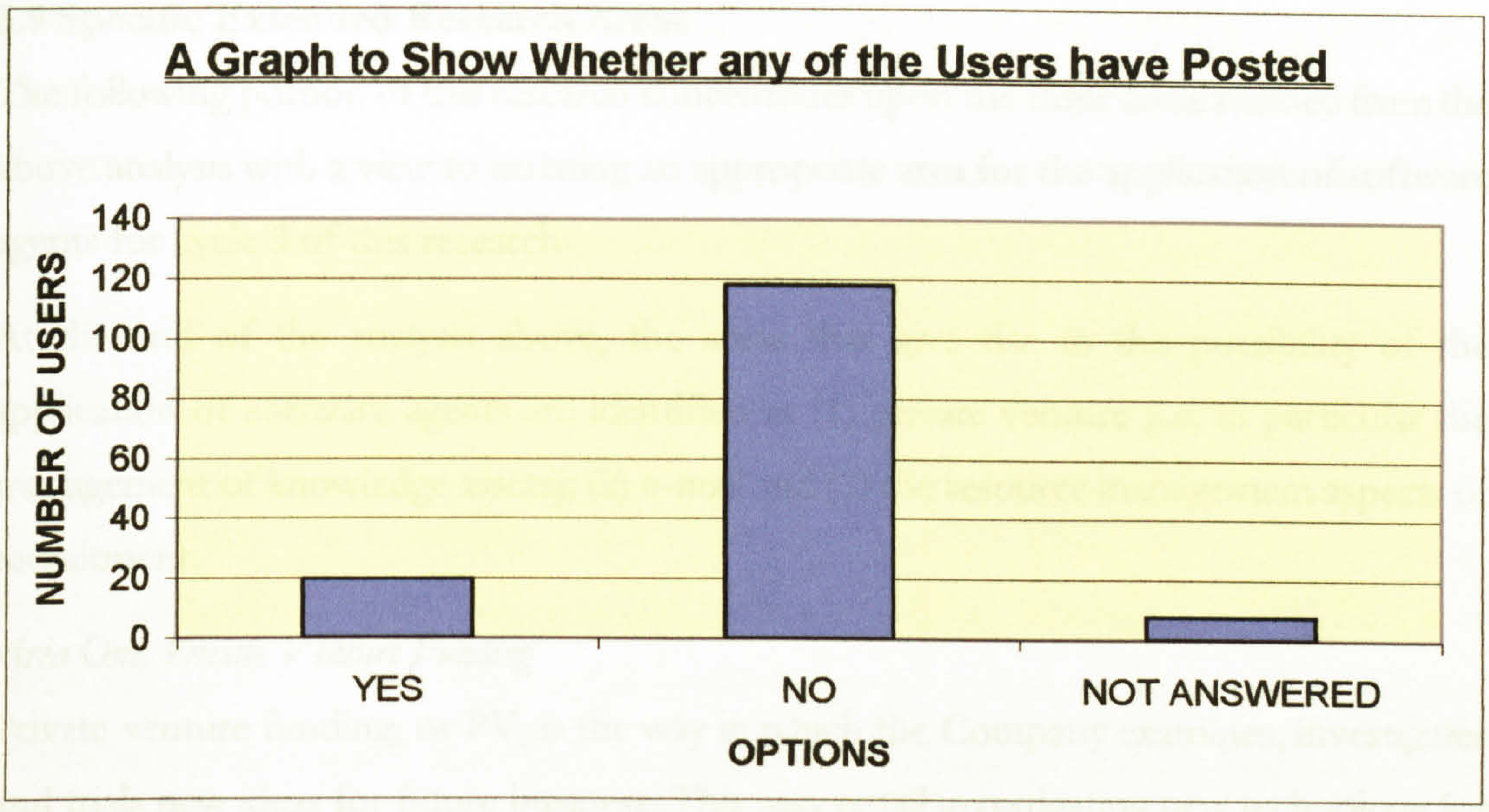


Figure 5-16: CDI Survey Results Showing the Usage of the Newsgroups

Finally the CDI Survey examines the users overall satisfaction with the CWW and the services provided by the group operating the service (See Figure 5-17). The results indicate another strong dissatisfaction (Total of 38.94%) with the facilities and services as opposed to satisfaction (Total of 26.45%). These results are not a surprise considering the research results already presented in research cycle one and earlier in this chapter.

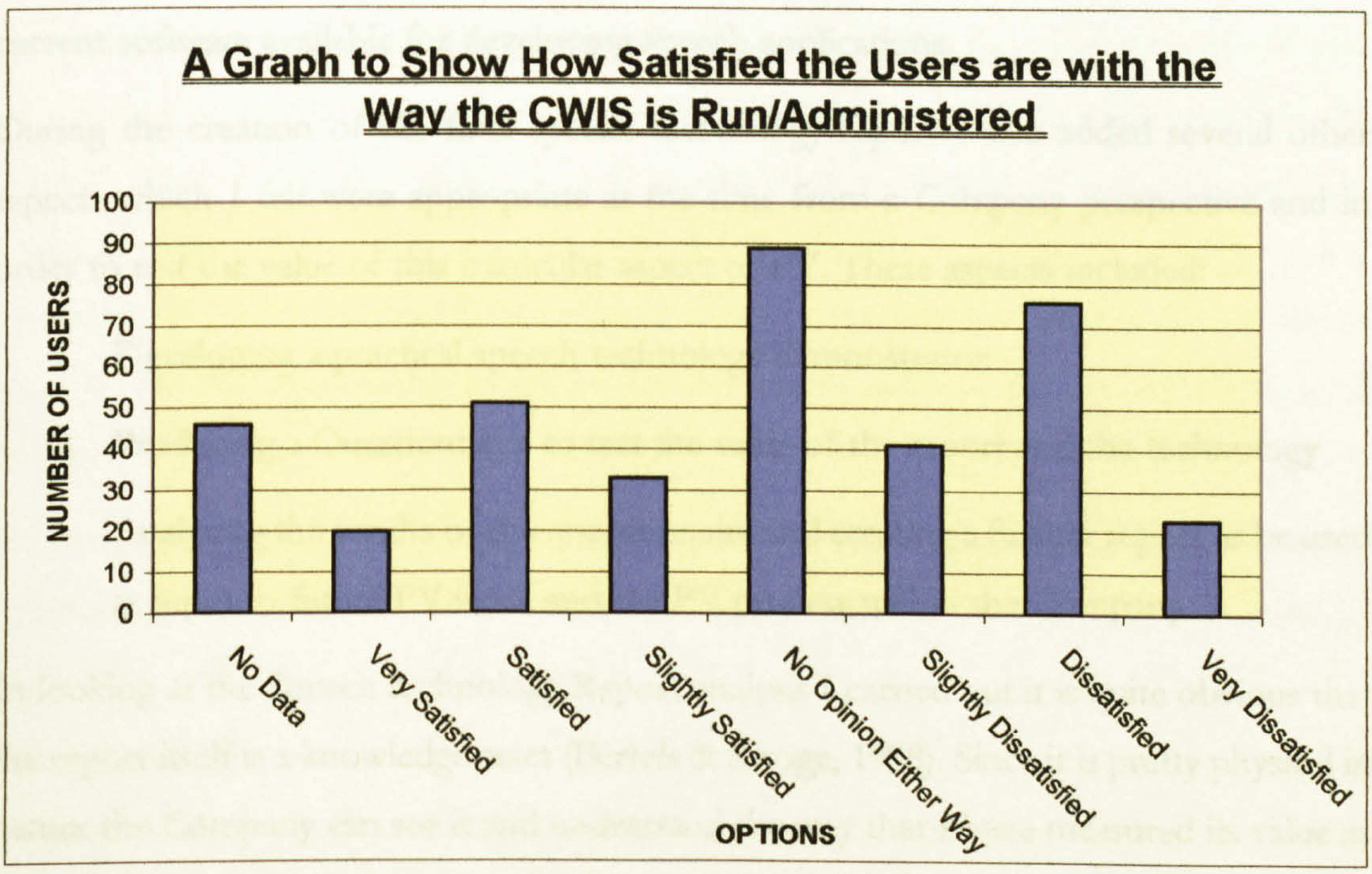


Figure 5-17: CDI Survey Results Showing the Users' Overall Satisfaction With the CWW and its Services

5.9 Specific Extended Research Areas

The following portion of this research concentrates upon the three areas selected from the above analysis with a view to isolating an appropriate area for the application of software agents for cycle 3 of this research.

At the end of the analysis above, the areas that give rise to the possibility of the application of software agents are identified as (1) private venture [i.e. in particular the management of knowledge assets]; (2) e-mail and (3) the resource management aspects of recruitment.

Area One: Private Venture Funding

Private venture funding, or PV, is the way in which the Company examines, investigates and trials new ideas for future business. This may entail investigating new technology for enhancements to the current product range, or to try out new software tools to improve software development processes. The range is extremely varied. In this section I examine one particular example of private venture that involved me fully. When I joined the Company I was asked to complete a piece of work for private venture in the area of speech technology. My original scope was communicated verbally and was not precise or accurate. The main emphasis was to research speech technology and produce a report on the capability of this technology within the Company; I was also asked to examine the current software available for developing speech applications.

During the creation of the final speech technology report I also added several other aspects which I felt were appropriate at the time from a Company perspective and in order to test the value of this particular aspect of PV. These aspects included: -

1. Developing a practical speech technology demonstrator
2. Producing a Questionnaire to test the value of the report and the technology
3. Analysing the results of the questionnaire and creating a further report to be used as input to future PV work and the PV process within the Company

In looking at the Speech technology Report analysis I carried out it is quite obvious that the report itself is a knowledge asset (Bertels & Savage, 1998). Since it is pretty physical in nature the Company can see it and understand the way that I have measured its value as an asset. I can quite easily access the financial data associated with the report and show measures of assessment in this way too. The information captured from the Speech technology Report Questionnaire falls into two areas. First, the specific quantitative data relating to how many people responded with which answers to specific questions, how many managers responded, how many engineers etc. However, there is also another set of data here, which has meaning for the Company – this is the soft data allowing the people filling out the questionnaire to express personal views. These personal views bring out ideas, things that may be important in similar areas of the business. This latter set of data can point to the intangible, the experience the personal knowledge held in the heads of individuals. Doing the questionnaire is just one way of discovering that knowledge. But if it is uncovered and revealed to the business then they need to see how it can be relevant to the Company too. The Company will learn nothing if they do nothing with what the research reveals. The Company cannot afford to ignore the hidden value of experience, ideas and knowledge in the people within the business (Bertels & Savage, 1998). This kind of knowledge is harder to capture and measure but researchers are looking into this area as well as various ways of developing and creating knowledge (Nonaka & Takeuchi, 1995).

I was also concerned to see that the work involved in creating a report on new technology for both managers and engineers would be used effectively within the Company.

I completed the Speech Technology Report and then devised a questionnaire to assess the strengths and weaknesses and tried to gauge how valuable the report (as a knowledge asset) was to the Company through the eyes of the engineers and the managers. This speech report questionnaire was carried out early on in research cycle one as an extended area of research to assess the value of producing knowledge assets in an explicit format under the Company's Private Venture (PV) process. I was asked to look at the whole area of speech technology to see if the Company should be looking at using it within the product range. I was also asked to look at providing an update on this technology to assess where the technology is going now and in the future. Although this report was completed in the timescales of research cycle one, it was considered to be an area where agent technology may be applied and for that reason the data and the trends were analysed more closely in this phase.

My reflective diary gives consideration to the process of creating this report from an engineer's perspective and discusses the issues I faced when trying to get the information I required in order to complete this task.

The Method

In terms of the content of the questionnaire and how it was carried out I went through the following steps:

- I sought to get the views of those sponsoring the Speech Technology Report on what they would like to know from such a questionnaire.

- I researched the types of questionnaires I could utilise and attended a University workshop on developing surveys and questionnaires. At the end of my research I opted for the Likert scale as the measurement as I was primarily interested in employees' opinion, attitude and beliefs. However, I also wanted some open-ended comment boxes for people to have an opportunity to mention issues that I had not covered or to explain why they were answering with a particular response.
- I set about drawing up a first draft of questions. At this point I felt that I wanted to divide the questionnaire into two parts to look at two different factors. Firstly, the report itself (as a knowledge asset) and what value it had to the individuals surveyed. And secondly the technology content of the report because the sponsors were particularly interested in the responses from employees in this area.
- I then discussed these questions with a Company official from the engineering techniques division who had experience in developing surveys and questionnaires and I tried it out on them as a pilot experiment. The results of this were incorporated into the questionnaire and the finalised version was produced.
- This survey was aimed at the Domain Expert community who had received a copy of the Speech Technology Report. The report was carried out for this specific group and the results are based on their views. The Domain Expert Group consists of both engineers and managers and based upon their grade within the Company the results were analysed from this perspective.
- The questionnaire was developed in Outlook as a form. This method was chosen in order to create an easy to complete format by the targeted individuals in a relatively quick method. The individuals received this as an e-mail form that they filled in and returned. I chose this method because it was easy to produce and made efficient use of my time rather than learning up on web pages and html forms. As the Speech Report had been produced it was timely to follow up with the questionnaire sooner rather than later too.

The final speech report questionnaire consisted of 16 questions. The questionnaire was split into two sections, the first covering the report itself and was made up of 9 questions and an additional 3 number of boxes for comments. The second section referenced the technology and consisted of 7 questions and 3 boxes for open-ended comments. A total of 25 members of staff from the Domain Experts group were canvassed for the questionnaire and a total of 20 responses were collected in a time scale of one month. This sample was purely the Domain experts group from within the Company. The candidates were categorised as either engineers (10 candidates) or managers (15 candidates) – this was achieved by splitting the group by their grade scale. The non-responses were all in the manager category alone.

Once returned the results were collated and analysed in Excel using traditional statistical analysis techniques. A report was produced using these results and delivered to the department officials and the Engineering Director dealing with Private Venture funding. Meetings were also had to discuss the content with the Engineering Director. The marking scheme used to evaluate the results is listed below.

Category	**Score**
Strongly agree	[7]
Agree	[6]
Slightly agree	[5]
Don't know	[4]
Slightly disagree	[3]
Disagree	[2]
Strongly disagree	[1]

The data recorded from the questionnaires is detailed in Appendix D at the back of this thesis. Some of the specific elements measured by this questionnaire relate directly to this research are discussed in more detail here.

Analysis of Results

"Q3.1 will find this report useful for the type of work with which I am involved"

This is an important question relating to the actual usefulness of the report to an individual for doing the work that they are doing. This question raised the following responses. Ten candidates of whom seventy per cent are engineers responded positively to this question suggesting that the material contained in this report would be useful to their work. Three managers responded by disagreeing with the relevance of the technology to their work and three candidates did not know the relevance to their work (See Figure 5-18).

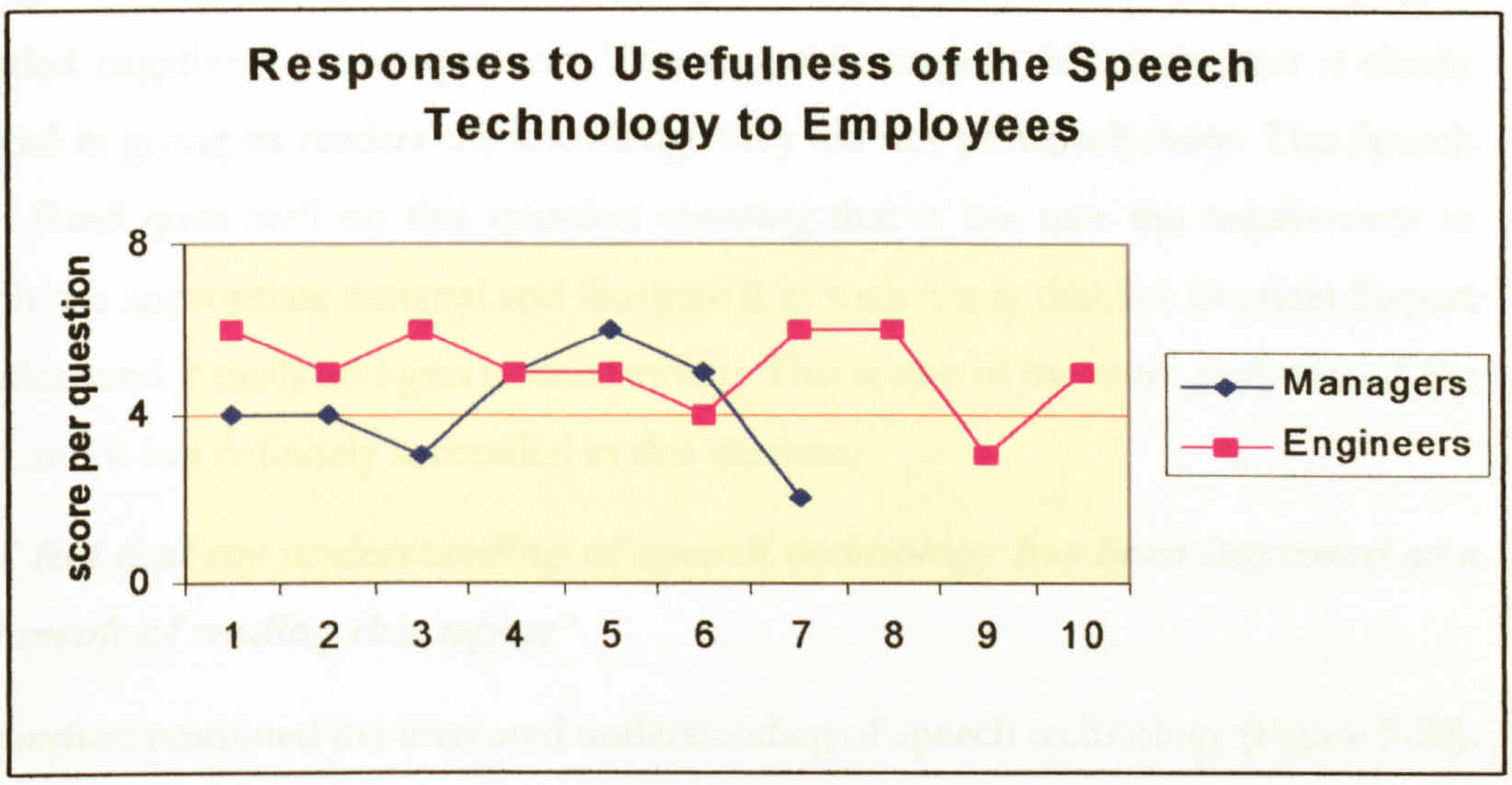


Figure 5-18: Graph Showing the Response to the Usefulness of the Speech technology to Employees

"Q4. This report is relevant to my role within BAE SYSTEMS"

A similar question to the previous one sought to see the relevance of the Speech Technology material in the report to the Domain Experts role in BAE SYSTEMS Ltd (Figure 5-19). Once again the engineers were more positive than the managers were. Thirteen candidates of whom 69% are engineers responded very positively, whereas three managers responded with negative answers and one other manager did not know.

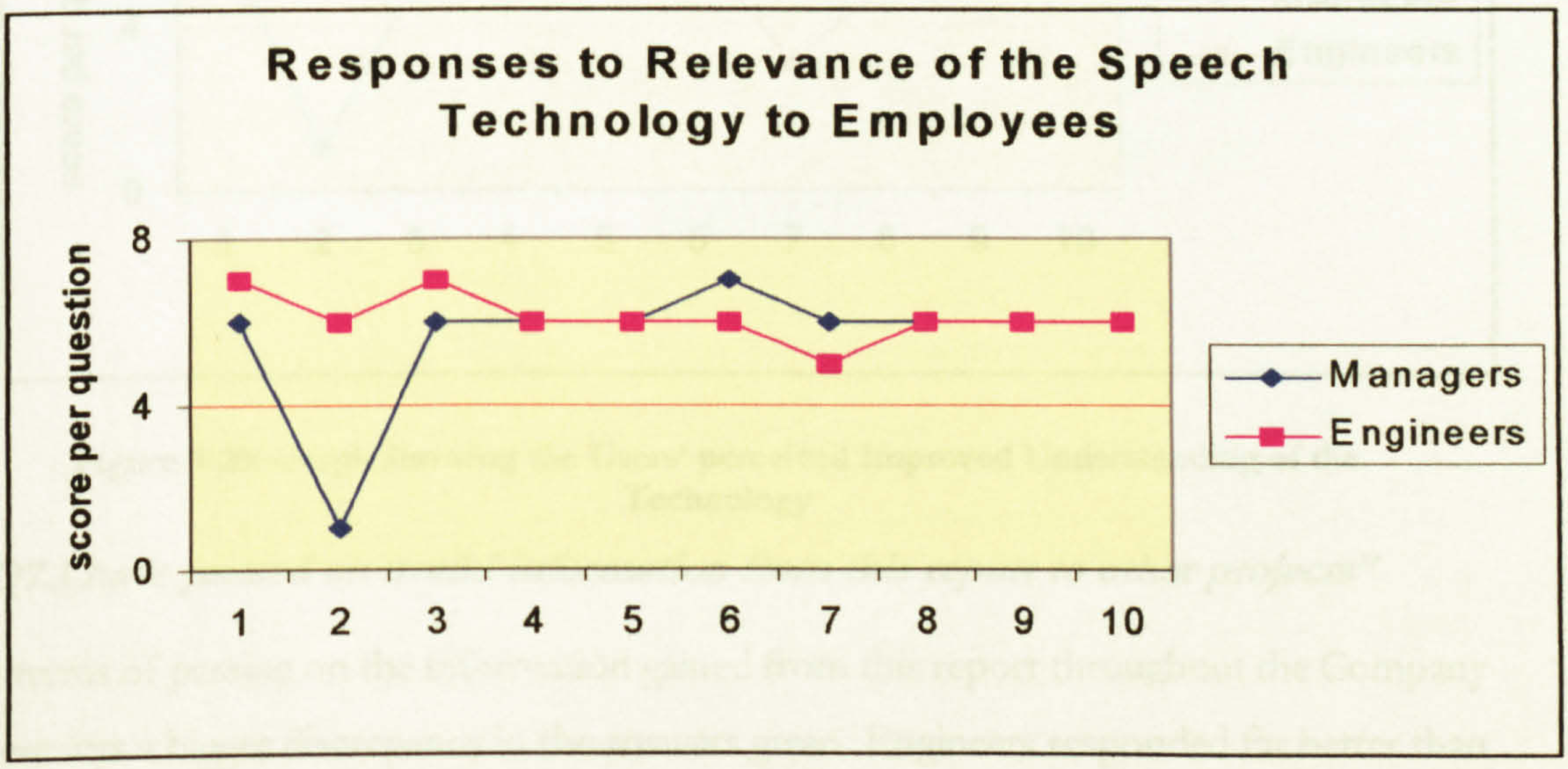


Figure 5-19: Graph Showing the Relevance of the Report to Particular Roles within the Company

"Q5. I feel that my knowledge of speech technology has been improved as a direct result of reading this report"

This question examined the personal gain in knowledge after reading the report. In answering this question ten engineers and seven managers responded very positively showing that they had gained knowledge by reading this report. Only two managers responded negatively to this question. This seems to suggest that the report is clearly beneficial in giving its readers the knowledge they did not previously have. The Speech Report fared quite well on this question showing that it has met the requirement to research the appropriate material and illustrate it in such a way that the Domain Expert can understand it easily and gain understanding. This is one of the main purposes of the Report and it has definitely succeeded in this element.

"Q6. I feel that my understanding of speech technology has been improved as a direct result of reading this report"

This question examined the increased understanding of speech technology (Figure 5-20). Here the results consisted of sixteen positive responses made up of nine engineers and seven managers and three negative responses. Once again it shows that both groups gained in their understanding of speech technology.

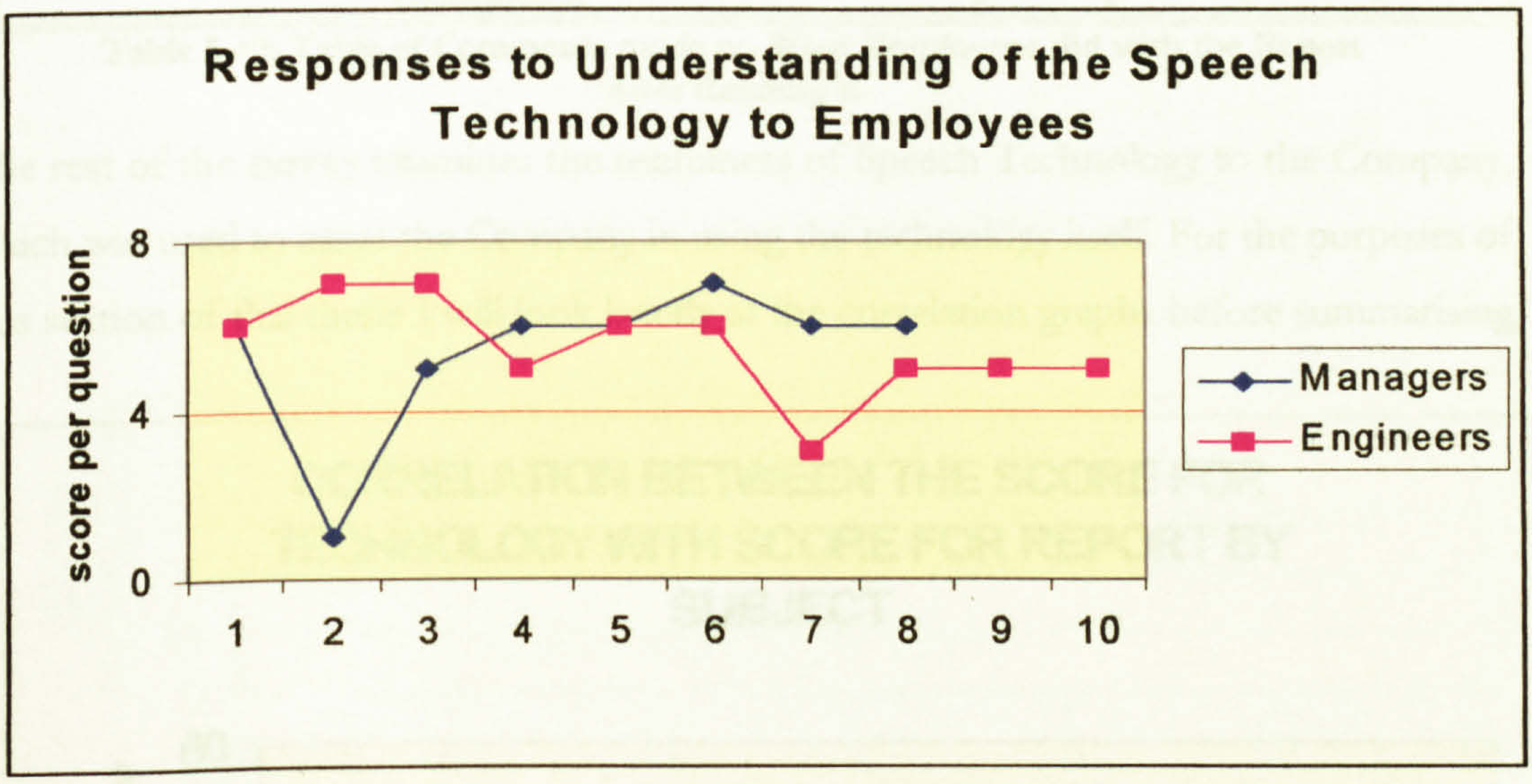


Figure 5-20: Graph Showing the Users' perceived Improved Understanding of the Technology

"Q7.I have passed on useful information from this report to other projects"

In terms of passing on the information gained from this report throughout the Company there was a bigger discrepancy in the answers given. Engineers responded far better than the managers in taking on this task. However, neither managers nor engineers responded by strongly agreeing that they would pass on information. Three engineers responded positively, two managers did not know and nine candidates from both groups responded negatively.

This suggests that although read by the majority of the sample and positively adding to both of the groups' knowledge and understanding (Q5 and Q6) of speech technology very few candidates were willing to pass on that information. Of the groups that were willing to pass on that information - the engineers fared far better.

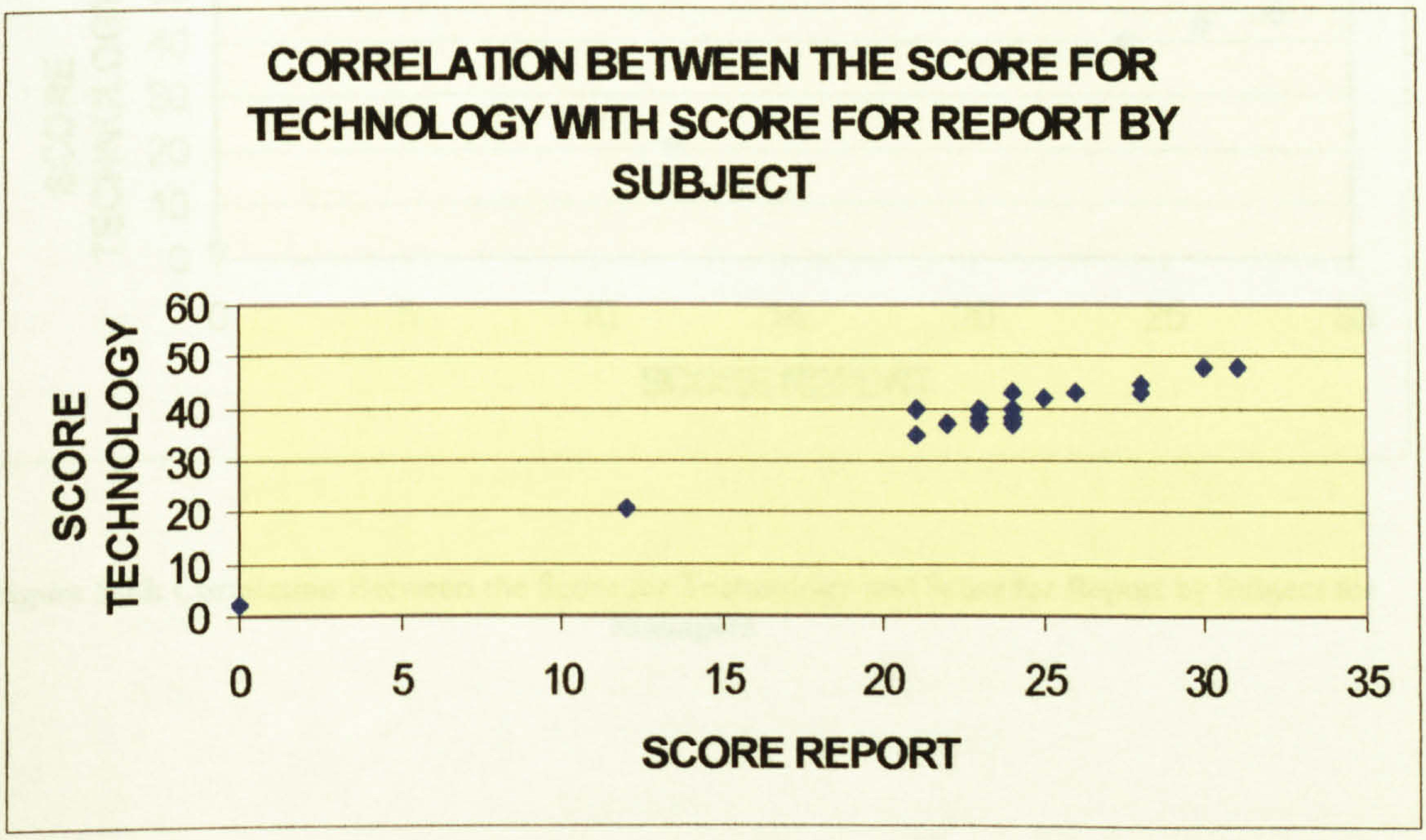
Comment element of ***"Q8: What have you done with this report since reading it?"***

The results of the comments recorded showed that a total of seven Managers and five Engineers responded (See Table 5-10). In most cases most candidates did little with the report up to nine months after it had been sent out. This just adds weight to my previous answers suggesting that the Company needs to rectify this by putting in a mechanism to deal adequately with such reports and research.

Action Taken	Manager	Engineer
Nothing	6	1
Filed it	1	2
Referred other people to it	0	1
Circulated it	0	1

Table 5-10: Table of Comments made on What Employees did with the Report After Reading it

The rest of the survey examines the usefulness of Speech Technology to the Company, which was used to assist the Company in using the technology itself. For the purposes of this section of this thesis I will look briefly at the correlation graphs before summarising



the results.

Figure 5-21: Correlation Between the Score for Technology and the Score for the Report by Subject

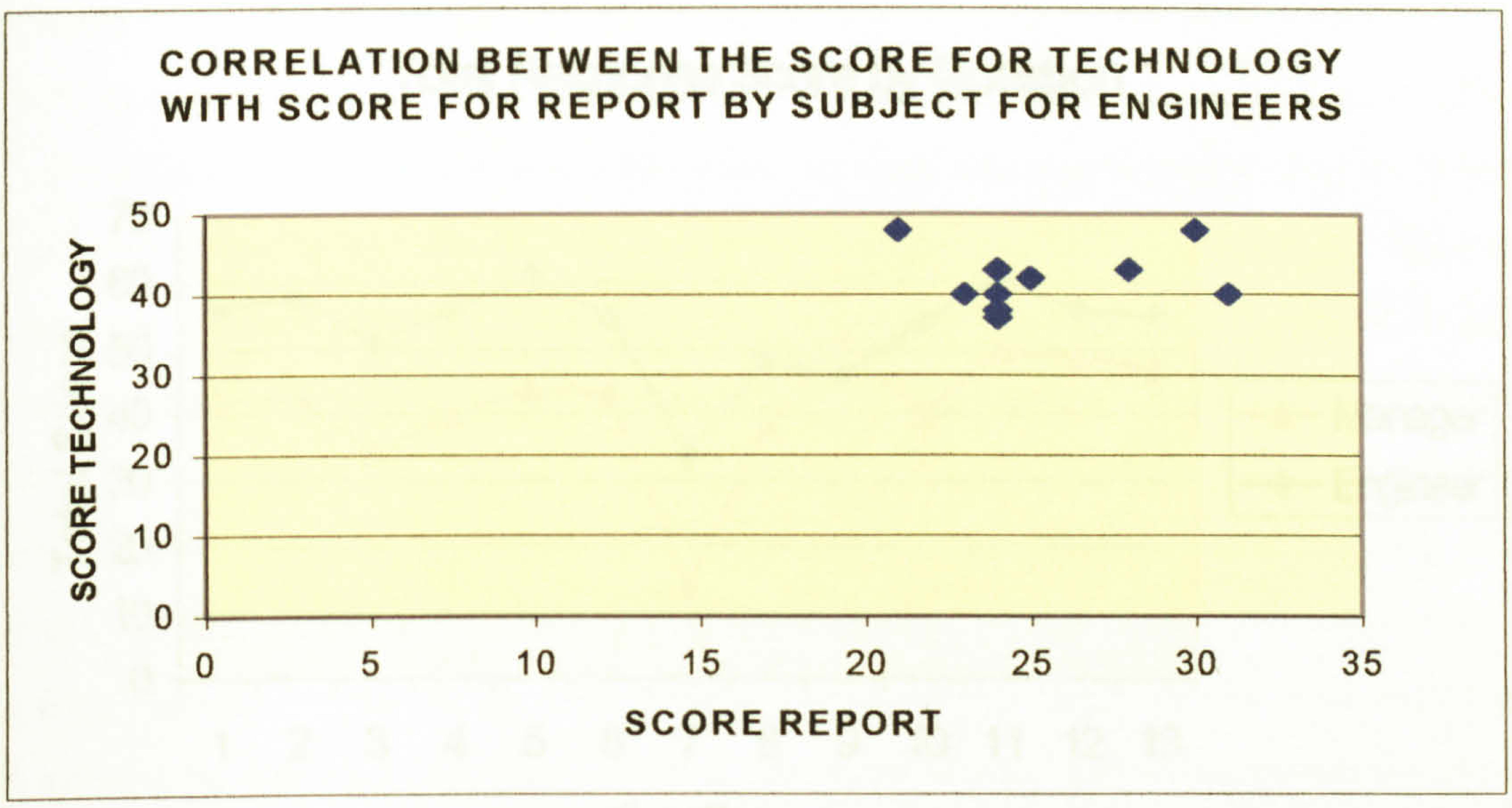


Figure 5-22: Correlation Between the Score for Technology and the Score for Report by Subject for Engineers

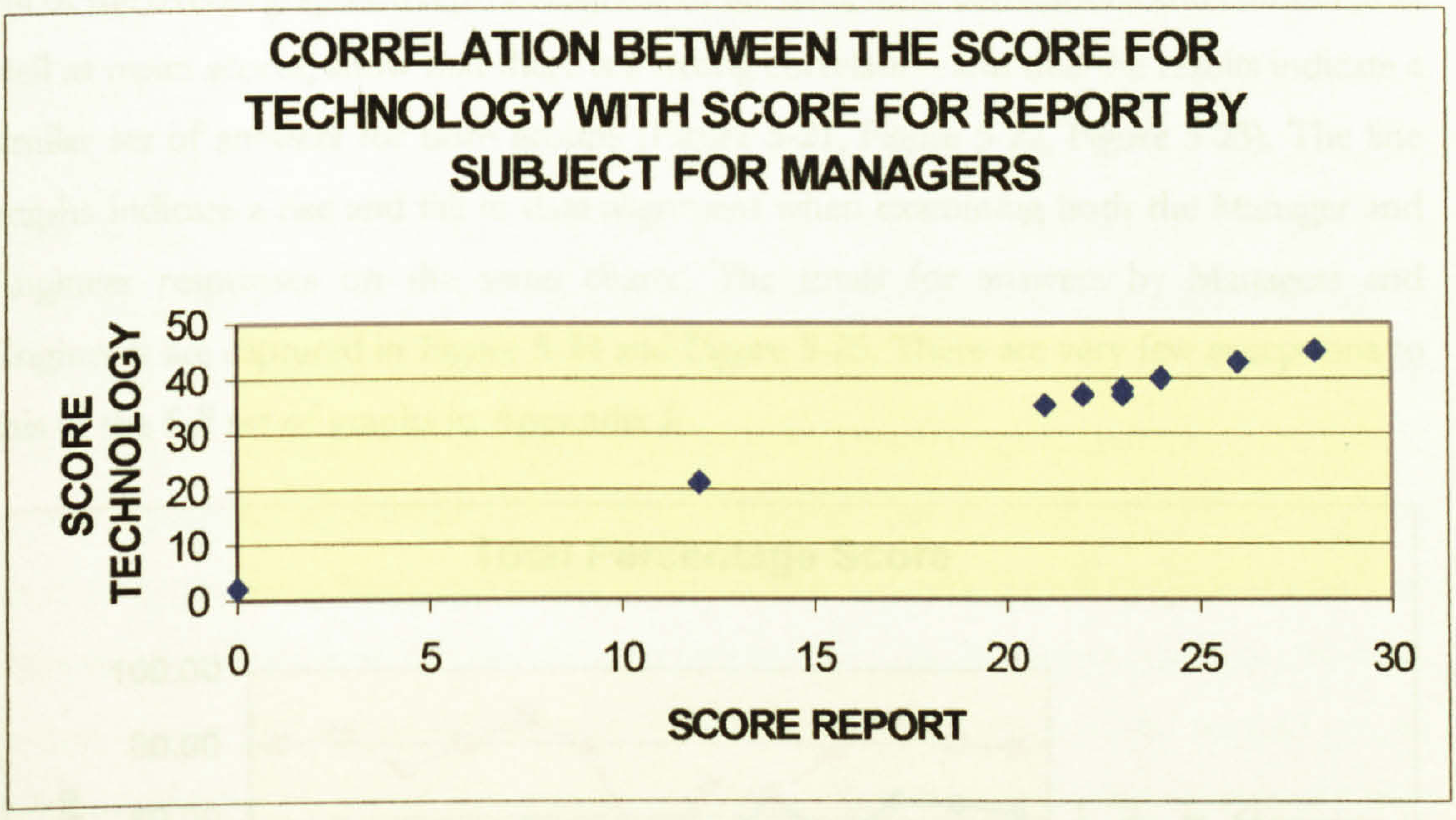


Figure 5-23: Correlation Between the Score for Technology and Score for Report by Subject for Managers

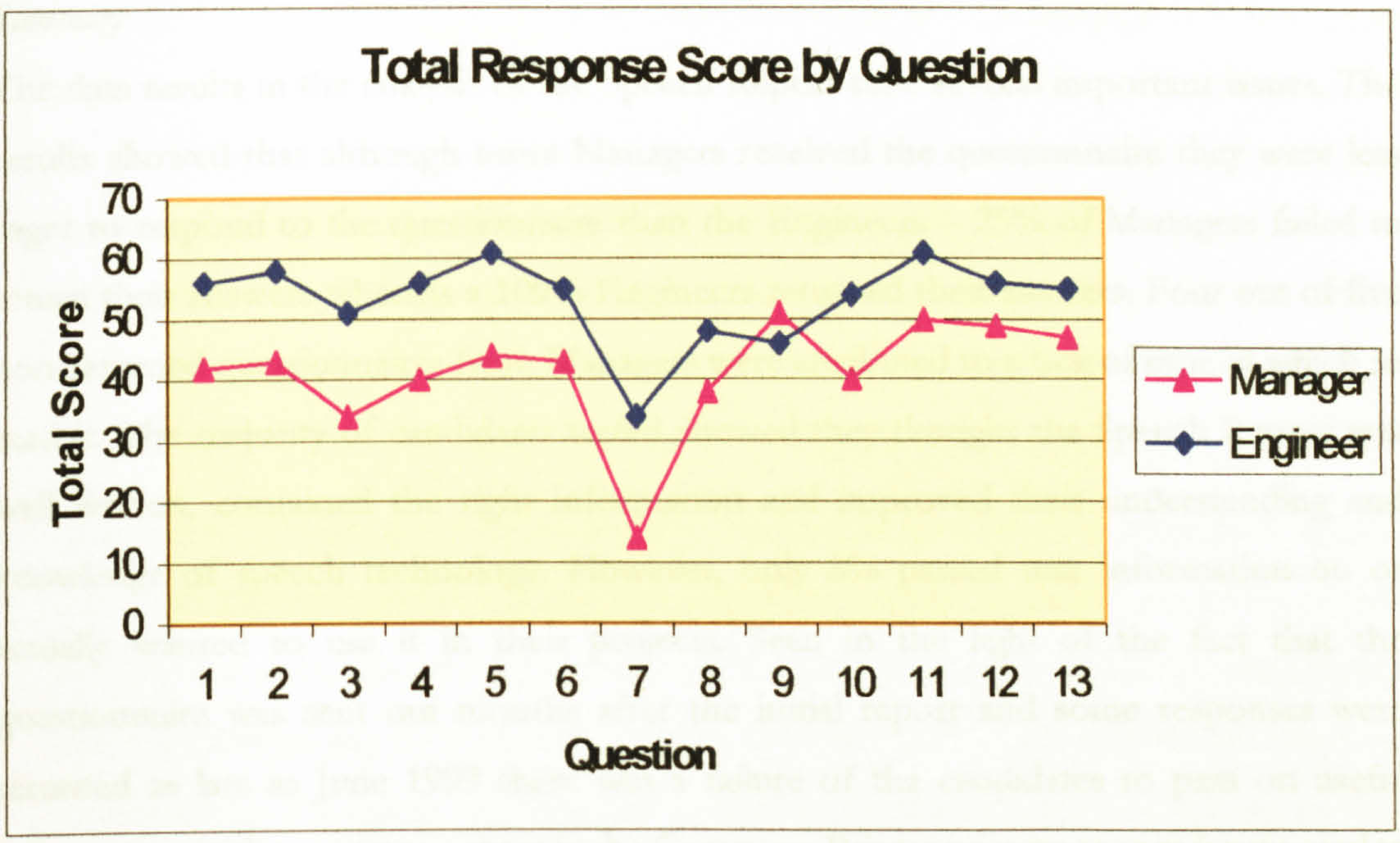


Figure 5-24: Total Responses to Questions by Managers and Engineers

All of the overall graphical representations of the data, both correlations and combined as well as mean scores, show that there is a strong correlation and that the results indicate a similar set of answers for both groups (Figure 5-21, Figure 5-22, Figure 5-23). The line graphs indicate a rise and fall in data alignment when examining both the Manager and Engineer responses on the same charts. The totals for answers by Managers and Engineers are captured in Figure 5-24 and Figure 5-25. There are very few exceptions to this in the full set of graphs in Appendix F

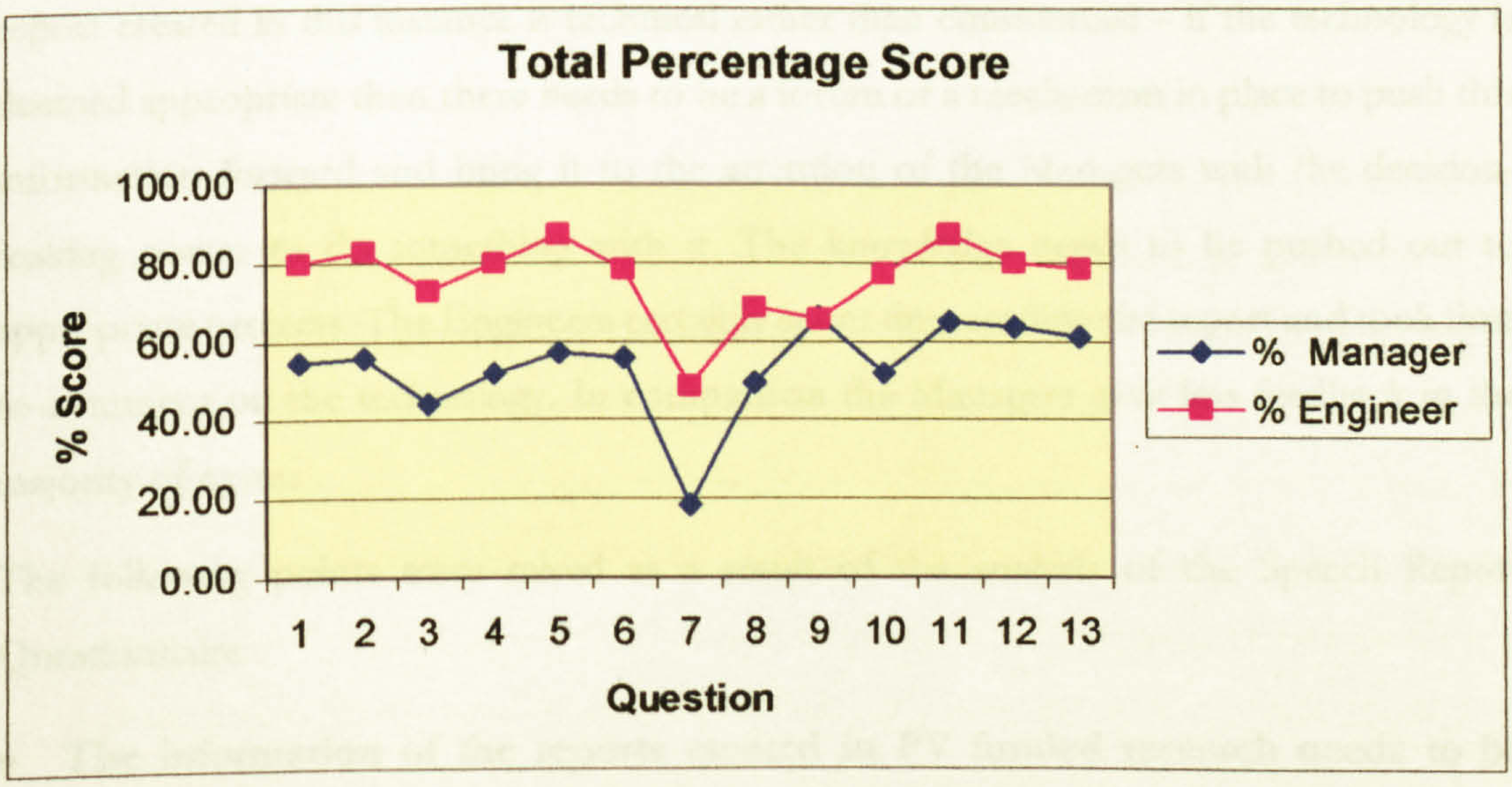


Figure 5-25: Total Percentage Scores for Managers and Engineers

Summary

The data results in the analysis of the Speech Report raise several important issues. The results showed that although more Managers received the questionnaire they were less eager to respond to the questionnaire than the Engineers – 25% of Managers failed to return their answers whereas a 100% Engineers returned their answers. Four out of five non-returned questionnaires from Managers were attributed to a lack of time in which to read it. The majority of candidates tested showed they thought the Speech Report was well written, contained the right information and improved their understanding and knowledge of speech technology. However, only 8% passed that information on or actually wanted to use it in their projects. Seen in the light of the fact that the questionnaire was sent out months after the initial report and some responses were returned as late as June 1999 there was a failure of the candidates to pass on useful information in the report to others in the Company. Private venture money is supposed to increase the knowledge and understanding of new technology and to provide innovation for the future of various technologies within the Company. Considering the fact that the results of this survey indicate that the ***right*** information was gathered, correctly distributed (to those that the management believe are in the best position to utilise this information) there is a hole in the process if this information never gets passed on to those in a position to do something with it. In my view it would be better to provide a report of a technological nature which is passed to key Engineers (those identified by the Company/Community as engineering/technical experts) who are in the position to use this information and bring it to the appropriate managers' attention. The bulk of the report created in this instance is technical rather than commercial – if the technology is deemed appropriate then there needs to be a forum or a mechanism in place to push this information forward and bring it to the attention of the Managers with the decision-making power to do something with it. The knowledge needs to be pushed out to appropriate projects. The Engineers certainly spent time reading the report and took time to comment on the technology. In comparison the Managers gave less feedback in the majority of cases.

The following points were raised as a result of the analysis of the Speech Report Questionnaire:

- **The information of the reports created in PV funded research needs to be passed on in some way that is deemed appropriate by the Company.** The analysis of the results suggests that a very small proportion of the information contained in the report was passed on or made available throughout the Company.

The Christchurch site is just one of many and my personal experience is that most people are unaware of expertise or other PV work in existence across the other sites in the business as there is no central point of this information. In examining the scores on the graphs it can be seen that there is a drop below average on question seven which relates to the distribution of the report. However, in looking at the results of question three it is noted that the managers do not see a relevance of the report to them. This may explain why the managers fail to pass on the information.

- **A mechanism for discussing the PV outcomes would also provide a useful forum to discuss issues arising from such research.** If the PV work was carried out and then explained and demonstrated through an appropriate technology group this would make the information available to those on the Christchurch site who are interested in attending. Perhaps the added cost of preparing and giving such a presentation or demonstration should be included in future PV funding estimates. Alternatively a short term PV working group could bring together all of the current year PV work in order to discuss the work that has been carried out with a view to continue further funding, or to start a new PV with a similar flavour but a different target and to look at mistakes made in order to achieve future improvement to PV funded activities.

- **Material discussed and raised should also be passed on appropriately and a mechanism for this needs to be in place too.** Following on from the previous point, the information and details of the decisions made should be made available too. I would expect these to be kept with the other PV material and communicated to staff too.

- **The information needs to be stored appropriately for easy retrieval and access by other sites (whether this is the PV site or not) and should be made clear.** A mechanism for storing, categorising and even cataloguing the PV work and associated PV reviews needs to be established. Once established it needs to be made available to all staff and the process for applications for new PV should also be stored within the proximity of this material. Currently, several PV sites exist across the business and they are all out-of-date; also the information for reports, for demonstrations and even contact points for those directly involved should be stored with that information. It would be good to have a manager contact and an engineering one and then other staff can contact the appropriate person dependent upon their requirements.

- **The clarification of the requirements for reports being written should be in some generic format on the PV web site.** When looking at a common set of requirements for the PV report staff will become familiar with these and tailor their research within these boundaries. This helps staff writing the reports to get clarity and direction.

- **The standard formats for documentation should be determined and stated on the PV web site (e.g. what template is required, where you get document numbers and other administrative issues related to keeping conformity across all reports).** If reports are going to continue to be produced a template report should be devised and made available on the Intranet to all staff. This kind of report is quite different from the normal engineering documents produced within the Company and so by defining a common template it means that those producing the report have a better idea of what kinds of things are expected of them. It also means that the format will become familiar and staff will be able to go directly to the section they want to read.

- **Some sort of announcement as to new research reports should be made – either at briefs at the local level or by e-mail to all staff.** If new reports are written or new demonstrations available through the PV work then these should be announced and communicated to all staff. At the moment this does not happen at all.

- **There should be a single storage place for all research and innovation related materials – perhaps through the VU.** As an engineer and more recently as a manager I would expect to find all Company PV material from all Company sites on the Intranet. The Company can make financial savings in doing this since there will be no direct duplication of work. The Company also benefits in that all staff can locate the important PV material relevant to their work/project efficiently if this is done.

- **Information from research that is intended to be used needs to be filtered to the appropriate technical directors or heads of divisions to make a decision.** If PV work triggers new products or improves processes etc. then this information should also be communicated to all staff. If a technique is adopted and used, for example then other members of staff may want to know the difficulties and issues this has developed or the successes they have met with. Decisions on whether a PV project should be used elsewhere needs to be made quite quickly especially in a fast moving technology field or the opportunity will pass by.

This Speech Technology Report is one example of many such Technical PV Reports and although the evaluation looks at this Speech Report in isolation the concepts relate to all technical PV reports as a whole. In order to clarify the evaluations made by this first questionnaire it is planned to run a similar survey on another PV Report to see if there is any correlation between the results. The results of this first analysis were fed back to the Head of the Engineering Department and the PV Manager together with suggestions for discussions in order to improve the PV process. This approach was also discussed with the Software Engineering Process Manager. However, I decided at this point that I would not advance this element of my research further because I had now raised the visibility of the results to the Engineering Director and passed the survey results on to the domain experts within the Company. I had passed on the responsibility for further action to the Engineering Director and made recommendations that can be dealt with through that channel. I have considered the usefulness of agents in PV reports such as this in my concluding chapter.

Having firstly made the information and analysis available to the relevant members of staff within the Company it has become clear that many of the issues raised are dependent upon a change in various company processes including the PV process itself. There are other issues which need to change such as the social and cultural views of the PV work and why it is important. The Company needs to revisit its PV process and establish how to get the best from it. There are many ways of making the PV work available to all staff, for example if the Company utilised the Intranet site more readily with direct access to the information that would be a start. All in all this area seems inappropriate on its own in terms of lending itself to the application of software agents.

Area Two: E-mail

E-mail was selected as a possible area for further research because it was mentioned at many interviews and seemed to be one source of overload of information. The e-mail survey was carried out at the end of cycle two (Interviews with the engineering community) in order to establish on the basis of cycle one and two whether this was a suitable area for the pilot to be carried out. This survey was not a questionnaire as in other aspects of the research but a quick view to measure the real quantities of e-mail data being received by individuals in the engineer and manager groups and how long it takes them to completely close down the individual e-mail. There is an assumption that e-mail is partly the cause of increased workload and information overload. This survey examines how much of a real problem this is if the results are scaled up to the Company view.

To examine the amounts of time spent dealing with e-mail responses a small survey of three Managers and three Engineers was used to establish what percentage of time each group spends on average dealing with different types of incoming e-mails. An Excel electronic form was created to contain the data to be examined and this was sent to a selection of candidates who were approached prior to the survey and agreed to participate.

The Method

This study focuses on the number of e-mails received by employees (into their In Box in MS Outlook) within the company and the time spent dealing with each of the e-mails (Figure 5-26).

This survey identifies particular criteria by which measurements are made. Firstly, there is a distinction between **Personal E-mail** and **Work-related E-mail**. Secondly, there is a distinction between the time spent dealing with each incoming e-mail, which are categorised as: -

Read Only: This category is received and read and requires no further action on the part of the receiver. They are usually the communication of information of some description e.g. in the personal category this could be a joke or in the work-related category it could be some kind of Company notice.

Immediate Response: This category is received but interrupts the employees' workflow in order to respond to a request which is required more expediently e.g. a superior requires information urgently for a specific purpose which cannot wait. Action by the employee is necessary to complete the request.

Slower Response: This category requires a response from the receiver in order to complete them but this is not required immediately. There may still be a deadline to respond later in the week, or month, or no deadline given but a response expected. These e-mails may trigger other action in order to completely close down the e-mail e.g. a superior asks for a check on the number of reviews a software team has carried out in the last 12 months – this would trigger the receiver to spend time talking to individual team leaders and identifying information from the project directory in order to respond to the request.

Each e-mail was recorded on a spreadsheet for ease of use and included an e-mail identity number and description used by the candidate for personal tracking only. The subject matter or content was not specifically identified for the purposes of this research.

The time factor used was explained to the candidates prior to them beginning the recording. The time factor was the time to completely close down an e-mail – in this case if one incoming e-mail triggered further e-mails this was included as part of the original e-mail time spent closing the original e-mail down. This time factor includes all the work or actions taken in responding to the original e-mail e.g. talking to others, drafting a proposal etc.

The survey was sent at random to three managers and three engineers within the Company. This division is based on the same prior categorisation used in the Doctorate to keep it consistent with this view. These candidates were selected using the Christchurch Outlook address book.

The candidates were told verbally by telephone what was being requested and asked if they were content to take part in this survey over a one working week period and return the results to me. They were also told that their identities would be confidential. The request was to open the e-mail In Box on Monday morning and categorise and complete the day one part of the spreadsheet. They were to track the progress and completion of each of these e-mails. For the rest of that working week they were to maintain the survey spreadsheet in order to track the total number of incoming e-mails in one week and record the details requested. Realising that some e-mail would be incomplete within a working week a request was made to estimate the remaining time required to close down the outstanding e-mails.

The survey (See Appendix C) looks at the two categories of Managers and Engineers separately and deals with issues such as the amount of each type of e-mail; the time spent dealing with each type; the difference in the personal and the work-related e-mails; and analyses the trends found in the data. The report then compares the results before drawing some conclusions and finalises with an analysis of the survey and how this information can be used in the future.

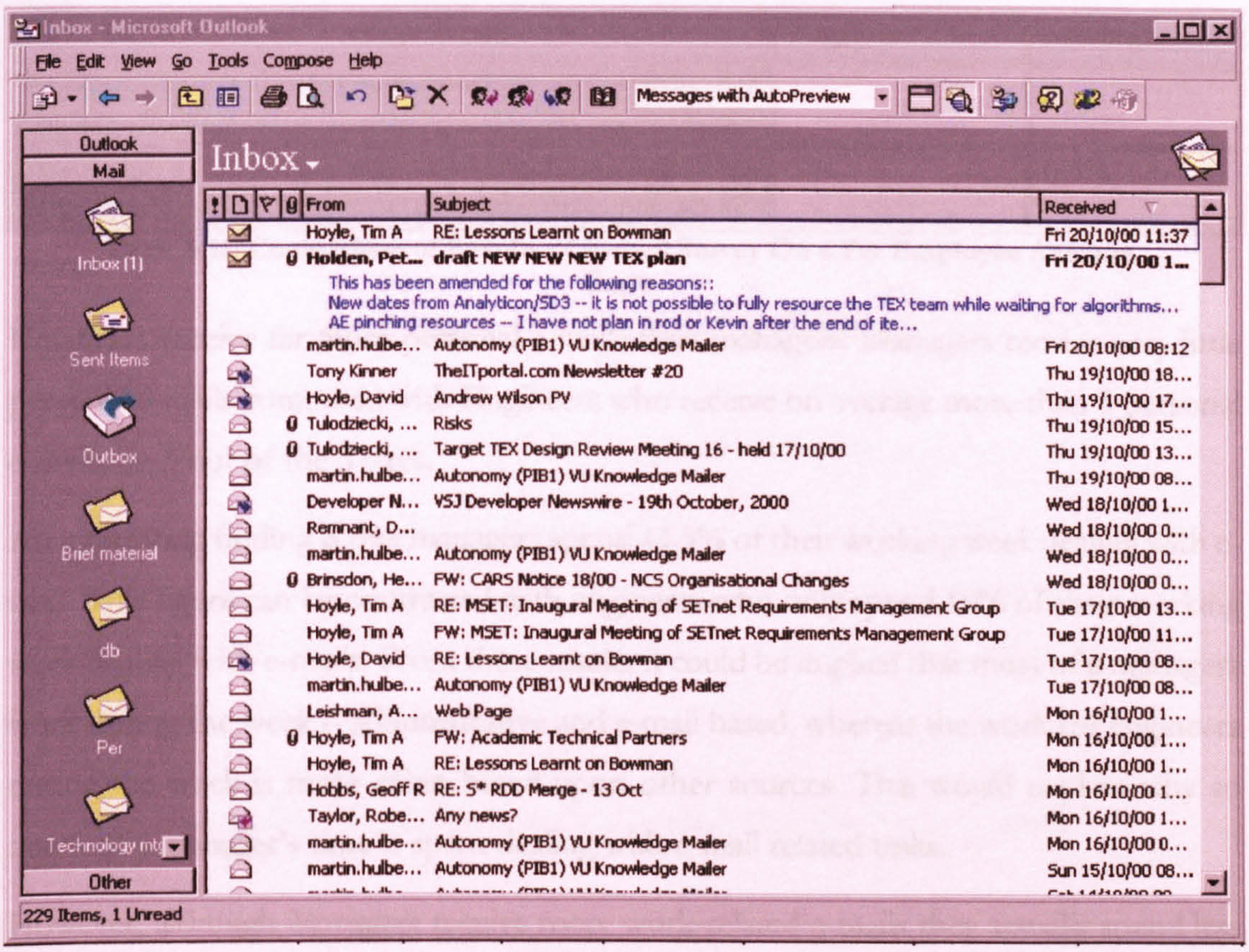


Figure 5-26: BAE SYSTEMS Outlook E-mail Facility

Analysis of the results

The results are described in detail in Appendix C at the end of this thesis. However, of particular interest are the comparisons between the two sample groups and the overall conclusions from this survey. As an indication of a comparison between the two groups on a per employee average basis Table 5-11 illustrates the far greater number of e-mails received by the Manager group (108 for a Manager and 47 for the Engineer) and the higher amount of work-related e-mails in particular.

On a Per Employee Average Basis	Engineer	Manager
On average how many e-mails does an employee receive per week?	47 e-mails	108 e-mails
What is the average time spent by an employee dealing with e-mails per week?	6 hours 15 minutes	16 hours 20 minutes
On average how many work-related e-mails does an employee receive per week?	19 e-mails	106 e-mails
On average how many personal e-mails does an employee receive per week?	28 e-mails	2 e-mails
What is the total time that an employee spends on work-related e-mails per week?	5 hours 39 minutes	16 hours 8 minutes
What is the total time that an employee spends on personal e-mails per week?	1 hour 3 minutes	12 minutes 20 seconds
Assuming a 37 hour week, how much time does an	15%	44%

On a Per Employee Average Basis	Engineer	Manager
employee spend dealing with work-related e-mails per week?		
Assuming a 37 hour week, how much time does an employee spend dealing with personal e-mails per week?	3%	0.5%

Table 5-11: Comparison of Results of E-mail Survey On a Per Employee Average Basis

Engineers receive far more personal e-mails than managers. Managers receive very little personal e-mails compared with Engineers who receive on average more than 5 personal e-mails on 3 out of the 5 days.

An interesting finding is that managers spend 44.5% of their working week dealing with e-mail. This figure can be contrasted with engineers who only spend 18% of their working week dealing with e-mails. From these results it could be implied that most of a managers work during the week is administrative and e-mail based, whereas the work for engineers during the week is more often based upon other sources. This would explain why so much of a manager's time is spent dealing with e-mail related tasks.

However, although Managers receive more work-related e-mails they actually spend less time, on average, dealing with these e-mails. Managers spent on average 9.13 minutes dealing with a work-related e-mail. This can be compared to Engineers who spend 17.83 minutes dealing with work-related e-mails. This trend also applies to personal e-mails where Engineers receive more personal e-mails and spent on average 1.3 minutes dealing with each personal e-mail. On the other hand, Managers receive fewer personal e-mails but spend on average 2.34 minutes dealing with each one. Managers receive more e-mail but spend less time dealing with these e-mails. This may be due to the fact that when an Engineer receives a work-related task via e-mail it tends to require more effort than a work-related task that is received by a Manager. This may be the result of the specific e-mail content since engineers are likely to receive technical e-mails that may be complex, however Managers are more likely to receive managerial or administrative e-mails that potentially require much less thinking. This aspect of the survey is hard to assess but could be investigated further by the Company at a later date.

This survey has revealed that Managers receive far more e-mails than Engineers. This may be due to the fact that Managers have contact with a far greater volume of employees than Engineers, which will subsequently put them in a position where more people are likely to make contact with them. Managers will interact with other managers and will be responsible for a larger proportion of Engineers. This number will outweigh the number of people that an Engineer will come into contact with, who tend to be other Engineers they work with and their direct manager.

These numbers can be broken down further to analyse the number of work-related e-mails received by Managers and Engineers on a daily basis. From the e-mails collected it appears that Managers received far more work-related e-mails than Engineers. On the other hand it was discovered that Engineers received far more personal e-mails than Managers. The reason for Engineers receiving more personal e-mails than managers is a cultural issue. Engineers engage in more social e-mails than Managers whether it be organising football games or organising a social event. It is far easier to send one e-mail addressed to a number of people rather than phone each person individually.

Examining these results further was done by calculating the total time per Engineer or Manager divided by three to get the average time. This is represented as a percentage of a standard working day (i.e. seven hours or 420 minutes) and is represented in the following pie charts: -

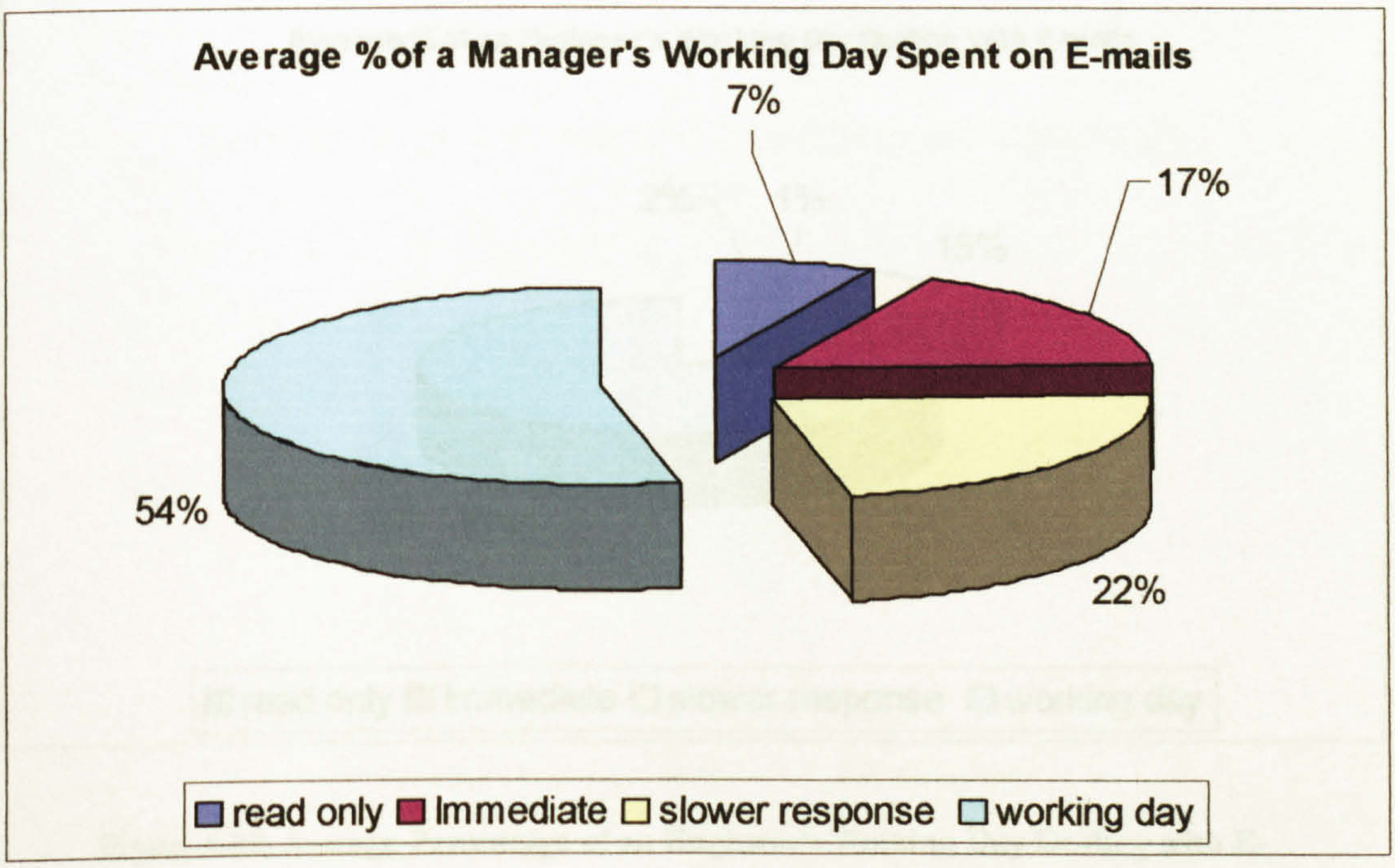


Figure 5-27: Average Percentage of a Manager's Working Day Dealing with E-mails

This gives some indication of how dealing with e-mail eats up the Manager's time. The figures are indicators of the amount of time managers spend on dealing with e-mails, which is a big concern here.

Managers seem to have a lot of **immediate** e-mails (Figure 5-27) whereas engineers get hardly any (See Figure 5-28). There is less difference in the amount of **slow** e-mails. Therefore it is the **immediate** e-mails that are taking up most time, followed by the **read only** category then the **slower** ones. The **read only** are probably there to ensure good communication within the business and thus it may not be possible or desirable to reduce these. But where it is possible to improve the situation for the Manager is to reduce the amount of those e-mails in the **immediate** response category. The first question that comes to mind is: are these **immediate** responses only able to be dealt with by the Manager? Also are any of these duplicates, since this was mentioned in several of the interviews in cycle one? In order to answer these questions further research would need to be carried out to determine the content type and the relevance to a Manager.

If the Managers have more **immediate** e-mails requiring a response these may relate to the kind of role they are doing (Figure 5-30). They are likely to be making quick responses in order to manage their projects and to let others get on with the rest of the work that needs to be done. It is likely to be critical to their role to respond immediately to these questions that they are able to answer more immediately. This is unlikely to apply to the Engineers

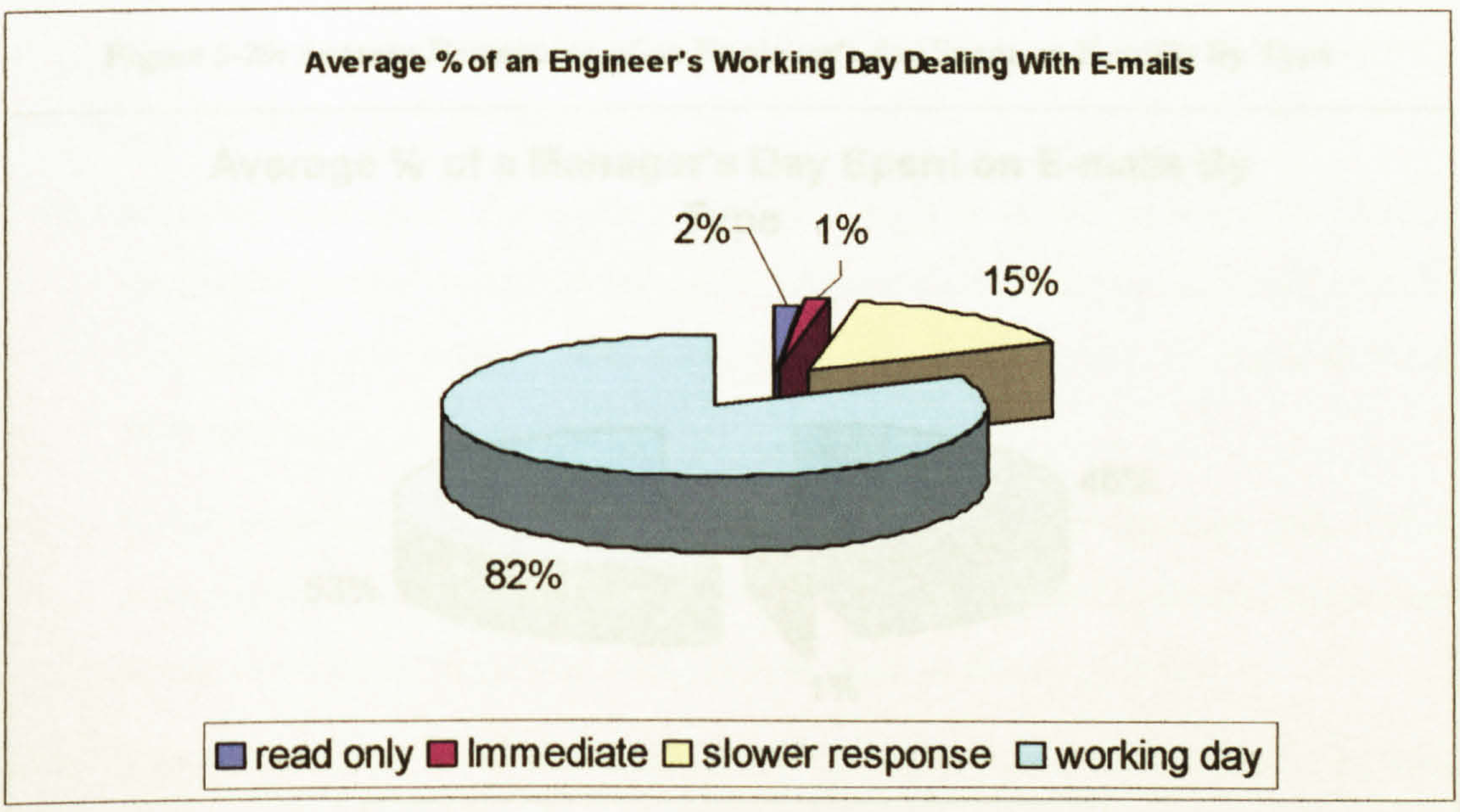


Figure 5-28: Average Percentage of an Engineer's Working Day Dealing with E-mails

Engineers are weighed down mostly by e-mails in the **slow** category (Figure 5-29). In a further investigation it may be worthwhile considering the content of these **slow** e-mails e.g. are these helping the engineering team or are they answering questions? Or are they passing information? Or are they problem solving? Etc. Or are they issues that should be more effectively dealt with by someone who is more appropriate to deal with them e.g. a team secretary or technical administrator? None of these issues have been pursued here but could be considered by future research.

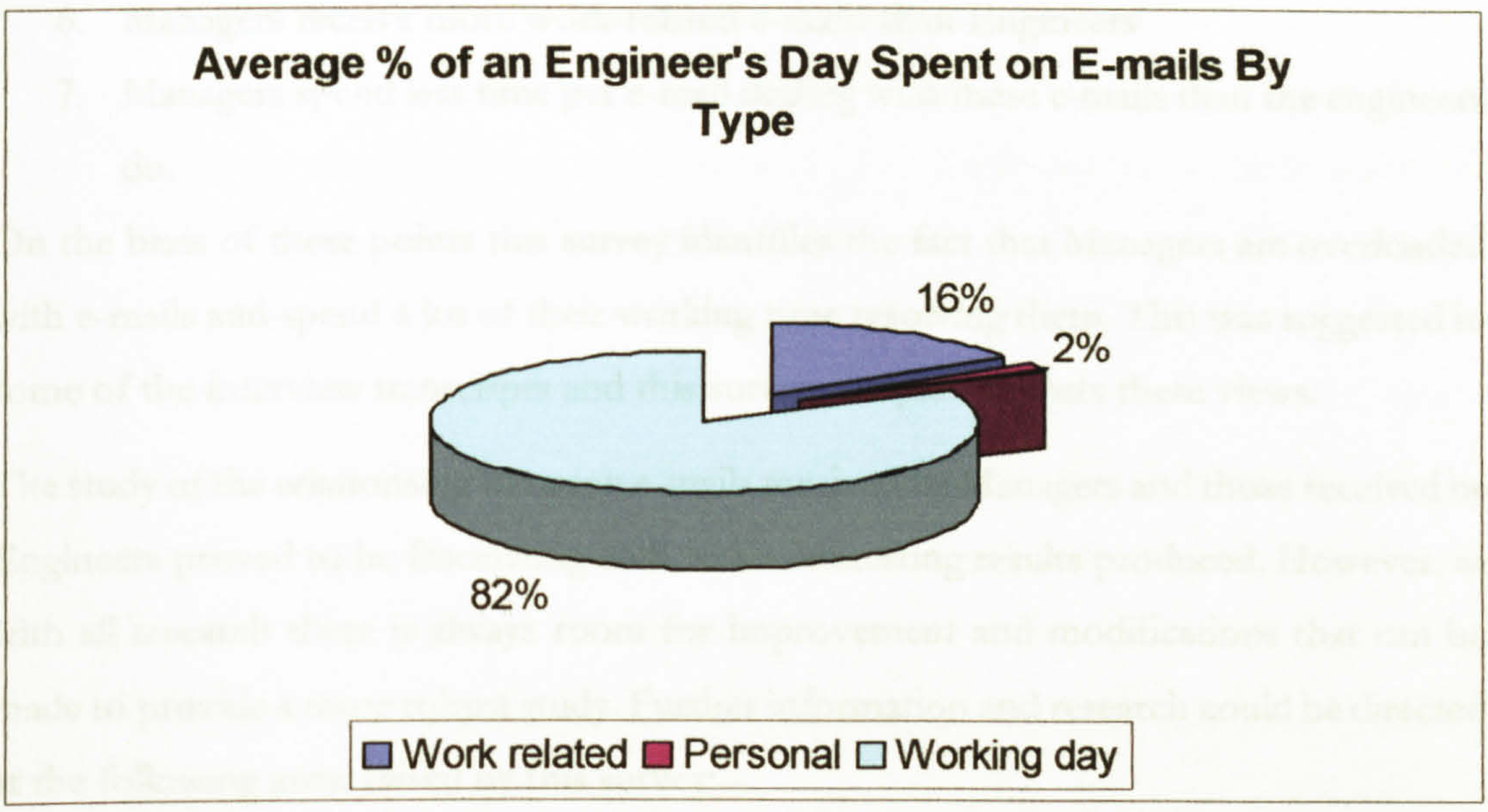


Figure 5-29: Average Percentage of an Engineer's day Spent on E-mails By Type

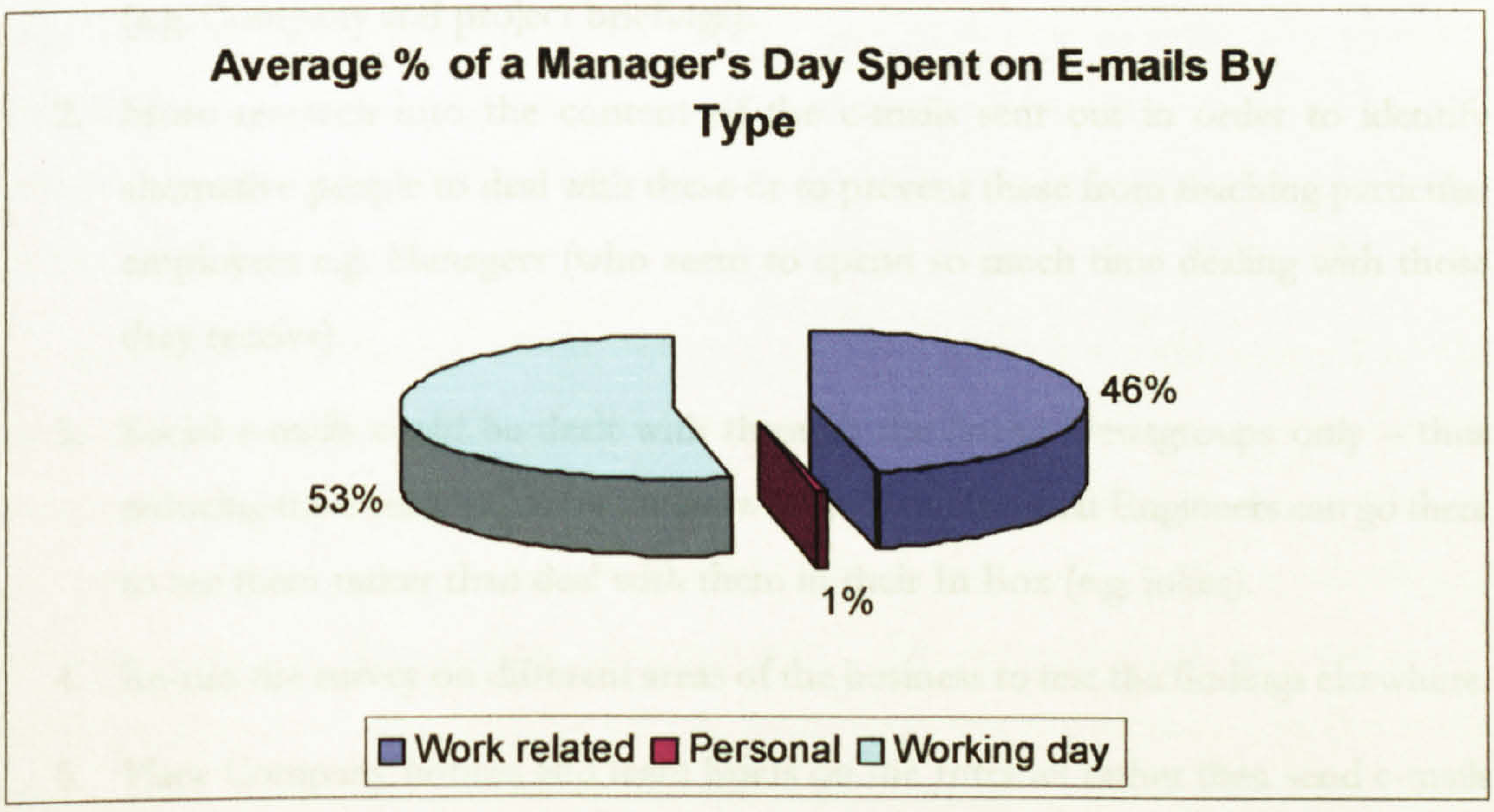


Figure 5-30: Average Percentage of a Manager's Day Spent on E-mails By Type

Summary

The results of this survey provide the following results: -

1. Managers receive more e-mails than Engineers
2. Managers spend more time dealing with e-mails than Engineers do
3. Managers spend on average 47% of their working day dealing with e-mails
4. Engineers spend on average 18% of their working day dealing with e-mails
5. The immediate category of e-mails is the one that takes up the most time resolving for Managers.

6. Managers receive more work-related e-mails than Engineers
7. Managers spend less time per e-mail dealing with these e-mails than the engineers do.

On the basis of these points this survey identifies the fact that Managers are overloaded with e-mails and spend a lot of their working time resolving them. This was suggested in some of the interview transcripts and this survey sample supports these views.

The study of the relationship between e-mails received by Managers and those received by Engineers proved to be fascinating with some interesting results produced. However, as with all research there is always room for improvement and modifications that can be made to provide a more robust study. Further information and research could be directed at the following areas raised by this survey: -

1. Investigate the amount and type of repeated information sent from several sources and look at providing central co-ordination of communications material (e.g. Company and project briefings).

2. More research into the content of the e-mails sent out in order to identify alternative people to deal with these or to prevent these from reaching particular employees e.g. Managers (who seem to spend so much time dealing with those they receive).

3. Social e-mails could be dealt with through the Social Newsgroups only – thus reducing the e-mail traffic on the network and the fact that Engineers can go there to see them rather than deal with them in their In Box (e.g. jokes).

4. Re-run the survey on different areas of the business to test the findings elsewhere.

5. Place Company notices and team briefs on the Intranet rather than send e-mails relating to this information to so many individuals. Individuals' responsibility to get the information if they want it.

6. Increase the scope of this survey to include all time spent receiving e-mails, dealing with responses to e-mails and using the e-mail to send out messages. This would provide a more holistic view of the usage and efficiency of e-mail.

7. Look at the Managers' e-mail workload in isolation. Examine the content of e-mail and look at the process being used to deal with specific tasks. For example, if e-mail is just being used to get Managers to provide information available in the project directory – perhaps a technical administrator would be a better person to get and pass that information on. The immediate response e-mails could be

examined in more detail – perhaps this is an indication of poor planning e.g. there should rarely be an interruption in a Manager's day for emergency information (it should be the exception rather than the norm). If information is required like this then why hasn't it been planned into official formats like agenda minutes for resolution or planned early allowing for effective time management for the Manager?

8. To give a higher amount of confidence in the results further repeated trials may be seen as a pertinent step forward. However, the sample was representative of the Company at the time of the research.

9. The time period over which this survey was carried out could be repeated at other times in the year to isolate monthly or quarterly trends and peaks and troughs of e-mail activity.

This survey was a quick turnaround extension of the previous analysis in order to assess whether it was worth pursuing this area for the pilot study in cycle three. Therefore the analysis carried out was only based upon the overview and average statistics of the two groups rather than an in-depth coverage of individual responses and what these may mean.

On the basis of the findings of this survey it has been decided that this area will not be pursued in the experimental application of software agents. The main reasons for this include the fact that several areas for concern which are raised in the results are predominantly Company process issues and these are unsuitable for the application of software agents e.g. the repetition of e-mails sent. Other aspects include the social side of sending personal e-mails – this is a cultural issue which was not addressed by this study, although it could be considered as important to the Company in any future investigation.. The e-mail statistics and survey results were passed on to the internal division responsible for maintaining the e-mail system (CSC) and the Intranet Solutions division of the Company. Finally, there are plenty of ways of filtering and dealing with incoming e-mails, which can be resolved through the Outlook package e.g. e-mail can be prioritised and flagged – individually sorting on these or other criteria can enable users to manage their e-mail better. During the research a number of e-mail specific software agent applications were identified which the Company could pursue in the future. But the overall benefit to the organisation would give little return on investment. However, these purely manage the filtering of the e-mails and carry out no intelligent knowledge management. The aim of this research is to examine the application of software agents for knowledge management and these fail to meet those expectations.

Area Three: Resource Management

The final area of investigation examined the Resource Management role within the Company. This was instigated by the views provided during cycle one concerning the resource planning management, use of the skills database and the area of identification of Company expertise within the organisation. In the clustering process at the beginning of this cycle (based upon the cycle one output) it is clear to see that there are a number of significant areas of interest in this domain that can be investigated further e.g. out-of-date information, usability issues, time-consuming process and the inability to locate the experts and expertise (See Appendix E).

This survey considers the whole process of recruitment and career advancement within the Company and utilises the following web-based survey. This survey was aimed at Resource/Staff Managers and Project Managers who would be seeking to fill vacancies on their projects.

The Method

The resource management questionnaire is also based on the opinion and beliefs of the employee answering it and uses another Likert scale analysis. Once again there were open-ended questions and comment boxes for a record of qualitative information. The survey was carried out at the end of cycle two (Interviews with the engineering community) in order to establish on the basis of cycle one and two whether this was a suitable area for the pilot to be carried out. The questions were devised based on criteria arising from the interviews. I wanted to try to understand what factors in the resource management process individuals rated highest, dependent upon the role of that person. The criteria from the interviews included CV, training, qualifications, technical skills, staff dialogues, personal development plans (PDP), their domain experience and current post. However, after having several meetings with human resources and other resource managers I decided to add other factors as a test of both the individuals' knowledge of the Company (e.g. its values), personal skills and social skills. The final list was discussed with a senior resource manager before being prepared for delivery.

The survey was placed on the Company's internal Intranet site. The results were then submitted to an Access database where they were available for analysis. All Christchurch Staff Managers and Resource Managers were identified and sent e-mail instructions of why the survey was available and the purpose of it. This first group are users of the recruitment process as part of their day-to-day role within the Company. The e-mail included a hyperlink to the survey. A second group of individuals was also identified – this group included Development Managers and Project Managers. This second group was identified as the key personnel requesting the service of the first group to meet their project resourcing needs – they were selected at random once the human resources division of the Company had defined a subset. Then e-mails were sent out to equal numbers of staff in the first and second group. The target audience for this survey did not include the engineering community representatives. These were considered as irrelevant sources to evaluate this recruitment process since they would not have much knowledge of the process or its operation, as they are not involved with it directly. Also many of the issues relating to the resource management information and process are from the management domain. There were still two groups to compare and correlate since there are the resource/staff managers and secondly the project and development managers. There is a distinction between these two groups because the first group initiates and drives the process and supplies candidates to the second group. The project managers are part of the process and are being provided with services by the resource management group in order to meet the resource needs for their projects. So both groups can supply useful feedback and views of the system based on the appropriate supply of staff.

The survey was written in HTML on this occasion since I had learned to develop web pages in an evening class and used this for practice of that knowledge. The results were collected and imported into an Excel workspace and traditional statistical analysis was carried out on the results. The results were incorporated into a report that was distributed to those who requested a copy when filling in the questionnaire; it was also given to a senior resource manager within the business. The questionnaire and the survey results report can be found in the appendices at the back of this thesis (See Appendix B).

The survey consisted of two sections. The first section recorded data such as the name, job title, grade and specific site as well as the candidate's involvement in the recruitment process. This is illustrated in Figure 5-31. This data is used to statistically analyse the results in the two groups identified particularly in examining the correlation of the results and the differences and similarities in responses to the questions in the survey.

The second section contains Likert scaled responses to various criteria identified prior to the survey (by collaboration group interactions) as being a part of the process in some form. The scaled questions were divided into the following categories: -

Technical Factors – These factors consist of applicants' experience, academic ability and past record e.g. Personal Development Plans and Staff Dialogue Records if they are an internal candidate or curriculum vitae, educational qualifications for external and internal candidates. There are 10 areas identified within this group– see Figure 5-32

Company Factors – These factors consist of the applicants' Company experience or project and domain experience within the Company. They also examine the Company values and the applicants' knowledge of the internal workings of the Company. The majority of these factors will only apply to an internal candidate seeking to move within the Company. There are 10 areas identified within this group – see Figure 5-33

Skill Factors – These factors examine the applicants' desire for a new position, their determination and enthusiasm. They also look at issues like personality and how they present themselves. There are 7 factors identified in this category – see Figure 5-34

Social Factors – These factors consist of the more extra-curricular or less common aspects of the categories e.g. personal circumstances or personal recommendation. There are 11 factors identified within this group – see Figure 5-35

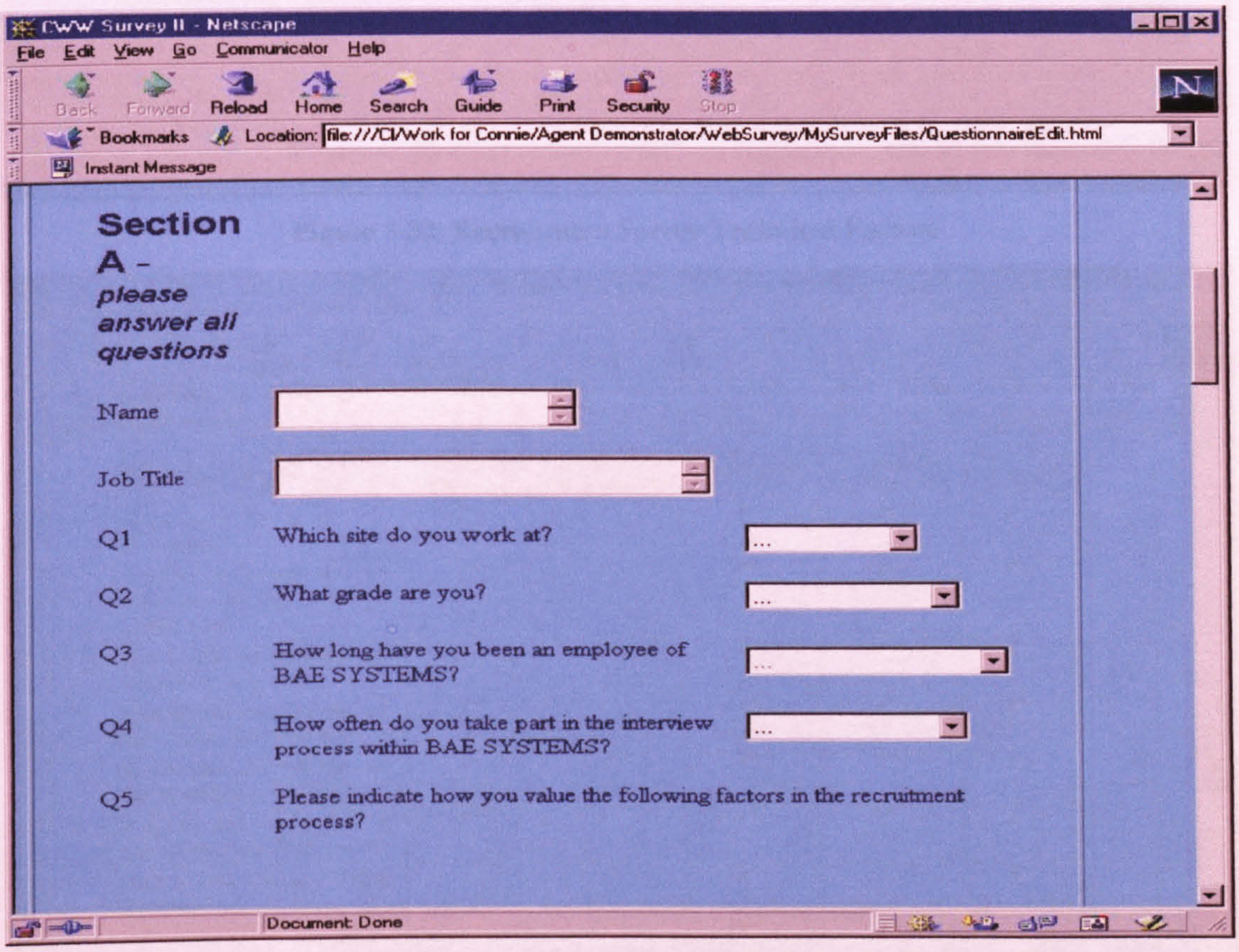


Figure 5-31: First General Section of Recruitment Survey

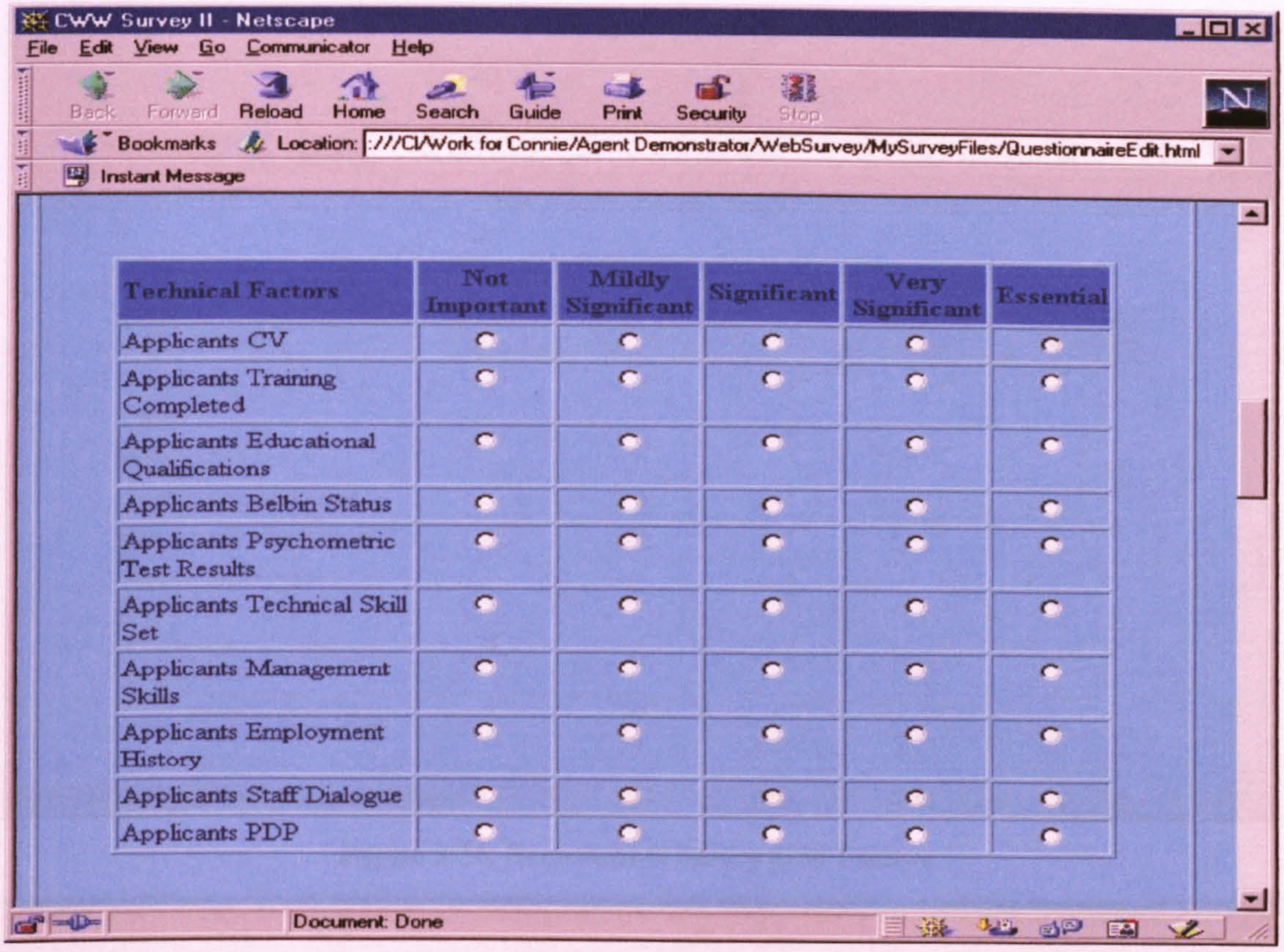


Figure 5-32: Recruitment Survey Technical Factors

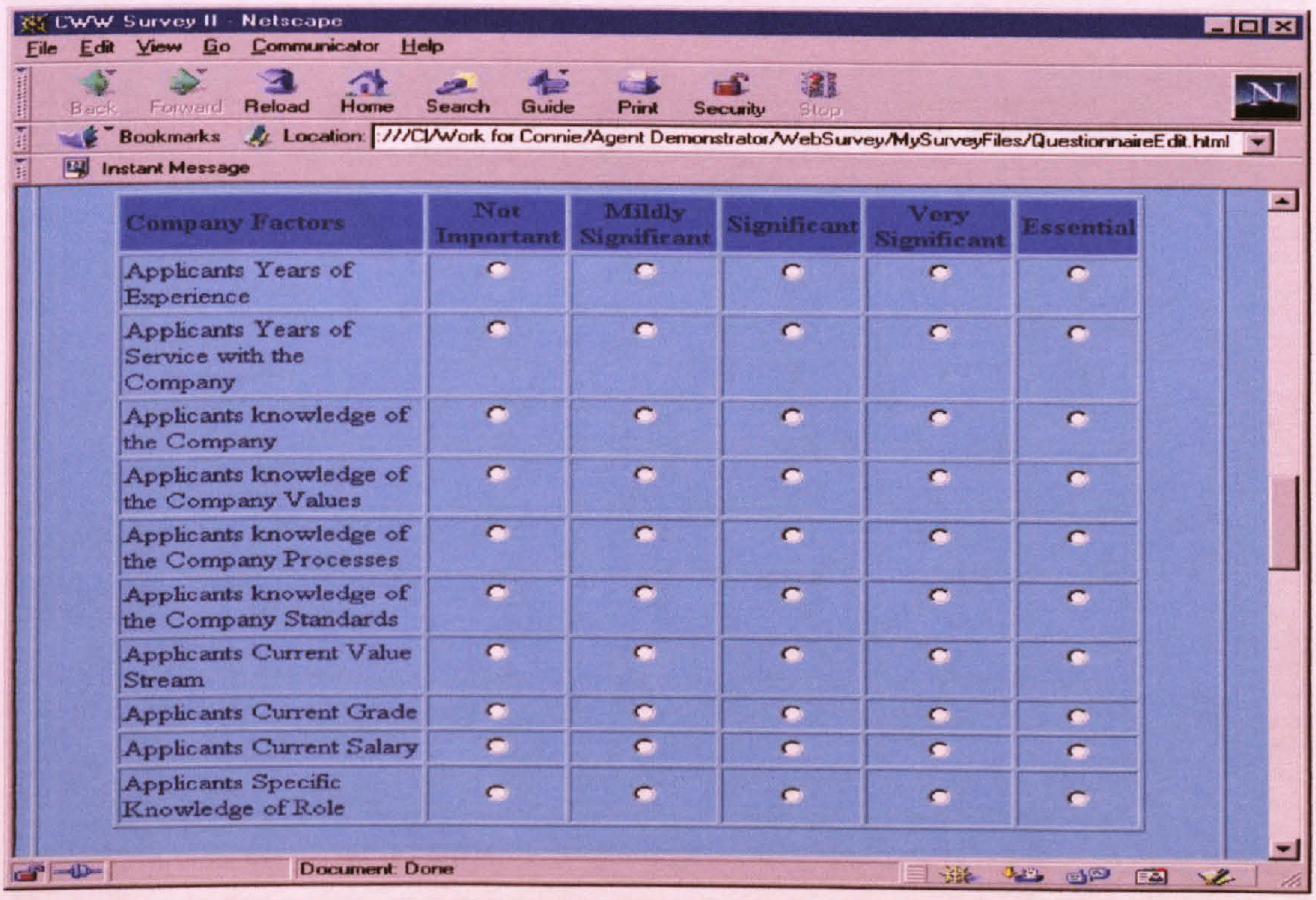
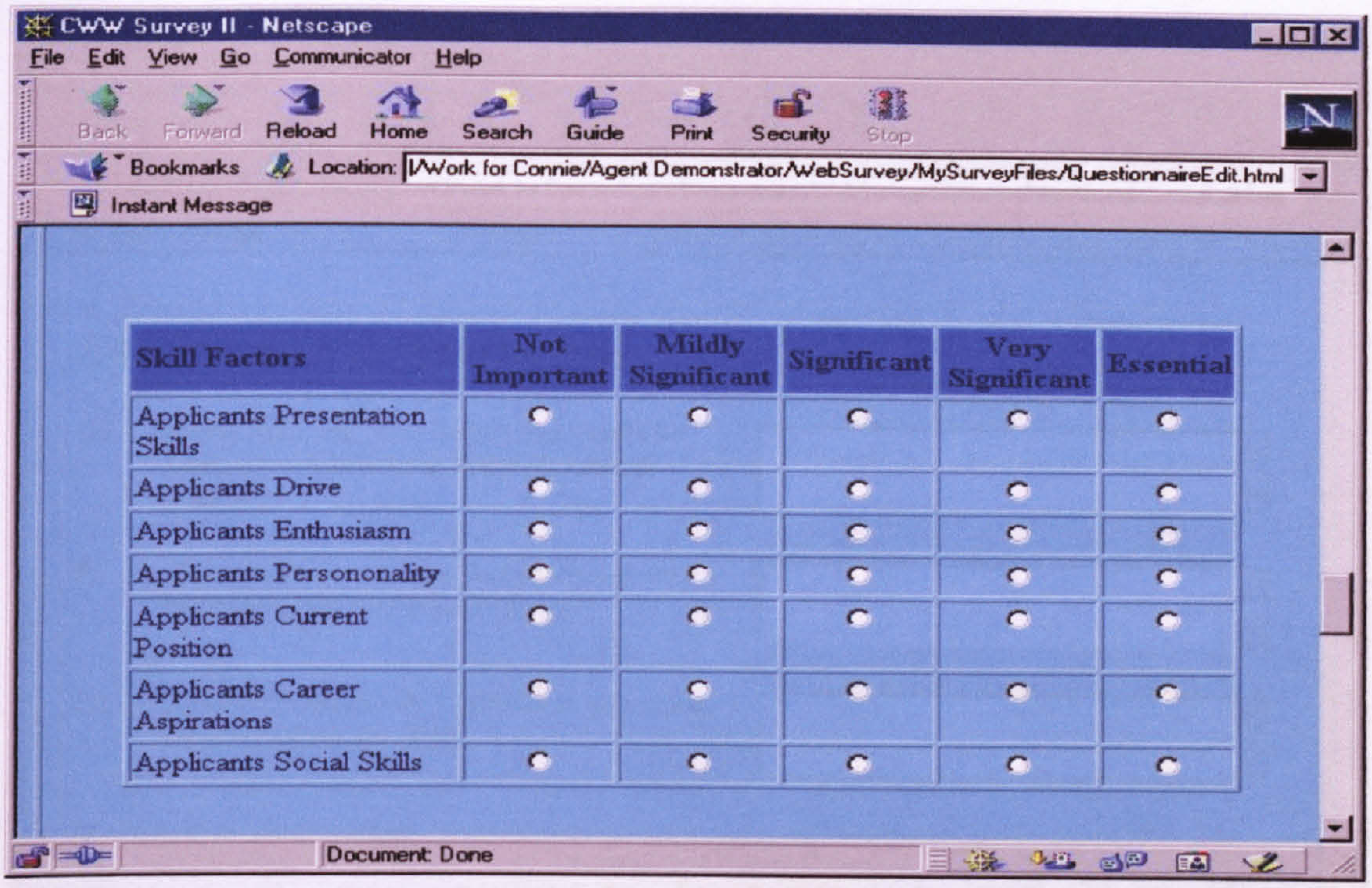
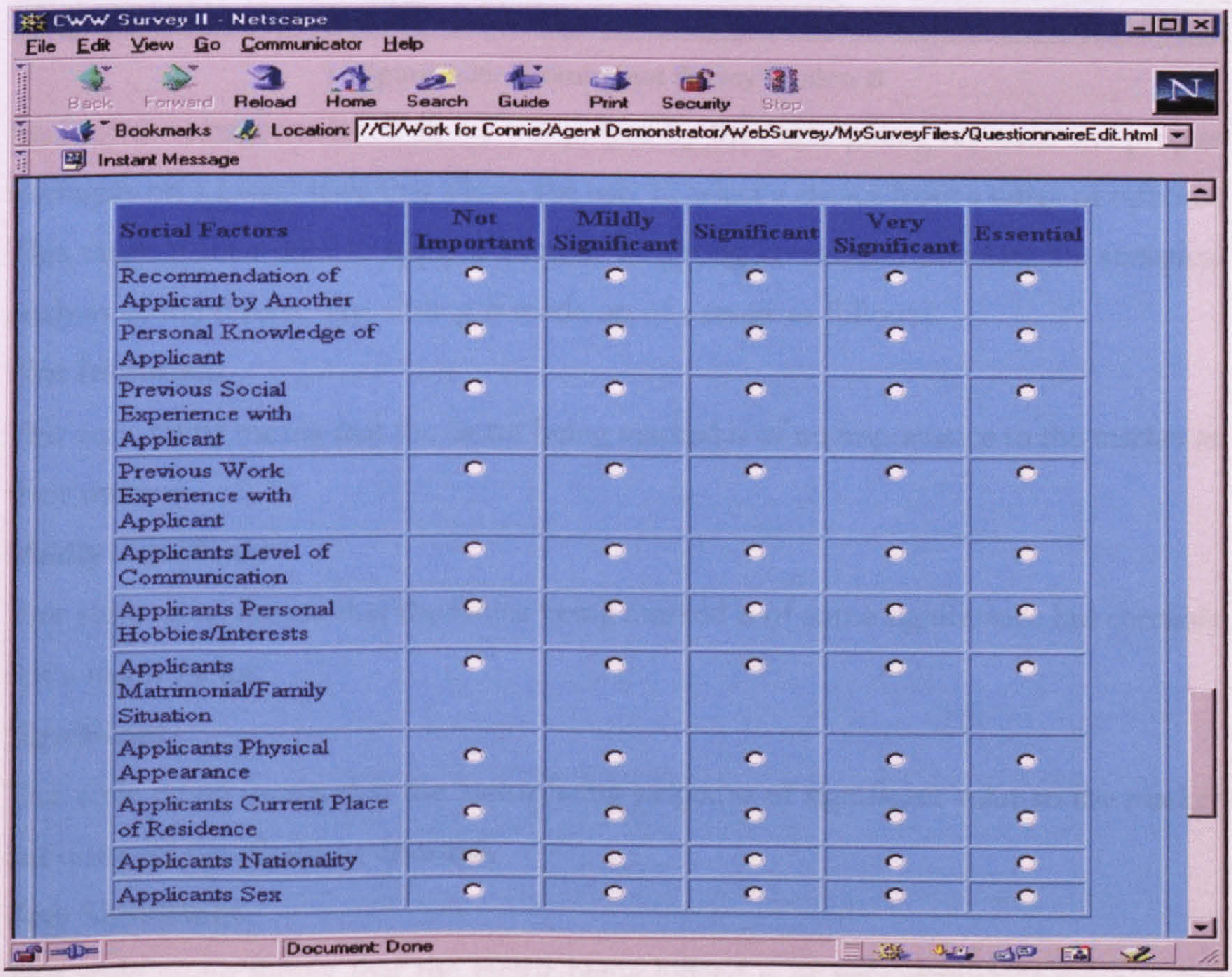


Figure 5-33: Recruitment Survey Company Factors



Skill Factors	Not Important	Mildly Significant	Significant	Very Significant	Essential
Applicants Presentation Skills					
Applicants Drive					
Applicants Enthusiasm					
Applicants Persononality					
Applicants Current Position					
Applicants Career Aspirations					
Applicants Social Skills					

Figure 5-34: Recruitment Survey Skill Factors



Social Factors	Not Important	Mildly Significant	Significant	Very Significant	Essential
Recommendation of Applicant by Another					
Personal Knowledge of Applicant					
Previous Social Experience with Applicant					
Previous Work Experience with Applicant					
Applicants Level of Communication					
Applicants Personal Hobbies/Interests					
Applicants Matrimonial/Family Situation					
Applicants Physical Appearance					
Applicants Current Place of Residence					
Applicants Nationality					
Applicants Sex					

Figure 5-35: Recruitment Survey Social Factors

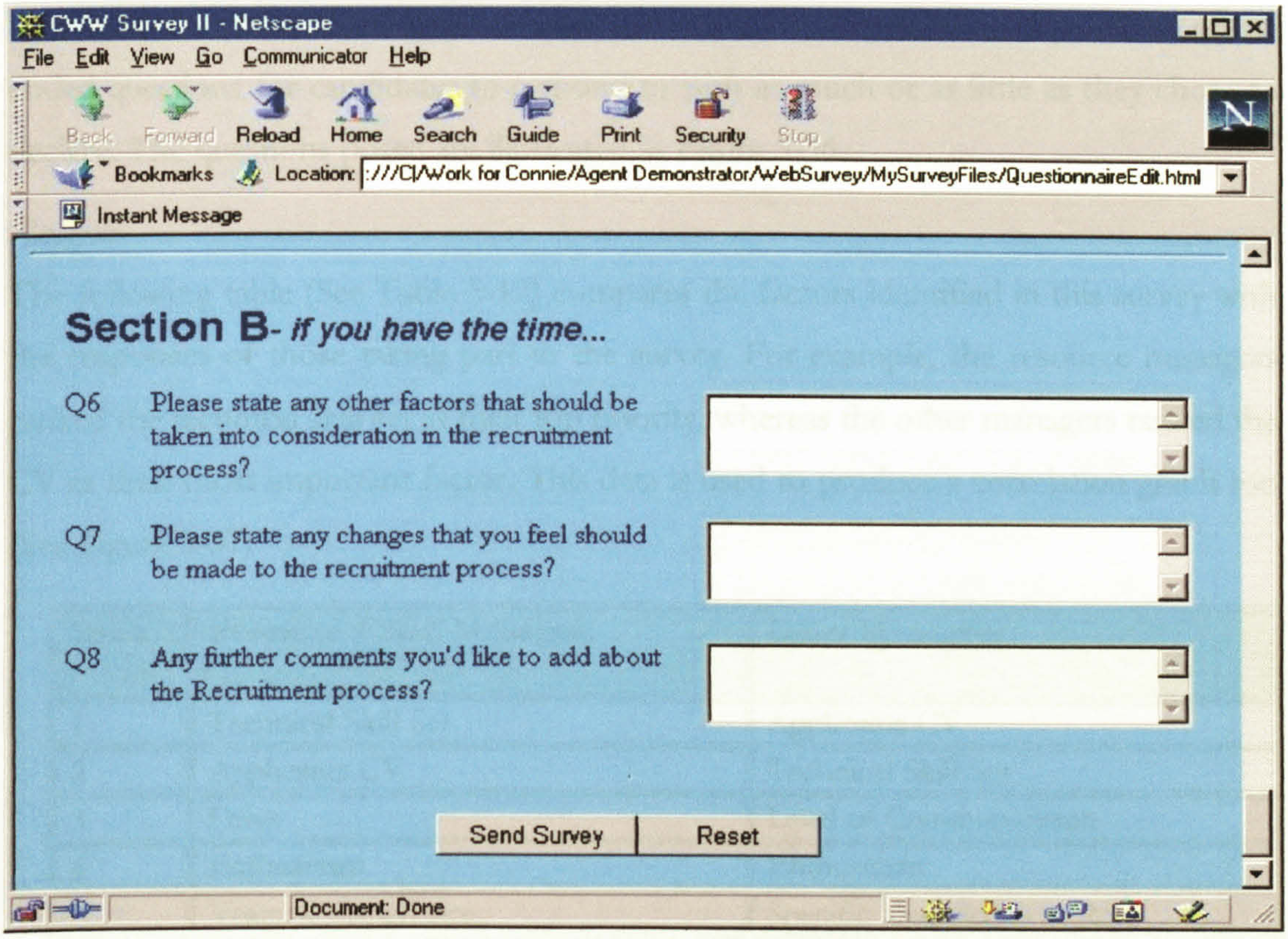


Figure 5-36: Recruitment Survey Section B

Each of the categories listed above was judged by the participating resource and project managers on a Likert scale that allows the user to select a choice from a range of options. This range is then used to apply a number weighting in order to calculate the statistical analysis of the results. The scaling is made up of a range as follows:

Not Important

This scale rating means that the factor being marked is of no importance to the marker in their opinion.

Mildly Significant

This scale rating means that the factor being marked is of some significance but certainly not a major factor.

Significant

This scale rating means that the factor being judged is of significant value to the marker but not very significant or essential.

Very Significant

This scale rating means that the factor being judged is of very significant value to the marker but not essential

Essential

This scale rating means that the factor being judged is essential value to the marker. Implying that the marker feels he could not work without knowing that piece of information.

The second section of the questionnaire aimed to collect opinions and provided open-ended questions for candidates to respond to with as much or as little as they chose to declare. The questions posed are illustrated in Figure 5-36

Analysis

The following table (See Table 5-12) compares the factors identified in this survey with the responses of those taking part in the survey. For example, the resource managers ranked the technical skill set as their top priority, whereas the other managers ranked the CV as their most important factor. This data is used to produce a correlation graph too (See Figure 5-37).

Rank	Resource / Staff Managers	Other Managers
1	Technical Skill Set	Applicants CV
2	Applicants CV	Technical Skill Set
3	Drive	Level of Communication
4	Enthusiasm	Enthusiasm
5	Years of Experience	Specific Knowledge of Role
6	Employment History	Personality
7	Career Aspirations	Drive
8	Level of Communication	Employment History
9	Management Skills	Career Aspirations
10	Specific Knowledge of Role	Management Skills
11	Educational Qualifications	Work Experience with Applicant
12	Current Grade	Social Skills
13	Personality	Years of Experience
14	Current Salary	Personal Knowledge of Applicant
15	Knowledge of Company Processes	Educational Qualifications
16	Recommendation by Another	Training Completed
17	Current Position	Presentation Skills
18	Training Completed	Recommendation by Another
19	Social Skills	Current Position
20	Staff Dialogue	Knowledge of Company Processes
21	Belbin Status	Current Grade
22	Knowledge of Company Values	Staff Dialogue
23	Work Experience with Applicant	Current Salary
24	Presentation Skills	Social Experience with Applicant
25	PDP	PDP
26	Personal Knowledge of Applicant	Belbin Status
27	Knowledge of Company Standards	Knowledge of Company Standards
28	Knowledge of Company	Knowledge of Company
29	Current Value Stream	Nationality
30	Years of Service with Company	Knowledge of Company Values
31	Psychometric Tests	Psychometric Tests
32	Nationality	Current Place of Residence

Rank	Resource / Staff Managers	Other Managers
33	Physical Appearance	Years of Service with Company
34	Current Place of Residence	Personal hobbies / interests
35	Personal hobbies / interests	Matrimonial/ Family Situation
36	Social Experience with Applicant	Current Value Stream
37	Matrimonial/ Family Situation	Physical Appearance
38	Sex	Sex

Table 5-12: Table Showing the Different Ranking of the Survey Factors Identified

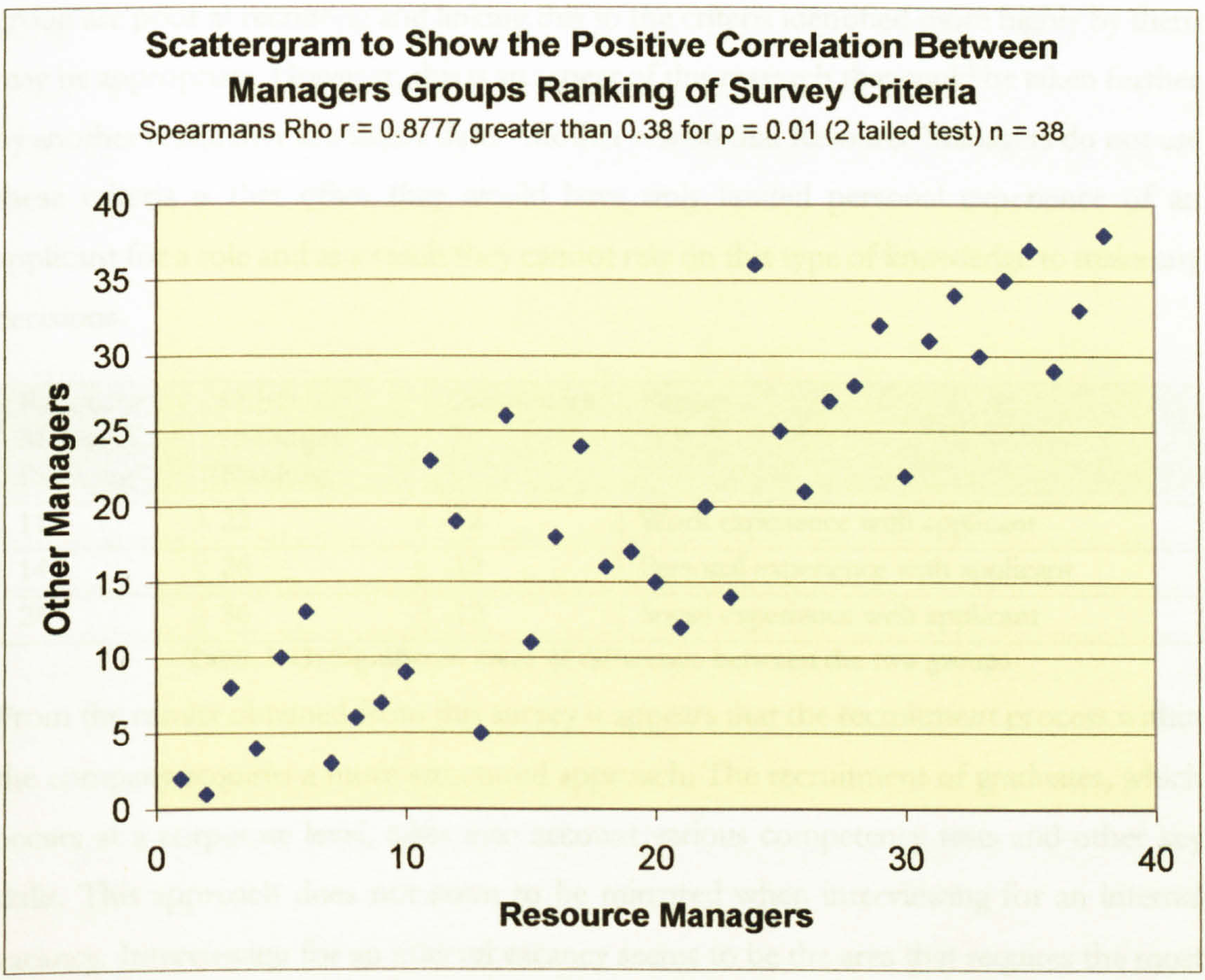


Figure 5-37: Scatter Gram Illustrating the Correlation Between Managers and the Survey Factors

The above correlation diagram was produced using Spearmans Rho for correlation between the two groups (i.e. Resource Managers and Other Managers) and the criteria listed. A score of 1 indicates a perfect positive correlation and a score of –1 indicates a perfect negative correlation. Finally, a score of zero indicates no correlation at all. Once the data series was ranked the correlation score was calculated to be 0.88, which gives a strong positive correlation suggesting that Resource Managers give the same level of importance to specific factors when allocating people to roles (See Appendix F).

Further investigation of the criteria highlights three significant areas where the difference is the most marked as the Other Managers group ranks as more important than the

Resource Managers group does. These include 'Social Experience with Applicant'; "Personal Knowledge of the Applicant"; and "Work Experience with the Applicant" (See Table 5-13). These criteria may support the views offered earlier – particularly by the Engineers that there is an 'old boys network' in place and if your face fits then the job is yours. However, this particular set of data does not prove irrevocably that this is the case. This data does not show whether an 'old boys network' is a negative or a positive issue. In order to prove that this is important, further research showing that the Other Managers group are poor at recruiting and linking this to the criteria identified more highly by them may be appropriate. However, this is an aspect of this research that could be taken further by another researcher at a future date. Another reason that Resource Managers do not use these criteria is that often they would have only limited personal experience of an applicant for a role and as a result they cannot rely on this type of knowledge to make any decisions.

Resource Manager Ranking	Other Manager Ranking	Differences	Factor
11	22	-12	Work experience with applicant
14	26	-12	Personal experience with applicant
24	36	-12	Social experience with applicant

Table 5-13: Significant areas of difference between the two groups

From the results obtained from this survey it appears that the recruitment process within the company requires a more structured approach. The recruitment of graduates, which occurs at a corporate level, takes into account various competency tests and other key skills. This approach does not seem to be mirrored when interviewing for an internal vacancy. Interviewing for an interval vacancy seems to be the area that requires the most work. Candidates are often recruited in an ineffectual manner and not on the basis of recruiting the most suitable candidate for the position. The speed of the recruitment process also needs to be increased as far too much time is spent on finding a suitable employee. A manager's time is extremely valuable and is often used up unnecessarily by searching CV's.

From the comments received by the managers it appears that a central vacancy list should be held in addition to a central reservoir of potential candidates. This will allow the skills of the candidates to be matched with those required for the role and enable the most suitable candidate to be allocated to the vacant position. This area is seen as a potential for HR involvement and may also call for a number of the current databases to be linked in some manner or for the information contained in these databases to be pooled into one central database.

In an interview situation it also appears that some formal training is required to enable interviewers to conduct interviews effectively and to know what points to look for in a potential candidate. This would be a valuable asset to the interview process, which is currently done in an ad hoc manner and relies on the interviewer's natural ability, or lack of it. This skill would be able to be applied both to recruitment on an internal basis and on an external basis.

In summary, a common structured approach to the internal recruitment process is what is required. The involvement of HR will be necessary to deal with CV's and other personal details. This will free up a manager's time to advertise for the post and to perform interviews for the position. In addition, interview training will also be necessary in order to maximise the potential for hiring the most suitable candidate for the advertised role.

Summary

The study of the recruitment process proved to be fascinating with some interesting results produced. However, as with all research there is always room for improvement and modifications that can be made to provide a more robust study. In this case I feel that more accurate results would be obtained by taking a larger cross-section of the manager population to provide more data from which to base the findings.

To further this research a new recruiting mechanism needs to be put in place. This mechanism will require the input of managers and engineers across the business in order to cover all aspects of the recruitment process and to make this a standard, streamlined and quicker mechanism for recruiting candidates both internally and externally to the company

The results of this extended research have proven that this whole area may prove appropriate for the application of software agent technology on the following grounds:

From the Survey carried out

- Resource management process takes too long and is inefficient
- The survey showed that skills matches were required but difficult to ascertain from the current process adopted
- The applicant's career aspirations were rated well yet project managers and similar employees searching for staff internally cannot often access that information
- Some information may not even exist – e.g. internal staff Belbin results and similar results showing details from surveys from team Leader courses – although these

have been carried out for the individual but the Company fails to save and use this information in the future.

- Projects fail to release individuals in order for them to fulfil their career aspirations in favour of the project needs.
- No domain competency testing is carried out when making a match for a vacancy
- Failure to consider an individual's long-term career prospects and potential
- Vacancy can often be filled with a "who you know" rather than the right person for the job. This has a negative knock-on effect to individuals throughout the Company
- Vacancies should not be based upon the opinions of resource group managers and the wider spectrum of employees should be included
- Poorly trained interviewers
- Poorly defined resourcing process
- CV data tends to be out-of-date
- Past achievements and competencies of the individual are rarely available to the interviewing project manager
- The vacancy list is not as up-to-date as it could be. There are still vacancies advertised at individual Intranet web sites that are not in the central vacancy list maintained by HR.

The Researcher's personal point of view

- Previous personal experience of employees obviously being in the wrong position within the Company (e.g. Project X Development Manager, previously discussed in reflective practitioner's sections)
- Some vacancies do not get advertised as they should and seem to be filled before they have come into existence for people to apply for them.
- Practical experience of using the resource management process within the Company from an internal applicant through to a manager seeking candidates for a project

- Previous personal experience of staff feeling undervalued and under used on projects where they feel they have the technical or managerial skills to do more within the projects. This experience included the following issues:
    - Data and information on individuals was distributed ad hoc in many formats across the site
    - Information and data was out-of-date and poorly maintained
    - Some information was inaccessible
    - Some information did not exist

So why is it difficult to get the resources? Some of the reasons I have experienced are:

- It takes a long time from the initial request to the actual resource becoming available
- It is hard to get hold of the resources with the right skills in the current employment market
- There is no room in the Company resourcing process to achieve short-term requirements for projects, such as a short-term need of an expert in a particular field in order to meet a deadline.
- It is hard to tell when resources are really becoming free on a project even though an RPM tool has been updated because a project can be lengthened at the last minute, or a project may be delayed due to other outstanding issues relating to that particular project.
- RPM may not be accurate because the manager has failed to update the resource schedule profile accurately and regularly and the resource is not available, or available earlier and taken onto another project in the meantime

All of these areas identified will be considered when the pilot is prepared and I will try to address as many as I can with the solution I am advocating.

5.10 Resource Management Recruitment Process

The following tables represent an amalgamation of figures giving an average time period and a full set of tasks associated with the current BAE SYSTEMS recruitment process. Table 5-14 gives the details of the recruitment of an externally identified interview candidate and Table 5-15 gives the view of an internal transfer appointment. Both assume success on the part of one candidate. The external recruitment process can take up to a maximum of 166.25 working days (i.e. 69825 minutes) and an average of 117.96 working days (i.e. 49545 minutes). Whereas the internal recruitment process is able to take a maximum of 57 working days (i.e. 23955 minutes) and an average of 43.5 working days (i.e. 18285 minutes).

These measurement figures were developed through five separate discussions with several HR representatives and one key resource manager. These figures will be used as a measurement against which the VacancyBot application will be evaluated. The process itself is illustrated in Figure 5-38 to enable the analysis of tasks which may be enhanced or carried out by software agents.

External Recruitment Applications

The key areas in this aspect of the recruitment process raised by those discussing this process were: -

1. The time taken to filter the CV's by (1) Personnel, (2) Resource Manager and then (3) Project Managers is duplicated and it is a subjective view of any candidate.
2. The fact that the resource planning profile is rarely up-to-date because Project Managers do not follow the process properly or because they do not know their needs until the contract has been accepted and this is often not on time.
3. At the time of writing there are very few official job descriptions for the type and level of candidate a project requires. Often there is a failure to create such a specification and merely a few ideal skills are listed or verbally passed on to the HR department. This makes it difficult to get a good candidate match.
4. Project demands change quite rapidly and are sometimes not clear depending upon the contract award and the time taken by the customers to give responses to contract timescales. Due to this more fluid situation sometimes recruits are not placed with the project they were originally interviewed for and can wait several months before the role is in place. Alternatively the role may not exist after the initial wait. This has a negative impact on the employee.
5. The security clearance process can be very slow. There does not seem to be a way around this situation.

Task ID	Task Description	Sub-task Description	Personnel/ resources involved	Time scale (mins)	Total Max Time scale (mins)
1	Vacancy identified				75
1.2		Forward Load updated	Project Manager	15	
1.3		Forward Load Meeting and discussion	Resource Manager and Project Manager	60	
2	Requisition Form filled out for vacancy		Project Manager	60	120
2.1		Write appropriate job description	Project Manager	60	
3	Resource planning meeting	Decision on whether internal or external recruitment. Assumption in this scenario is that external recruitment is appropriate	Human Resource Manager and Resource Manager	60	60
4	HR decision to recruit externally				34620
4.1		Advertise vacancy on web pages	HR person	120	
4.2		Contact 2-3 suppliers	HR person	120	
4.3		E-mail agencies	HR person	120	
4.4		Elapsed time for right candidate to be identified and receive the CV		420-25200	
4.5		CV's come back and sent to appropriate Resource Manager	HR + Resource Manager	420-2100	
4.6		Resource Manager reads and filters CV's	Resource Manager	420-2100	
4.7		Appropriate selected CV's sent to Project Manager	Resource Manager	420	
4.8		Project Manager reads and filters CV's	Project Manager	120	
4.9		Project Manager requests interviews with HR	Project Manager	60	
4.10		HR administration	HR person	120	
4.11		Elapsed time for setting up interview	HR Person	1260-4200	

Task ID	Task Description	Sub-task Description	Personnel/ resources involved	Time scale (mins)	Total Max Time scale (mins)
5	Interview candidate				300
5.1		Technical	Engineer x 2	120	
5.2		Departmental	Manager	60	
5.3		Personnel	HR person	60	
5.4		Interview feedback form completed	Engineer + Manager	60	
6	Suitable Candidate Identified				10500
6.1		Offer letter prepared	HR person	180 - 2100	
6.2		Administration documents completed	HR person	4200	
6.3		Time lapse on response from candidate		840 – 4200	
7	Offer accepted				420
7.1		Reply letter received and communicated	HR person	420	
8	Clearance				20160
8.1		Request references	HR person	2100	
8.2		Medical checks	HR person	420	
8.3		Criminal checks	HR person	840	
8.4		Clearance time lapse period		12600 - 16800	
9	Induction Process				3570
9.1		SAP enrolled	HR person	1260	
9.2		Payroll admin	HR person	1260	
9.3		Induction day	Manager + Engineer	420	
9.4		Induction pack	HR person	210	
9.5		Security issues (ID badge and codes)	Security Person	420	
Max				**166.25 days**	**69825**
Min				**69.678 days**	**29265**
Avg				**117.96 days**	**49545**

Table 5-14: External Recruitment Process Measurements

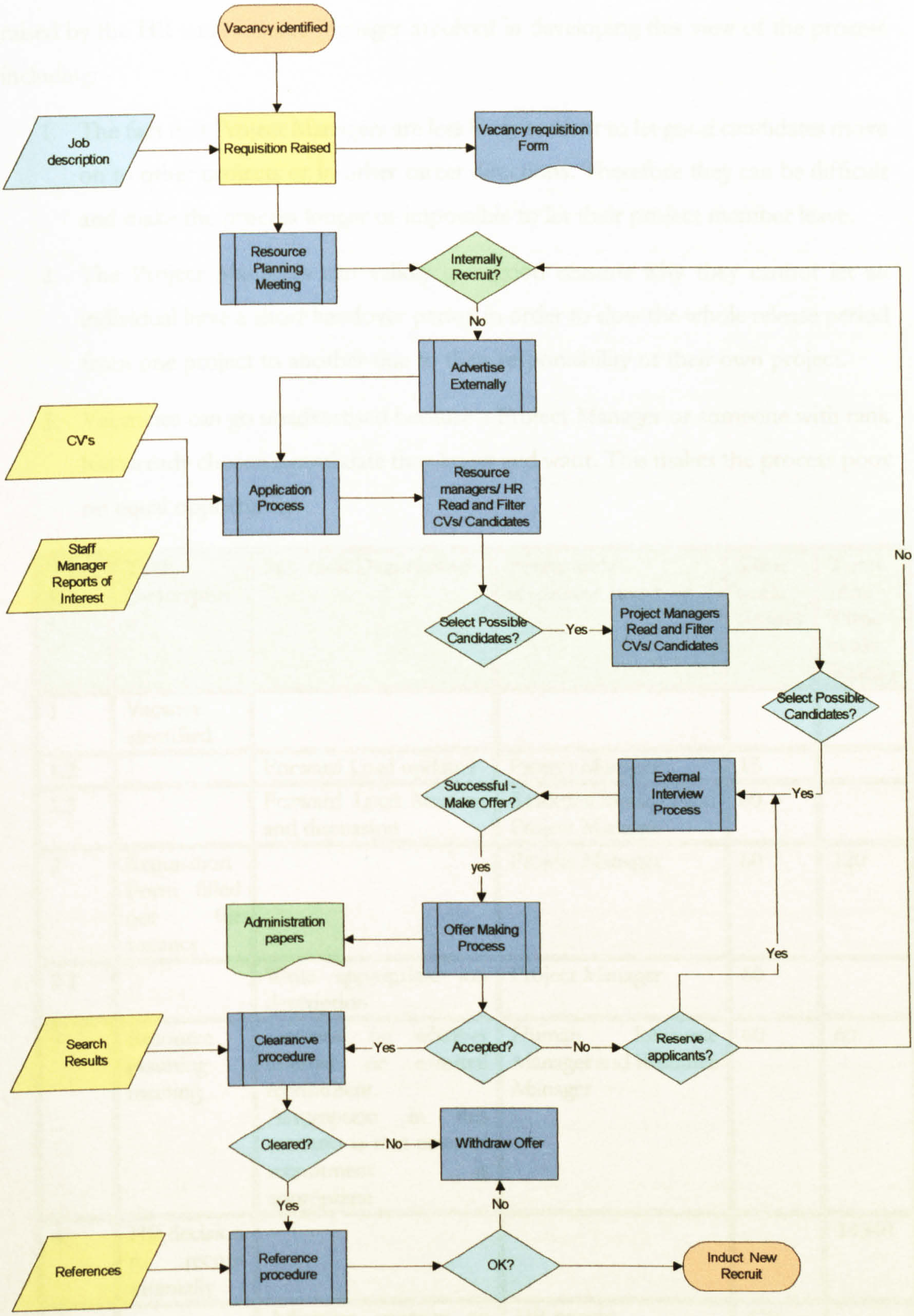


Figure 5-38: External Recruitment Process

Internal Recruitment Applications

Obviously the internal recruitment process is shorter. However, there were valid points raised by the HR and resource Manager involved in developing this view of the process including: -

1. The fact that Project Managers are less likely to want to let good candidates move on to other projects or in other career directions. Therefore they can be difficult and make the process longer or impossible to let their project member leave.
2. The Project Managers can validly give good reasons why they cannot let an individual have a short handover period in order to slow the whole release period from one project to another due to their responsibility of their own project.
3. Vacancies can go unadvertised because a Project Manager or someone with rank has already chosen a candidate they know and want. This makes the process poor on equal opportunity.

Task ID	Task Description	Sub-task Description	Personnel/ resources involved	Time scale (mins)	Total Max Time scale (mins)
1	Vacancy identified				75
1.2		Forward Load updated	Project Manager	15	
1.3		Forward Load Meeting and discussion	Resource Manager and Project Manager	60	
2	Requisition Form filled out for vacancy		Project Manager	60	120
2.1		Write appropriate job description	Project Manager	60	
3	Resource planning meeting	Decision on whether internal or external recruitment. Assumption in this scenario is that external recruitment is appropriate	Human Resource Manager and Resource Manager	60	60
4	HR decision to recruit internally				14340
4.1		Advertise vacancy on intranet pages/notice boards etc	HR person	420 – 1680	
4.2		Elapsed time for right candidate to be identified and receive		420 - 4200	

Task ID	Task Description	Sub-task Description	Personnel/ resources involved	Time scale (mins)	Total Max Time scale (mins)
		the CV			
4.3		CV's come back and sent to appropriate Resource Manager	HR person	420 – 2100	
4.4		Resource Manager reads and filters CV's	Resource Manager	420 – 2100	
4.5		Appropriate selected CV's sent to Project Manager	Resource Manager	60	
4.6		Project Manager reads and filters CV's	Project Manager	420 – 2100	
4.7		Project Manager requests local interview with HR	Project Manager	840 – 2100	
5	Interview candidate				180
5.1		Technical	Engineer x 2	60	
5.2		Departmental	Manager	60	
5.3		Interview feedback form completed	Engineer + Manager	60	
6	Suitable Candidate Identified				180
6.1		Make offer	HR person	60	
6.2		Administration documents completed	HR person	120	
7	Offer accepted				60
7.1		Reply communicated	HR person	60	
8	Project Release				
8.1		Agreed date of release	Resource Manager, Project Manager	60	8460
8.2		Hand over period time lapse	Project Manager	8400	
9	Induction Process				480
9.1		Minor project induction	Project	420	
9.2		Security issues (codes, access)	Security Person	60	
Max				**57 days**	**<u>23955</u>**
Min				**30 days**	**<u>12615</u>**
Avg				**43.5 days**	**<u>18285</u>**

Table 5-15: Internal Recruitment Process Measurements

The following flowchart (See Figure 5-39) illustrates the process timetabled above in Table 5-15. This helps to illustrate the process in action. From this flowchart it will be possible to examine the elements of the process that can be automated and provided for, using the capabilities of software agents and those that are not suitable for this technique. Then by examining these tasks measurements of time scales will be addressed using the figures quoted above in order to illustrate the potential efficiency.

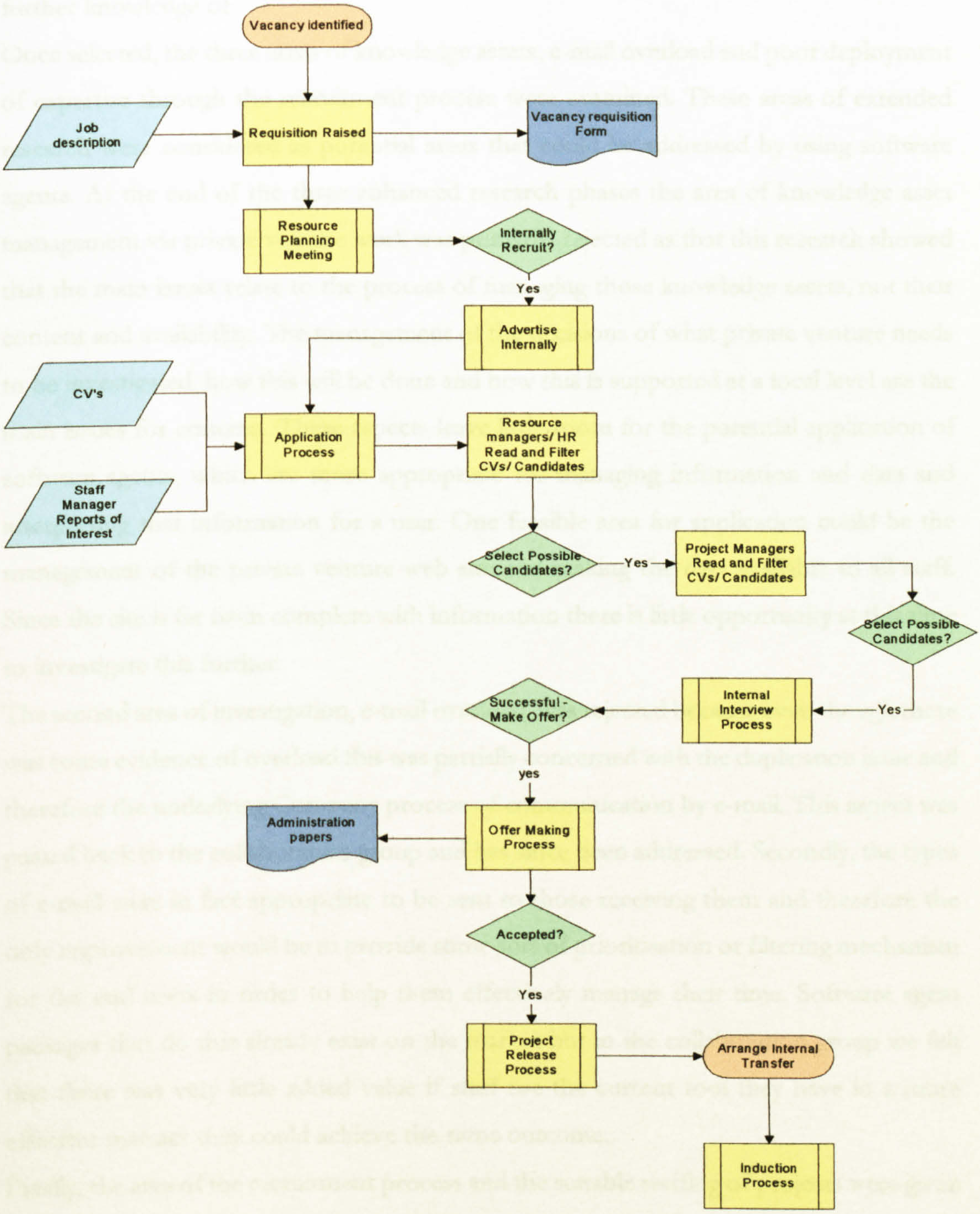


Figure 5-39: Internal Recruitment Process Flowchart

5.11 Summary

This chapter has examined the commonality and differences of views between the managers and the engineers within the Company based upon the previous cycle interviews. It has highlighted the difficultly in addressing some of those issues too. The input from cycle one was examined relating to the data and information problems that interviewees were having when they were trying to do their job. These issues were clustered and analysed at the beginning of cycle two in order to identify suitable areas for further investigation within cycle two. These areas were discussed through collaborative sessions in order to decide what aspects would be rewarding for the Company to gain further knowledge of.

Once selected, the three areas of knowledge assets, e-mail overload and poor deployment of expertise through the recruitment process were examined. These areas of extended research were considered as potential areas that could be addressed by using software agents. At the end of the three enhanced research phases the area of knowledge asset management via private venture work was primarily rejected as that this research showed that the main issues relate to the process of managing those knowledge assets, not their content and availability. The management of the decisions of what private venture needs to be investigated, how this will be done and how this is supported at a local level are the main issues for concern. These aspects leave little room for the potential application of software agents, which are more appropriate for managing information and data and interpreting that information for a user. One feasible area for application could be the management of the private venture web site and making the data available to all staff. Since the site is far from complete with information there is little opportunity at this time to investigate this further.

The second area of investigation, e-mail overload, was rejected because even though there was some evidence of overload this was partially concerned with the duplication issue and therefore the underlying Company process of communication by e-mail. This aspect was passed back to the collaboration group and has since been addressed. Secondly, the types of e-mail were in fact appropriate to be sent to those receiving them and therefore the only improvement would be to provide some sort of prioritisation or filtering mechanism for the end users in order to help them effectively manage their time. Software agent packages that do this already exist on the market but in the collaboration group we felt that there was very little added value if staff use the current tool they have in a more effective manner they could achieve the same outcome.

Finally, the area of the recruitment process and the suitable staffing of projects were given consideration. In this survey the results indicated that there were plenty of aspects that could be greatly improved but in particular through the survey, collaboration groups and the information surrounding the process there seems to be one area of growing concern and that is the placing of the right staff into the right role at the right time. This aspect of the recruitment process has several areas for potential improvement that could utilise software agents. The pertinent specific issues raised are recorded here and will be revisited in the cycle three in the pilot study.

The next chapter will introduce the concept of software agents and will begin the next research cycle involving the development of a pilot application to deal with some of the issues isolated in this chapter concerning the recruitment of suitable staff for specific project needs.

MY THIRD ACTION RESEARCH CYCLE: AGENTS PROVOCATEURS

6.1 Introduction

This chapter takes the area of resource management as the output problem domain from the previous cycle and uses it to test the use of software agent technology. It deals with the implementation of a software agent prototype (called 'VacancyBot') that demonstrates some of the capability discussed in cycle one and two as issues for resolution in the area of resource management. More particularly the chapter deals with the recruitment of appropriate members of staff within the Company. To this end a quasi-experiment is carried out to test the technology against the problem areas raised in the earlier cycle.

This cycle will examine these characteristics of the software agent application being demonstrated and draw out areas of improvement for the application as well as make comparisons with this set of criteria defined in cycle two: delegation, communication, autonomy, monitoring, actuation and intelligence.

6.1.1. The Research Themes Identified

This research started by exploring the possible needs of the Company for knowledge management in chapter one. These areas are discussed in detail in that chapter but the main ones of concern in this cycle are: (1) creating new knowledge for use within the Company including: discovering what knowledge already exists in the Company, generating understanding of that knowledge and information, facilitating the utilisation and usability of that knowledge and information; (2) protecting and retaining the knowledge within the Company including retaining employees; (3) understanding what knowledge exists in the Company – including information sources and true expertise and facilitating the sharing of that knowledge within the Company.

Chapter two reviewed the literature on knowledge management and at the end of that phase identified several areas for consideration during this research: (1) that explicit knowledge is often hard to locate; (2) explicit knowledge requires proper validation; (3) the cost of finding and extracting explicit knowledge can be problematic; (4) there is an issue with making explicit knowledge available to the right population in the right format; (5) there can be problems with making future use of this explicit knowledge.

Action research cycle one dealt with understanding the problem domain in an attempt to isolate key areas for this research to continue to investigate in cycle two and eventually apply in this cycle using a practical demonstration. Cycle one identified twenty-two areas of information which interviewees discussed as domains containing problems and issues.

These twenty-two areas were clustered using NVivo at the beginning of cycle two in order to identify the principal themes that could potentially be resolved using software agents and to dismiss with good reason those that were inappropriate. In filtering this mass of data and forming a set of clusters it was then possible to begin to determine which areas could be investigated further in cycle two. In cycle two the aim was to develop efficient methods of gaining a better understanding of three selected areas with the potential for usage in cycle three. In so doing a set of surveys and an analysis of these was completed in order to determine the suitability of one specific domain for further research in cycle three. Cycle two completed by identifying the domain of resource management, in particular the need to pull many sources of data and information together, interpret it and pass it on in a suitable form to the resource and project managers. There is a real need to appoint the right personnel to the right positions within the Company and this was seen in cycle two to be a suitable area for practical consideration.

6.1.2. General Research Objectives

Once considered in their entirety these problems were evaluated in order to scope the research carried out in cycle three. The research in this cycle was developed to investigate the use of software agent technology in knowledge management within the Company in order to make the business more effective. This research cycle examines the following aspects of this technology:

1. The effectiveness of software agents to a specific area identified from the previous two action research cycles
2. The Users' opinion of the use and appropriateness of software agent technology in the identification of staff for Company projects
3. The Users' opinion of the Usability of the particular interface of the solution provided
4. The potential of organisation-wide deployment of such agent systems to resolve other areas of knowledge management within the Company.

Agents also need to co-operate with one another and have co-ordinated tasks (Papazoglou et. al. 1992). This functionality enables the work to be performed effectively for the user. In the case of VacancyBot this element was not developed in any detail, as the need for co-ordination was not considered important in the development of a single standalone software agent. However, looking into the issue of co-operation this could be managed successfully through NQL or through programming intervention. The time slots for activities and when an agent should run can be very easily scheduled using multithreaded programming.

6.2 Resource Management Problem Domain

As discussed in section 6.1.1. The Research Themes Identified, the input from cycle one was clustered and examined in NVivo (See Appendix E). On the basis of the analysis, three areas were selected for further investigation in cycle two (knowledge assets via private venture, e-mail overload and the resource management process). Each one of these areas was considered a potential aspect where software agents could be applied. The knowledge asset management aspect via private venture reports was rejected because the research showed that the main issues relate to the process of managing those knowledge assets, not their content and availability. Although the former could have been transformed into an agent-managed process (possibly using the intranet web site as the driver) there was an extremely small amount of data with which to test such a process with any rigour and to create it would have been extremely time-consuming. The main issues raised were of value to the Company in that they are now considering the issues surrounding local support of private venture and the whole process with its associated outputs. Secondly, the area of e-mail overload was investigated but rejected because of the problems that were raised e.g. the duplication of e-mails, which was due to a communications process issue. Secondly, the types of e-mail were in fact appropriate to be sent to those receiving them and therefore the only improvement would be to provide some sort of prioritisation or filtering mechanism for the end users in order to help them to effectively manage their time. Software agent packages that do this already exist on the market but in the collaboration group we felt that there was very little added value: if staff use the current tool they have in a more effective manner they could achieve the same outcome.

Finally, the area of the recruitment process and the suitable staffing of projects was given consideration. In this survey the results indicated that there were plenty of aspects that could be greatly improved but in particular through the survey, collaboration groups and the information surrounding the process there seems to be one area of growing concern and that is the placing of the right staff into the right role at the right time. This aspect of the recruitment process has several areas for potential improvement that could utilise software agents, which are appropriate for managing information and data and interpreting that information for a user. Therefore this experiment concentrates on Resource Management and the resourcing of projects with the right member of staff, based on the previous research cycles.

The Company has many projects in operation at one moment in time. The main business is the development and integration of software and systems for the defence industry. Several issues affect the success of a software project including the personnel appointed to do the work required for that project. The whole area of successful resource management across the whole business presents several problems, raised in the earlier research:

1. The project manager may speculate the continued growth of a project which then fails to happen thus leaving resources without a project to move to.
2. The project manager may request the skills required for a role on his project but no member of staff has been identified with that skill set so the project success is delayed.
3. Although several methods have been applied and failed, the process of identifying and capturing individual skills has been unsuccessful.
4. The entire recruitment management process can take a very long time from beginning to end. This can be applied to both internal and external recruitment (See Figure 5-38 and 5-39 and Tables 5-14 and 5-15 in Chapter 5) e.g. the time taken to filter the CV's by (1) Personnel, (2) Resource Manager and then (3) Project Managers is duplicated and is a subjective view of any candidate.
5. Not all vacancies are advertised on the vacancies lists for open applications (e.g. someone can recommend a candidate who is then appointed) and therefore the wrong member of staff can be appointed for the vacancy and the project then pays the price.
6. Employees often feel that they don't get the opportunity of career development that they expect. The engineering population have stated that they have skills that are not utilised for a project and therefore the business suffers by not appointing the appropriate person to the appropriate role. This is an ineffective resource management process.
7. Much of the data used to predict the future trends and future need for resources is out-of-date and inaccurate. How can the business be effective unless it resolves these issues?
8. The survey showed that skills matches were required but difficult to ascertain from the current process adopted
9. The applicant's career aspirations were rated well yet project managers and similar employees searching for staff internally cannot often access that information
10. Some information may not even exist – e.g. internal staff Belbin results and similar results showing details from surveys from team Leader courses – although these have

been carried out for the individual but the Company fails to save and use this information in the future.

11. Projects fail to release individuals in order for them to fulfil their career aspirations in favour of the project needs. The Project Managers are less likely to want to let good candidates move on to other projects or in other career directions. Therefore they can be difficult and make the process longer or impossible to let their project member leave.
12. No domain competency testing is carried out when making a match for a vacancy
13. Vacancies should not be based solely upon the opinions of resource group managers and the wider spectrum of employees should be included
14. Poorly trained interviewers
15. Poorly defined resourcing process
16. CV data tends to be out-of-date
17. Past achievements and competencies of the individual are rarely available to the interviewing project manager
18. The vacancy lists are not as up-to-date as they could be. There is more than one vacancy list available, even by site base and Intranet, Internet listings. None of these match up properly. There are still vacancies advertised at individual Intranet web sites that are not in the central vacancy list maintained by HR.
19. In the researcher's personal experience employees have obviously been in the wrong position within the Company (e.g. Project X Development Manager, previously discussed in reflective practitioners sections)
20. Previous personal experience of staff feeling undervalued and under-used on projects where they feel they have the technical or managerial skills to do more within the projects. This experience included the following issues:
    - Data and information on individuals was distributed ad hoc in many formats across the site
    - Information and data were out-of-date and poorly maintained
    - Some information was inaccessible
    - Some information did not exist

21. It is hard to get hold of the resources with the right skills in the current employment market

22. There is no room in the Company resourcing process to achieve short-term requirements for projects, such as a short-term need of an expert in a particular field in order to meet a deadline.

23. It is hard to tell when resources are really becoming free on a project even though an RPM tool has been updated because a project can be lengthened at the last minute, or a project may be delayed due to other outstanding issues relating to that particular project.

24. RPM may not be accurate because the manager has failed to update the resource schedule profile accurately and regularly and the resource is not available, or available earlier and taken onto another project in the meantime. Project demands change quite rapidly and are sometimes not clear, depending upon the contract award and the time taken by the customers to give responses to contract timescales. Due to this more fluid situation sometimes recruits are not put with the project they were originally interviewed for and can wait several months before the role is in place. Alternatively the role may not exist after the initial wait. This has a negative impact on the employee.

25. At the time of writing there are very few official job descriptions for the type and level of candidate a project requires. Often there is a failure to create such a specification and merely a few ideal skills are listed or verbally passed on to the HR department. This makes it difficult to get a good candidate match.

26. The clearance process can be very slow. There does not seem to be a way around this situation.

27. The Project Managers can validly give good reasons why they cannot let an individual have a short handover period in order to slow the whole release period from one project to another due to their responsibility of their own project.

6.3 Research Method Adopted for Cycle Three

There are three alternative approaches which could be used in order to research these objectives and problems identified above: first by carrying out a case study; secondly by carrying out surveys and questionnaires; and thirdly by experimentation. The choice was made to carry out a practical demonstration of software agents and experimenting with this technology. This option was chosen for the reasons identified here. In order to carry out a full-blown case study a lot more work would be required in order to get a fully operational agent system developed. For example, I would need access to specific confidential information and personnel – which for a defence company would provide me with many obstacles. The case study would require a real environment, and without fully understanding the practical demonstration of software agents it would be impossible to allow the technology to work in that environment. I would also require far more support and backing from the Company in order to do this kind of study which would be impossible without my being released from my current project to work full time on this aspect. Therefore cycle three in isolation will not use a case study approach. Surveying techniques with interviews and/or questionnaires have already been used extensively within the previous two research cycles. In order to investigate the objectives mentioned earlier the use of surveys alone is considered to be inappropriate. However surveys can measure the users' actual opinion of something they have used or seen applied. Surveys on their own will only provide speculative views as to the application of software agents. However, the aim of this cycle is to apply the technology and evaluate it whilst gaining a better understanding and insight of the future development of such technology within the Company. Based on these points the best option has been to carry out a practical application and experimentation of the technology. In this cycle the interrelationship with both previous cycles has been used to guide the details of the experiment and a questionnaire has been chosen to get the desired feedback on the technology demonstrator. The experiment utilises a simulated environment consisting of all the elements of the real system together with some added factors based upon the earlier research. This simulated environment consists of the databases identified by the Company in research cycle one together with additional databases that it was felt were enhancements to the current systems in operation within the Company. For example at the time of the experiment there were very few proper job descriptions available across the Company and some duplications of roles that offered different skills. Therefore I gathered all of the existing roles and examined the vacancies lists to work out the content of the others. The resultant role descriptions were passed to a resource manager for review and the results of his input were incorporated thereby giving me a suitable level against which to measure the matches. These were added to a database. The skills database offered up by the Company at the time of this experiment was used to create the generic data for the skills database but during discussions and dealings with the interviewees there were some additional fields added to the database e.g. project start date and end date which were absent but useful criteria for matching the availability of a member of staff. The full database fields and requirements are contained in Appendix G. Basically all the fields that exist within the Company databases were included as a minimum before adding these extra elements which were deemed necessary. All the fields were discussed and added to with the HR representative group inputs. By having this simulated environment it was possible to run tests and experiments whereby experimental sample users can recognise the information they handle on a day-to-day basis and make comparisons with the current resource management process available within the Company. Other users are using the system for the first time and will understand the concepts and the necessity for the vacancy matching functionality that has been provided but will not be able to make any kind of comparison with something they recognise as a part of their daily job because they are from the engineering community. This engineering group will of course recognise the roles and the technical and qualification skills as a minimum. All of the candidates should be able to comprehend the simple aspect of matching the candidate to the roles available.

Experimentation really evolved in the positivist domain of the sciences. Although this is a different approach for this cycle of the research from the others it is still appropriate. Experimentation looks at investigating the relationship between variables (Emory & Cooper, 1991). It allows me to take a subset of the existing system and experiment with that in order to test an idea or a hypothesis and allow an inference of the results (Clover & Balsley, 1979). Bailey (1987) suggests that experimentation allows the control of the environment; the compositions of the experiment and the subjects involved in it; control of the independent and dependent variables associated with the experiment; and finally, the ability to measure variables before and after the experiment and enabling a comparison to be made. This cycle will not undertake a full experimental approach to the implementation of a practical software agent demonstrator. This will be a quasi-experimental approach which looks to test the software agent application in a simulated situation in order to get the opinions and views of the system created and whether it meets the needs of the user and is fit for its purpose. At a later date it is possible to run a full experiment in the real environment should the Company wish to trial that. The whole issue of evaluating the software agent system is discussed later in this chapter, however the main thread is that it will be tested using the following criteria: reliability, validity and usability. The main reasons I had for taking this kind of quasi-experimental approach were:

1. To control the simulated environment as this is easier than trying to use the real environment.
2. This approach is far less time-consuming to create and run than for a full-blown experiment.

3. This experiment is repeatable at any point in time after the original one using the same equipment and facilities and software.
4. Because the experiment can be repeated it will be possible in the future to try this again but change particular variables or make it available to different members of staff.
5. This is a less costly alternative for the Company and can be used to try other similar agent applications, in order to compare similar software more objectively or improve the process for getting and evaluating data from such a trial.
6. This exposure allows the de-risking of the application specific interface and exposes flaws in the application at a less costly phase of the implementation of a real application in a real environment.

There are some aspects of every experiment, including this one, that cannot be repeated, for example, the mood of the same members of staff if the experiment were to be repeated and they were to participate. Because this is a simulated environment then it is not possible to know fully the consequences of applying such an application to the real environment. The experiment allows the concepts to be demonstrated and tested.

6.4 Methods for building the agent system

There are several toolsets available to develop software agent systems on the market today e.g. NQL Scripting language, Autonomy, Verity and Zeus. Normally these toolsets allow the construction of specialised applications, for example, Autonomy's' Portal-In-A-Box allows the development of individual portals for individual users or server-based single entry portals. Other toolsets allow developers to use the tools to write their own scripts and run an application the way they would like it to work. This means that developers can develop the applications for the company but the company will require a developer application environment in order to produce the code and will require training and a licence to do this.

These toolsets allow companies to develop their own software or buy in a commercial off-the-shelf package. Buying in a package in this way allows a very quick set up of the application. However, the company may be restricted to the application specific functionality available or be forced to buy additional packages of licences in order to make the application fit the company's purposes. This may mean there is a scalability issue for usage and a new way of working required in order to get the best from the system. For example the licensing arrangements may mean that not everyone has direct access to everything across all sites and terminals, however once the Company has re-evaluated what they really need this may not be a problem. This quasi-experiment may raise issues, which the Company has not considered previously and this could also mean a change in the process that is currently in use in order to make any new system work effectively.

The third alternative is for the company to give developers training and then develop a company-specific set of agents developed in-house. This is very time-consuming and there is a steep learning curve for the developer at the beginning of a project. However, once in place the usage can be very rewarding allowing for domain specific development to take place and the ability to handle local Company issues. If architecturally well designed the agents can have scalability and meet the company needs.

6.5 An Experiential Implementation

In this quasi-experiment I identified two software toolsets that I could use to develop the system specification for this research: the first was Autonomy and the second was NQL. Both of these products offered similar functionality including interaction with Microsoft tools applications such as Word, Excel, and Outlook. Both offered the ability to develop company-specific agents or use the applications offered off-the-shelf. When I joined the Company I made contact with the Company's Virtual University who were looking at implementing a new kind of search engine for the Company Intranet (CWW). In the discussions I mentioned Autonomy as I had been researching software agents at that time. The Virtual University (VU) did a survey on Autonomy and two other search engines and eventually adopted the Autonomy product. At this early stage I requested involvement with the work at the VU from the head of that department. During cycle one I kept in contact with what was happening with using the Autonomy software and asked for a test area to develop my own agents to experiment with the development aspects. I was never given access to a test site or any mechanism to develop my application using Autonomy through the Virtual University. Therefore I went back to my original research of identified tools and agent development environments and identified NQL as a suitable alternative. NQL was able to offer me the kind of application I was hoping to develop and the technical support during development and overall it made little difference to my research whether I used NQL's ContentAnywhere or Autonomy. From an action research point of view I was hoping to involve the Virtual University and to test some of the Autonomy capabilities during my research. Once I had a contact point in NQL Inc. I asked for demonstration software for evaluation purposes, which I received very quickly. Once I had looked at the toolset and the associated manuals I felt that this would be a good choice based on the following information: -

1. NQL provided a scripting language that was simple to use to produce an application rapidly.
2. The NQL could operate with NQL's interface (like Explorer) or one we created ourselves.
3. The NQL Content Anywhere application was a quick and easy alternative if the development was required early on for the experiment.
4. The NQL can integrate with Outlook, Word, Excel and other Microsoft applications without problems.
5. NQL Inc. was carrying out joint tests with clients in order to assess their new software versions at no cost but with an agreement to supply feedback and data for their release version.
6. Because of item 5 above there would be no licensing issues and cost to bear in order to develop a working demonstrator for this research.
7. NQL was scalable to any number of PC's and flexibility of location
8. The agent demonstrator required interaction with multiple databases and NQL offered interoperation with any database with ODBC (extremely common)
9. NQL technical support would be available throughout the construction of the agent demonstrator at no financial cost, as I would be testing their NQL software in the process.

In order to build a larger application environment with software agents the decomposition and distribution of tasks needs to be analysed and designed appropriately. This aspect was easy to analyse using the current resource management process defined and discussed in cycles one and two. The tasks are defined and included within the Requirements Document and are covered adequately within the VacancyBot application.

Much research is being undertaken in the distributed or mobile agent field examining how agents interact and communicate with one another (Itami & Roehl, 1987). Agents obviously need to know how to communicate with their peer agents and how they can move about in their environment and also how they can access the resources that they require. In order to be able to do these things the agents require the infrastructure to be in place and this environment will provide them with the capability or the limitations on carrying out their tasks. This thesis provides a single agent, which interacts with the Company infrastructure, however the technology utilised allows for multiple agent interaction and the agents communicate using the NQL scripting language. In the

VacancyBot application developed it is extremely easy to incorporate the Profiler Agent discussed later in this chapter, which communicates with the VacancyBot agent. The level of communication in this case is not the level of human reasoning however the rule-based algorithms do provide quite robust decision-making ability appropriate for the management of the tasks identified.

6.7.1 Requirements Analysis

This research is concerned with the use of agent technology for knowledge management within the Company. This element of the thesis looks at the development of a technology demonstrator and the testing of this prototype.

The programme began by isolating the requirements of a resource management system to identify the appropriate engineers from within the Company for incoming new vacancies. The requirements identified the databases that would be necessary to run such a system and the details of the User interface required to access that program. To ascertain the required databases the previous interviews in research cycle one were used as the first source of such databases. These identified the databases illustrated in Figure 6-5. Next I went for informal chats to gather information from HR and resource managers (collaboration group) to establish what other databases already exist which could be used in a trial in order to get the system up and running. From these conversations the HR database was identified. Within the informal discussions I collected a list of data fields used by these databases and these form the major part of the requirements description of these databases.

I also prepared a list of all the data identified by these informal conversations and made an appointment to see a senior resource manager to discuss the usefulness of the kinds of data and data fields to the development of my agent prototype. I collected feedback on the data that the resource manager deemed to be more important and got explanations as to why these bits of data were more important than others. After formulating the list I drew a suggested interface on his whiteboard and we discussed the layout of the screen. Once concluded I went away and drew a prototype interface using MS VC++. I then e-mailed this to the resource manager to see if this is what he was expecting and to get my first set of feedback on it. The resource manager was satisfied and liked the layout but asked for a logo to be included – I added this.

I used the previous research cycle responses to the questionnaire in order to establish the problems with the current Resource Management and recruitment process. I also spent some time speaking directly to Human resources employees and other Resource Managers in order to identify other areas for improvement and consideration within the scope of the demonstrator. The main issues identified for resolution through the software agent demonstrator is listed in section 6.2 Resource Management Problem Domain) but include aspects such as: -

1. Data being out-of-date
2. Data diversified and scattered throughout the Company
3. Time-consuming tasks
4. Often cannot identify specific skills because it is not known where to find them
5. A high reliance upon a usable interface for interaction with the system

All of these factors suggest that there is a lack of effectiveness in carrying out this task of matching a vacancy with an appropriate applicant. If the issues listed above are resolved then the resource manager can do a better and more effective job and the business benefits by using of his time more effectively with the knowledge that the roles within the projects are filled with the most suitable member of staff. Also the projects should work more effectively which means that the Company is also benefiting. The effect of deploying the right individual in the right job is likely to increase employee satisfaction, increase staff loyalty to the Company (because employees will feel they are recognised and rewarded for their capability and skills) and it should increase performance of a project since the right people are doing the right jobs. Based upon these factors the objectives for this specific demonstrator are: -

1. To select the right matches for a job with a member of staff (internal or external)
2. To cut down the amount of time a resource manager would use to identify the right match of a vacancy with a member of staff.
3. To allow diversified and disaggregated data sources to be used in order to make a match (saving time and effort in identifying, locating and extracting data from so many sources)
4. Providing the Resource Manager/Personnel Manager access to summarised information easily and effectively
5. Creating an interface that is easy to use for all staff (e.g. intuitive, familiar)

In order to meet these objectives a requirements specification was produced in order to scope the content of the development. The finalised document can be found in Appendix G. The proposed interface was discussed and developed early on with a senior Resource Manager who gave feedback on a mock version on paper.

6.7.2 Development

The software agent demonstrator (named: VacancyBot - Figure 6-1) was developed using the NQL software to develop the application functionality and VC++ to develop the application interface. The whole process of developing the application took one working week. However, the simulated environment and the database entry took two working weeks. The system was tried and configured for a period of two days and the application was available to members of staff over a consecutive four-day period. Preparation of a presentation slide show, administration set up and invitation to employees, together with all other paperwork and arrangements took ten working days to complete.

The main issues concerning the development and deployment of the application were: -

1. The e-mail system used to notify the resource manager of the results of his match for a vacancy did not work in the NQL format (HTML) due to a version problem between the NQL version of Outlook and the one available at BAE SYSTEMS Ltd. However using a plain text only format for the demonstrator rectified this.

2. The configuration of the system was a complex task and required Internal IT Support from the Company.

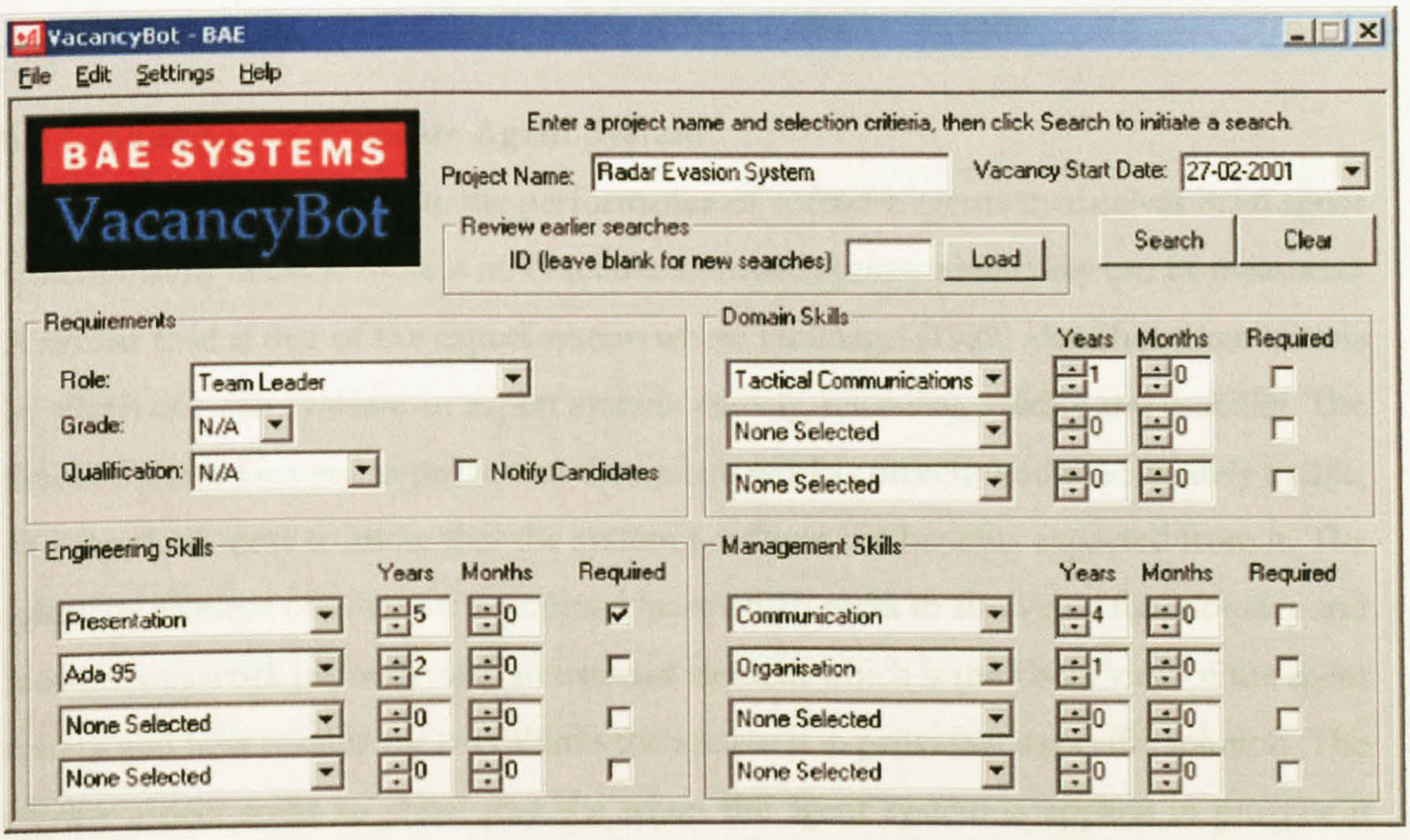


Figure 6-1: VacancyBot Interface Used in Experiment

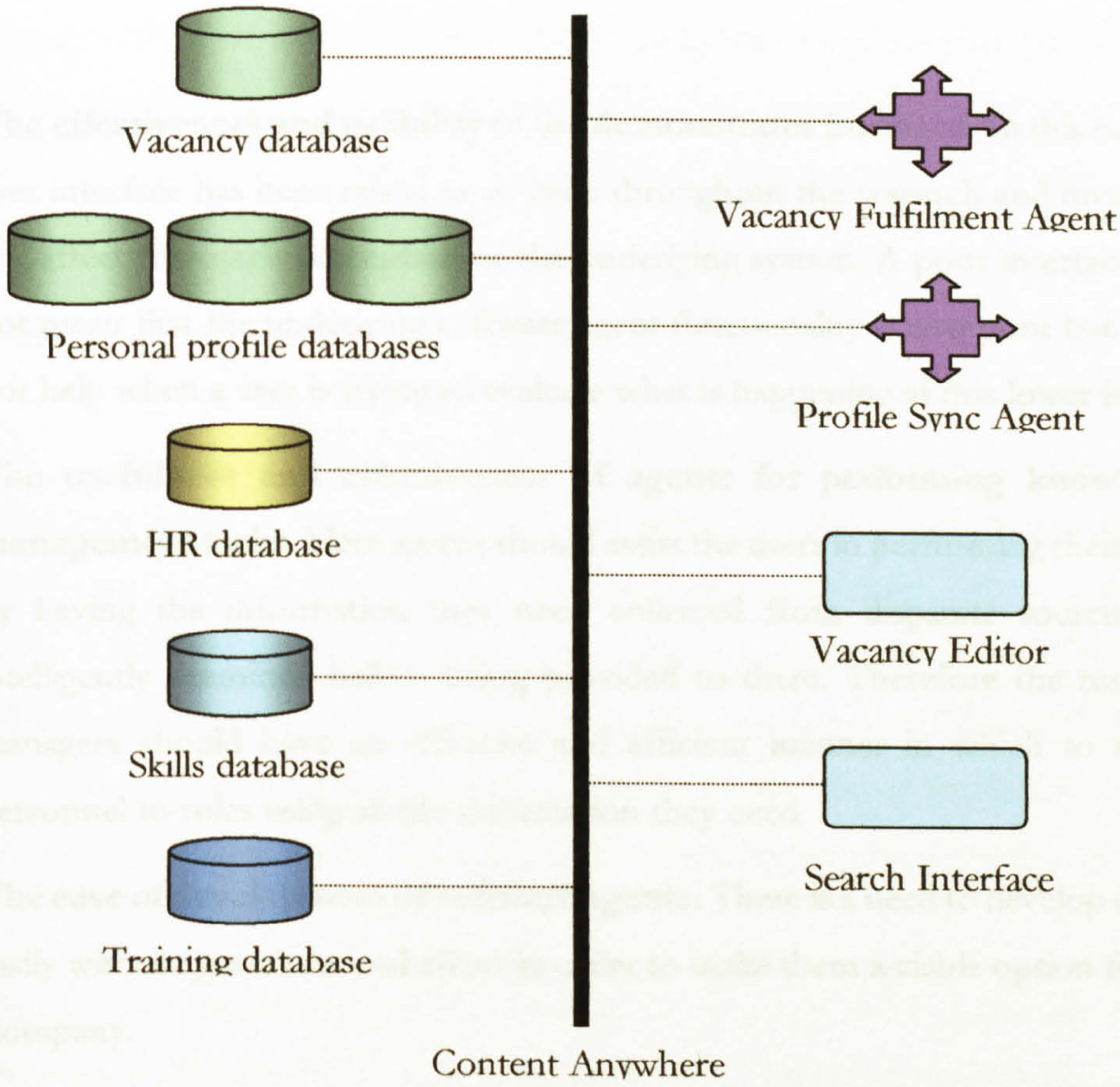


Figure 6-2: Overview of VacancyBot Architecture

6.6 Evaluating the Software Agent System

It is quite difficult to evaluate the performance of software agents themselves in an agent system mainly because there is no objective standard against which they can be measured. A similar field is that of the expert system where Hollnagel (1989) identifies three criteria by which one can evaluate an expert system: namely, reliability, validity and usability. The first and second set out to prove that the system works correctly and is adequately usable, and the third seeks to show that the system produces the benefits expected from it. The reliability element consists of: an internal facet which seeks to show that functionality and mechanisms work properly; and an external element which is the Users view of the agent system and how reliable the user thinks the system is in providing a specific solution. The validity aspect seeks to show that the when the agent system is applied in practice it produces the results that were expected from it. Finally, the usability aspect of the agent system illustrates the ease of use with which the User can apply the system no matter what their level of proficiency or experience for the system's purpose. These three elements are the chosen manner in which I am verifying, validating and evaluating the agent system demonstrator.

This quasi-experiment will seek to test the following aspects raised in the earlier research cycles:

1. **The effectiveness and usability of the demonstrator interface.** In this case the user interface has been raised as an issue throughout the research and invariably will affect the user's perception of the underlying system. A poor interface may not mean that the underlying software agent functionality is also poor but it will not help when a user is trying to evaluate what is happening at this lower level.

2. **The usefulness and effectiveness of agents for performing knowledge management tasks.** Here agents should assist the users in performing their goals by having the information they need collected from disparate sources and intelligently examined before being provided to them. Therefore the resource managers should have an effective and efficient manner in which to match personnel to roles using all the information they need.

3. **The ease of development of software agents.** There is a need to develop agents easily without great cost and effort in order to make them a viable option for the Company.

4. **The user's opinion toward software agent applications.** Here the users are given the opportunity to respond by making comments on the survey carried out as well as a small number of feedback interviews after the experiment.

5. **The possibility of organisational-wide application of software agent applications.** This will include the potential areas for the applicability of agents within the Company based upon the research carried out.

In the experiment the category of candidates using the application are (a) managers, (b) resource managers and staff managers and (c) engineers. Once again these categories are used in order to captured and ascertain the different viewpoints of the application by each group. When looking at the results there are some categories of the questionnaire, which are very pertinent to the specific groups. From an engineer's perspective I am particularly interested in their views of the flexibility and control, error prevention and correction and informative feedback since these elements require some technical knowledge of the underlying functionality. In particular, views from the engineers on these aspects could lead to better physical performance of the application. Resource and project managers' views are important to me when considering VacancyBot's fitness for purpose and appropriate functionality for the end users. In this case the views are important from those supplying the service and those receiving it. Another pertinent aspect to these two groups is the overall system usability section of the questionnaire because this will expose any poor quality interface issues. All of the other categories are equally as important to each group in order to examine any significant differences in views concerning particular aspects of the application. The results will be analysed in the light of these issues.

6.8.1 The effectiveness and usability of the demonstrator interface

This investigation into the ability of agents to perform knowledge management tasks will also examine the development of the human computer interface that has been developed for the agent application. The interface is a major part of the development of a usable tool and the best technology under the interface will never be used unless the interface is correct for the audience and the purpose (Neilsen, 1993; Galitz, 1997). All of the criteria are referred to in ISO 1942, which is an industry-accepted reliable standard that was developed over several years into its current format. Other issues considered in the layout and the dynamic behaviour of the interface was added by the use of the Windows Style Guide (Microsoft, 1995). The usability aspect of the evaluation measures the following criteria:

Visual Clarity: The interface should be visually, conceptually and linguistically clear – particularly the visual elements, functions, metaphors and words and text (Galitz, 1997; ISO 1942).

Consistency: The system should look, act and operate in the same way. E.g. the same action should have the same outcome and the functions of elements on the interface should not change (Neilsen, 1993; ISO 1942).

Compatibility: Should be provided with the User, the task and the job and the product. Whatever is done needs to be viewed from the User's perspective (ISO 1942).

Information Feedback: The system should respond to the User's requests letting him know that actions are being taken by visual, textural or auditory feedback e.g. if waiting for data to download a normal feedback reaction would be the visual display of a sand-timer or a progress bar until completed (ISO 1942).

Explicitness: There should be direct, clear and intuitive ways available to the User to fulfil the tasks (ISO 1942).

Appropriate Functionality: The system should provide the functionality expected for the tasks the User wishes to perform. This should be evaluated before creating the interface through discussion with the User (ISO 1942).

Flexibility and Control: The system should, as far as possible, take account of a User's knowledge and skills, experience and the conditions at the time. The User should also have control over any interaction, so actions should result from direct requests and should be interruptible or able to be terminated by the User (ISO 1942).

Error Prevention and Correction: The system should prevent Users from making errors in the first place, for example, in required fields the data should be forced into the correct form if necessary. If Users need to take a step back in a task this should be enabled. The User should be protected against catastrophic errors (ISO 1942).

System Usability: The system should be usable by the User. The User should be intuitively led through the application – there may be cues to help him and distinct screen elements that are clear. Help or guidance should be available and assistance such as tool tips available as necessary. The language and metaphors should be familiar to the User's domain (Neilsen, 1993; ISO 1942).

6.8.2 The usefulness and effectiveness of agents for performing knowledge management tasks

The experiment used captured the information relating to the fitness of this software agent demonstrator to the purpose for which it was designed. I also carried out several interviews after the experimental data was analysed where the candidates were asked to comment on the appropriateness of the application for its purpose (Appendix H)

6.8.3 The ease of development of software agents

Constructing a Software Agent System

In the past most artificial intelligent applications have relied upon specific programming languages, such as LISP and PROLOG (Russell & Norvig, 1995;. Cercone & McCalla, 1984). These languages require a greater understanding of the AI domain in order to develop any AI system. The previous era of artificial intelligence application development was very much based in academia and extremely theoretical (Genesereth & Nilsson, 1987). This phase of AI was viewed by industry in an extremely sceptical light since it was perceived to be a solution looking for a problem rather than a practical implementation that could be the leading-edge technology for companies (Russell & Norvig, 1995).

The other major issue is that with their earlier processing power computers were incapable of making this AI technology realisable. Now mainstream languages can be used such as C++ and Java, which are current and everyday engineering skills that are easier for developers to use. Powerful processors at low market cost are widely available providing the capacity and the capability for AI applications now and for the future. This capability leap in technology has made AI technology available for providing a solution to identifiable business problems. In this last case the problems are now seen as areas that AI technology can resolve.

Another significant factor affecting development of AI systems today is the availability of toolsets and scripting languages for developing these kinds of applications. Frameworks and agent-oriented language standards are also becoming more readily available and they remove the need to have a deep understanding of the underlying theories whilst still allowing powerful systems to be developed.

With these barriers to the development of AI applications removed the future of this technology is now at the forefront of providing powerful solutions to our business problems.

6.8.4.The user's opinion toward software agent applications

This aspect of the experiment involved user-feedback at the sessions through the open-ended questions in the questionnaire together with a set of follow-up interviews with some of the attendees selected at random. The interview data was analysed and is discussed later in this chapter.

6.7 Agent Demonstration Software Questionnaire

This questionnaire is one of the primary sources of analysis for the research of the pilot solution being offered to BAE SYSTEMS. The questionnaire consisting of 103 questions was prepared and circulated to 40 members of staff in Company during a concept demonstrator presentation. The questionnaire concentrated on the issues relating to the usability and fitness for the purpose of the demonstrator. Specifically the basis of the questionnaire was the International Standards on User Interface Development (e.g. ISO 1942). The usability criteria arising from this standard together with the research criteria I had previously identified in the graphical user interface literature (Galitz, 1997, Nielson, 1993) were used to define the categories. I had already identified in cycle one and two interviews that there was a perceived problem for individuals when interfacing with other tools, databases and in-house software. A total of 31 staff responded to the questionnaire.

The 103 questions were split into key usability criteria in the areas identified above. The only category in the ISO standards that was not included in the questionnaire was the online help facility and this was omitted because there was no such facility provided in the concept demonstrator. This is not to suggest that a real system would not have one. There were five categories of answer in the Likert scale ranging from (1) Not Applicable, (2) Never, (3) Some of the time, (4) Most of the time, and (5) Always. The respondents were required to express the absence or presence of certain characteristics by rating each characteristic against the 5 point Likert scale. Five open-ended comment boxes were provided at the end of the questionnaire allowing comment on (1) the interface, (2) the functionality, (3) enhancements, (4) workload and process improvement, and (5) whether this technology can assist staff to do their job more effectively.

The original invitation was sent out to approximately 60 members of staff by e-mail. The approximation is given because the e-mail requested that it should be forwarded to other individuals who might wish to attend. I started by sending the e-mail to all resource and staff managers as a key group of potential candidates for responses. I also originally sent out invitations to 8 key managers in different business areas of the company, to 10 engineers and 5 team leaders. The demonstration software was made available in a training-room facility on the site accessible to all members of staff. Timetabled slots were made available through a web site invitation page (See Figure 6-3 and Figure 6-4). Responses were booked in by a total of 31 members of staff. However, there were open times for those who might be able to make a time slot at the last minute. The actual number attending and completing the questionnaire included: (1) Managers - 10, (2) Engineers – 11 (3) Resource Managers - 10. Of these there were two anomalies, which were outside visitors from the University of Bournemouth. As these two candidates are within the Business Faculty their results were added to the Manager category as a best fit.

Agent Technology Software Demo Form

I am running a demonstration of the Agent Technology software prepared as part of my Doctorate. This is only a **concept demonstrator** to prove the concepts of agents used for infrastructure knowledge management. This demonstrator concentrates on the specialist area of Resource Management.

On arrival you will be given a feedback pack containing the documentation you will need to for your hour slot. During the hour you will be expected to follow scenarios to understand the principles being applied, fill out a usability questionnaire and a feedback form.

All the information you supply will be treated in the strictest confidence and your name will be removed from the final analysis of data for confidentiality purposes.

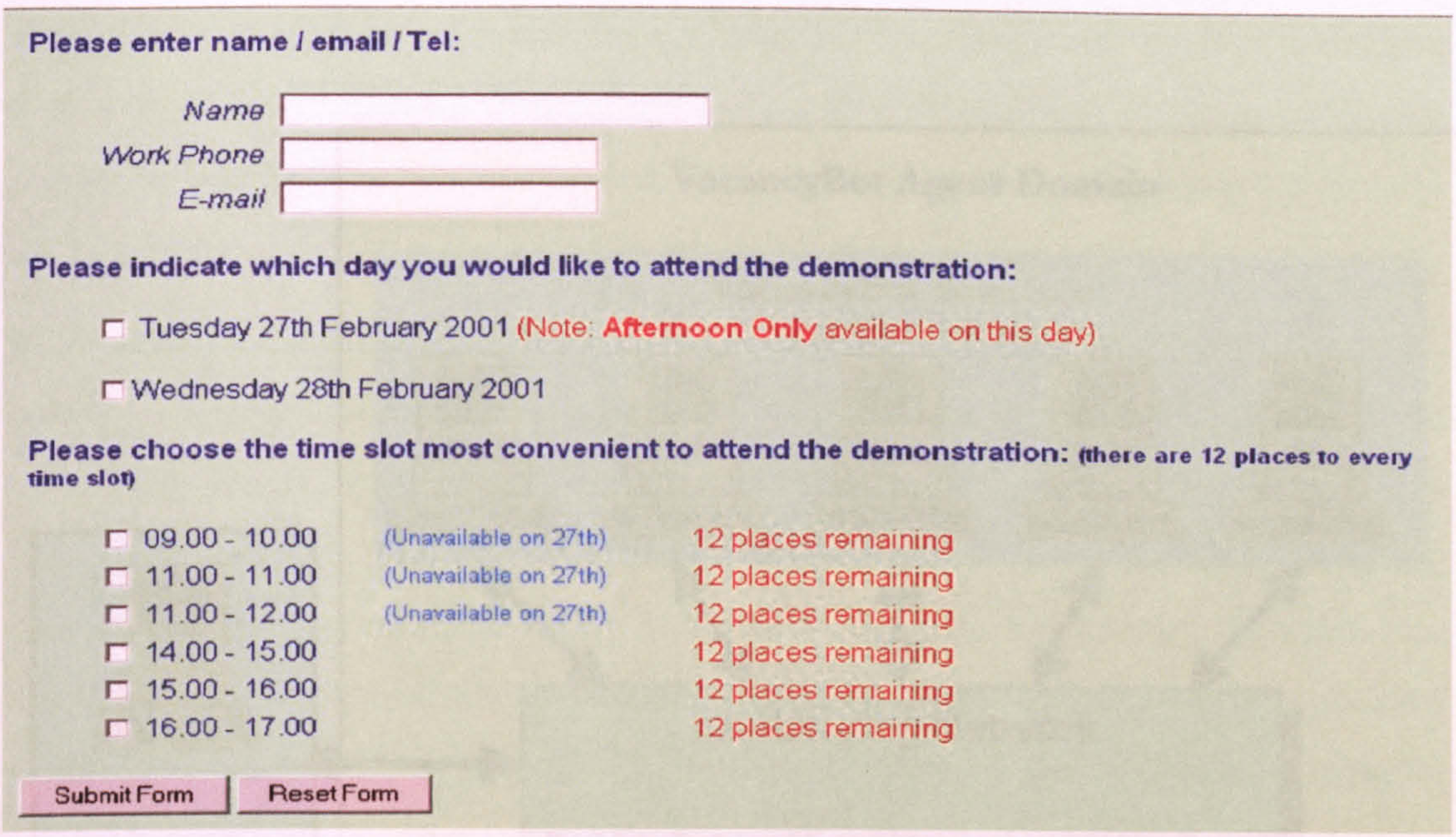
I hope you will take this opportunity to give your views and see first hand the possibilities that software agent technology can offer.

There is also a Technology Presentation Day following this demonstration on Software Agents which includes external renowned speakers from the UK and the USA. If you are interested in attending this or would like further information please contact (Tel: 7615 4268).

Please contact either myself or Charles, with any questions, comments or queries.

(Tel: 01202-408047)

Figure 6-3: VacancyBot Demonstration Booking Form Part 1



Please enter name / email / Tel:

Name

Work Phone

E-mail

Please indicate which day you would like to attend the demonstration:

Tuesday 27th February 2001 (Note: **Afternoon Only** available on this day)

Wednesday 28th February 2001

Please choose the time slot most convenient to attend the demonstration: (there are 12 places to every time slot)

09.00 - 10.00	(Unavailable on 27th)	12 places remaining
11.00 - 11.00	(Unavailable on 27th)	12 places remaining
11.00 - 12.00	(Unavailable on 27th)	12 places remaining
14.00 - 15.00		12 places remaining
15.00 - 16.00		12 places remaining
16.00 - 17.00		12 places remaining

Submit Form | Reset Form

Figure 6-4: VacancyBot Demonstration Booking Form Part 2

6.8 The Experiment

The VacancyBot application was deployed on the server and client machines in the training laboratory at the BAE SYSTEMS Christchurch site. The application was made available over a five-day period for staff to come into the training room and use the software.

Full instructions were provided to all attendees on the day, together with a presentation slide show explaining what the application was aiming to achieve together with a survey to record the results of using the application. The experiment was conducted with the assistance of two engineers and two support staff that provided any necessary assistance to users in accessing the VacancyBot application. Each candidate occupied his own computer and set of instructions and worked in isolation after the slide show presentation and instructions were presented (See Figure 6-5). At the end of their session the candidates were instructed to return their survey and leave the room quietly allowing others to complete their surveys without interruption. The completed surveys were added each day to an Excel spreadsheet allowing data to be evaluated and imported into other statistical analysis tools as necessary.

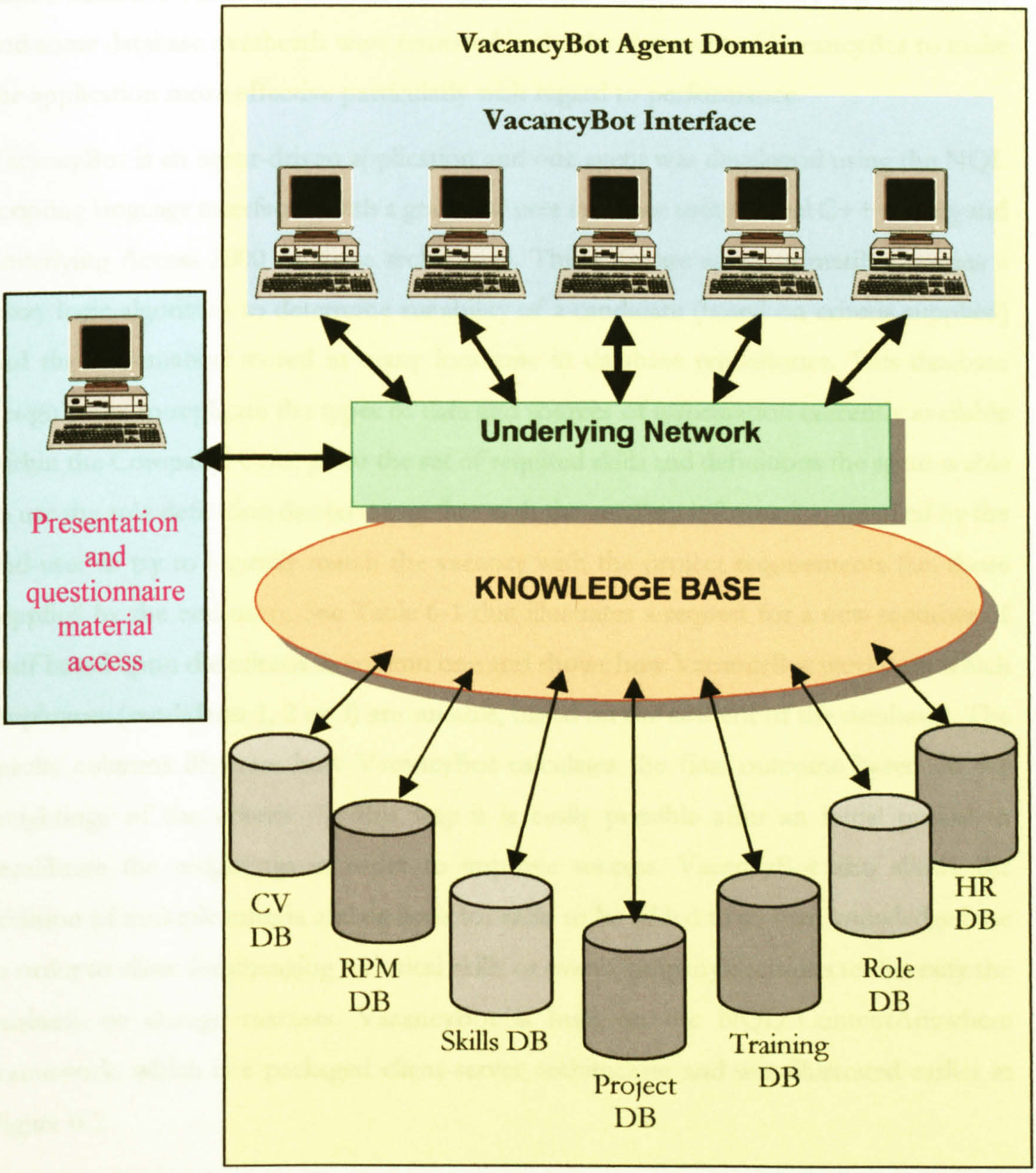


Figure 6-5: Set Up of VacancyBot Application

6.9 How VacancyBot Works

VacancyBot is used to locate the most suitable personnel for the project vacancies as described or represented by the end user. The application used a mimicked set of databases to represent those that are present in the Company at the time of the experiment. There are also some additional databases added, which include the project and the role databases which were seen as essential but were not currently available in the Company. These two databases include the fields described in the requirements specification document found in Appendix G. These two databases were necessary in order to make the application functionally sound in achieving its purposes. The skills database was developed in a better manner than the Company's own attempt to provide such a database. All of fields in the Company's skills database were used but duplication and some database overheads were removed in the development of VacancyBot to make the application more effective particularly with regard to performance.

VacancyBot is an agent-driven application and one agent was developed using the NQL scripting language interfacing with a graphical user interface using Visual C++ coding and underlying Access 2000 database technology. This software agent primarily contains a fuzzy logic algorithm to determine suitability of a candidate (based on criteria supplied) and the information stored in many locations in database repositories. This database design seeks to replicate the types of data and sources of information currently available within the Company. Once given the set of required skills and definitions the agent is able to use the role definition database together with the ancillary information supplied by the end-user to try to logically match the vacancy with the project requirements (i.e. those supplied by the end-user). See Table 6-1 that illustrates a request for a new member of staff based upon the criteria in column one and shows how VacancyBot works out which employees (candidates 1, 2 or 3) are suitable, based on the content of the databases. The results columns illustrate how VacancyBot calculates the final outcome based on the weightings of the criteria. In this way it is easily possible after an initial period to recalibrate the weightings in order to improve success. VacancyBot also allows the addition of multiple criteria and options for skills to be added to its own knowledge base in order to allow for changing technical skills or even Company decisions to diversify the business or change markets. VacancyBot is built on the NQL ContentAnywhere framework, which is a packaged client-server architecture and was illustrated earlier in Figure 6-2.

The use of fuzzy logic in the decision-making process is unlike traditional "black and white" computer programming, because fuzzy logic embodies degrees of belief. This is a far more flexible way to handle conditions than the old true or false approach and enables the ability to embody ideas such as "nearly", "almost" and "maybe". This allows the intelligent ranking of results: balancing of pros and cons, and good decisions even when only partial information is available.

Criteria	Employee 1	Result	Employee 2	Result	Employee 3	Result
Visual basic, 2 years (optional)	Visual basis, 1 year	0.500	Visual Basic, 1 year	0.500	Visual Basic, 6 years	1.00
Visual C++, 2 Years (required)	Visual C++, 3 years	1.500	No Visual C++	REJECTED	Visual C++, 3 years	1.000
Project Leadership, 3 years (optional)	No project leadership	0.000	Project leadership, 4 years	1.000	Project leadership, 7 years	1.000
Radar, 3 years (required)	Radar, 5 years	1.000	Radar, 3 years	1.000	Radar, 3 years	1.000
		0.625		N/A		1.000
Suitability		Yes		No		Yes

Table 6-1: How VacancyBot Performs its Match against the Desired Requests Made.

A manager adds a new vacancy using the Vacancy Editor application where he specifies both exact and optional criteria and this results in adding a new record to the Vacancy Database. Next the Vacancy Fulfilment Agent processes this new vacancy by determining the candidate's matching criteria and ranking the employee's suitability using fuzzy logic (See example results in Table 6-1). Finally the originating manager is notified of suitable candidates via e-mail (See example e-mail match Figure 6-6). It is also possible to notify employees who match a new vacancy that a new role has appeared in the Company vacancy database in order to allow them to see that vacancy and let their resource manager know they would be interested in applying for it. This element of the application is open to debate due to some of the comments received during the experiment that suggest that the local need for an employee on a project may override the employee's need to move to a different role. There was no Company policy adopted for this at the time of the experiment, however it was suggested that this was what happens now when employees want to change roles. This is unfounded at the time of the experiment and has not been investigated further in this research.

The results contained in the e-mail output can be investigated further by the end-user (providing they have the right security access in the real system) to investigate (1) further details of the candidate e.g. access to the candidate's records and curriculum vitae; (2) to the criteria which determined the candidate's suitability. This allows the end-user to determine if he wants to begin the interview process or enter into discussions with the resource manager in which this individual belongs.

The criteria currently used in this first prototype VacancyBot include the role, grade, and qualifications: including a set of engineering, management and domain skills (up to 4 of each) with details of the name and length of experience in each skill, as well as the level of importance associated with each skill (e.g. optional or essential).

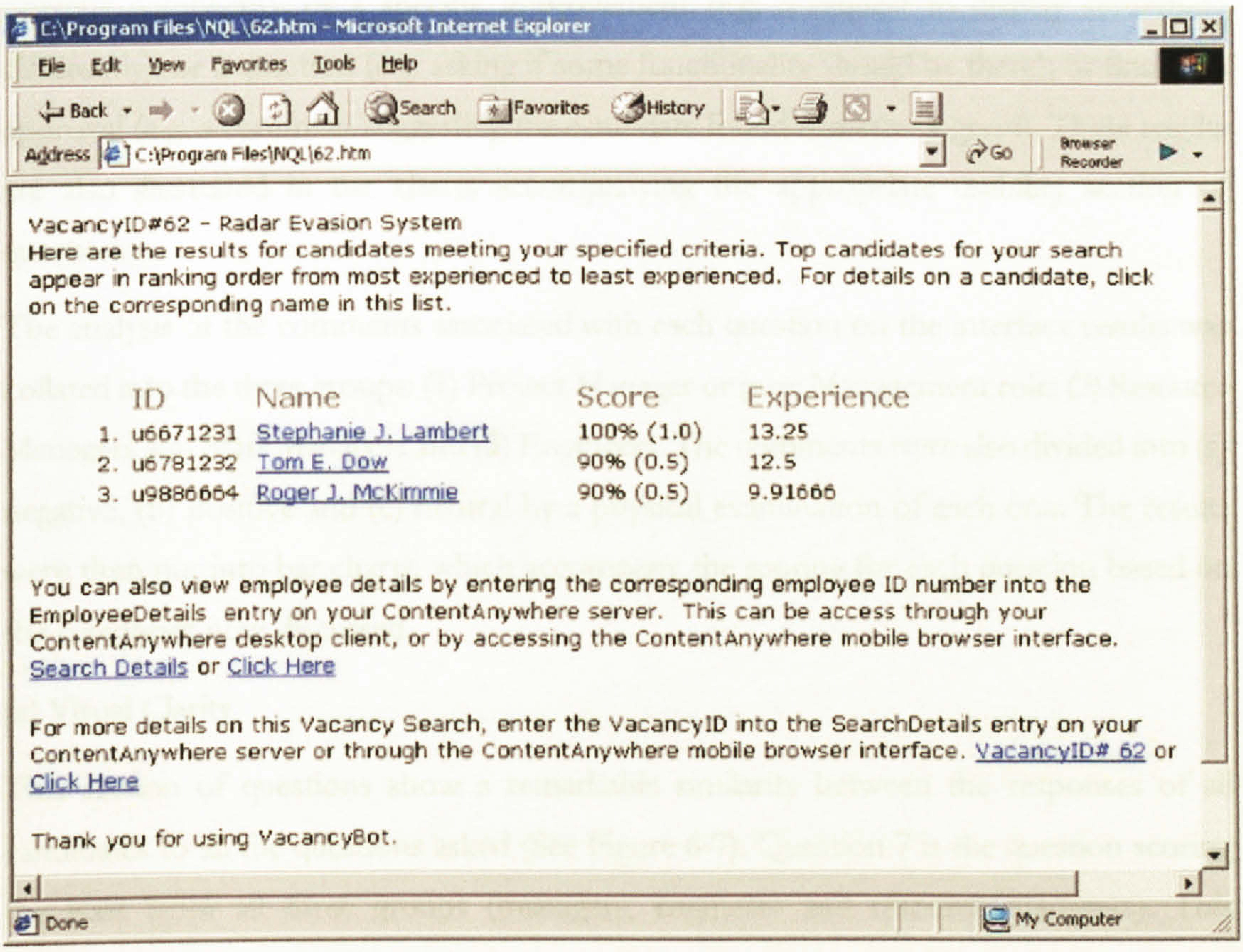


Figure 6-6: E-mail Output from Typical VacancyBot Search

6.10 The analysis of the results

The results of the survey are recorded in different ways and are evaluated in their separate categories. First there were the statistics derived from a Likert scale interface set of questions, secondly, a set of comments relating to those scores and also a set of comments relating to the applicability of the agent technology. Finally, 6 interviews were conducted, within one week of the experiment, relating to the specifics of agent technology and the results of these have been analysed and reviewed here also.

6.10.1 The Analysis of the Usability Factors

The overall results were collated in an Excel spreadsheet and statistical analysis of the results was made. The category of employee was noted as a division of the results; therefore there were employees within the (1) Project Manager or pure Management role; (2) Resource Managers and Staff Managers (3) Engineers. The results are viewed in the light of the perspectives of these three types.

The results from the Likert scale was graphed in the normal way and is illustrated in the results discussion that follows. Along with every single question asked there was an open opportunity for the candidates to add any comments alongside the question. Each of the comments was categorised in the analysis of the results as being either a criticism (e.g. an obvious complaint); or a specific improvement (e.g. a request to display something differently); or a question (e.g. asking if some functionality should be there); or finally an approval (e.g. a comment suggesting the candidate found something good). These results are also illustrated in bar charts accompanying the appropriate usability section of questions.

The analysis of the comments associated with each question on the interface results was collated into the three groups: (1) Project Manager or pure Management role; (2) Resource Managers and Staff Managers and (3) Engineers. The comments were also divided into (a) negative, (b) positive and (c) neutral by a physical examination of each one. The results were then put into bar charts, which accompany the scoring for each question based on the categories now discussed.

[a] Visual Clarity

This section of questions show a remarkable similarity between the responses of all candidates to all the questions asked (See Figure 6-7). Question 7 is the question scoring the least from all three groups (managers, engineers and resource managers). This question relates to whether the colours used are easy to see on a low-resolution screen, and colour blindness. In this case the users did not have an opportunity to see low-resolution in operation so many candidates answered with the lowest score (i.e. the not applicable response). However, overall the marking for this question still scored above average nevertheless.

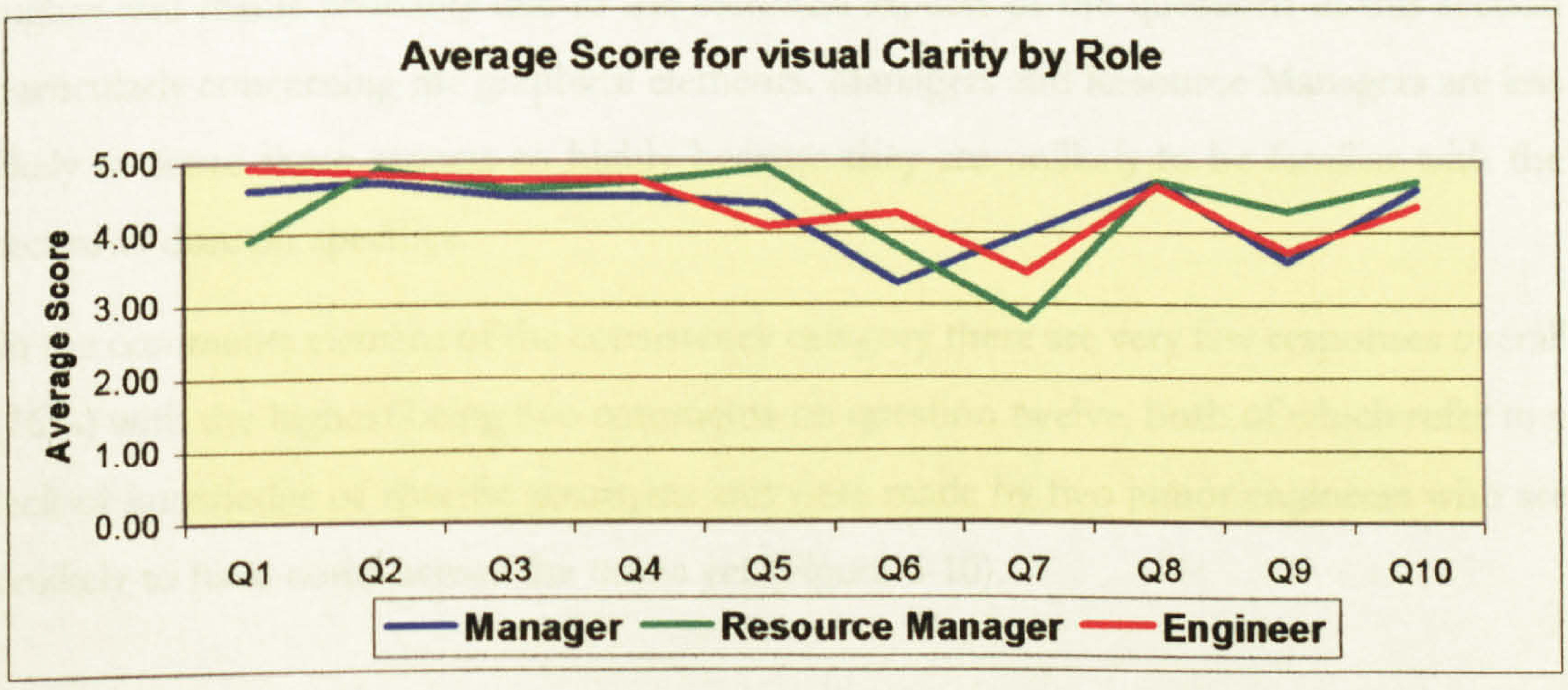


Figure 6-7: Average Scores – Visual Clarity

The following bar chart (See Figure 6-8) illustrates the comments made on this section and this shows that 62% of those responses were of criticism. However, 31% responded with suggestions for improvement and 7% made approval comments. It is also clear that 5 comments were the greatest amount any one question received out of 31 candidates completing questionnaires (i.e. 16%). These comments refer to question five concerning the use of contrasting colours, which have received comments relating to the over-use of different shades of grey. This is an enhancement to the application and can quite easily be incorporated once colours have been agreed.

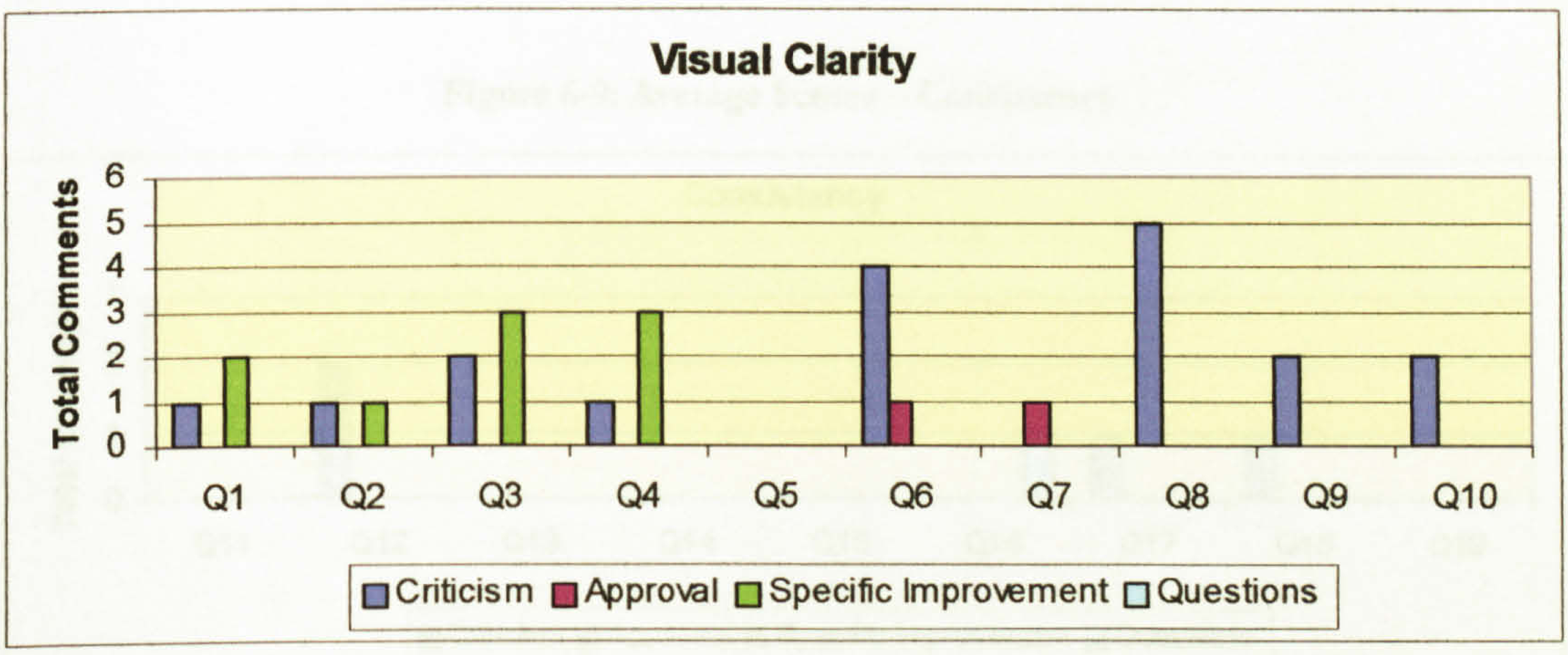


Figure 6-8: Visual Clarity – Comment Feedback

[b] Consistency

Once again this graph illustrates the general similarity between the three candidate groups (See Figure 6-9). The weakest scoring was that of the Manager population on question thirteen, which relates to the appropriateness of the symbology, icons and graphics. In this case several candidates responded with a neutral choice on the Likert scale, which of course reflects on the overall scoring. In this graph the Engineers are consistently scoring higher and this is probably due to the technical aspects of the questions in this section particularly concerning the graphical elements. Managers and Resource Managers are less likely to score these aspects so highly because they are unlikely to be familiar with the technical domain specifics.

In the comments element of the consistency category there are very few responses overall (16%) with the highest being two comments on question twelve, both of which refer to a lack of knowledge of specific acronyms and were made by two junior engineers who are unlikely to have come across the terms yet (Figure 6-10).

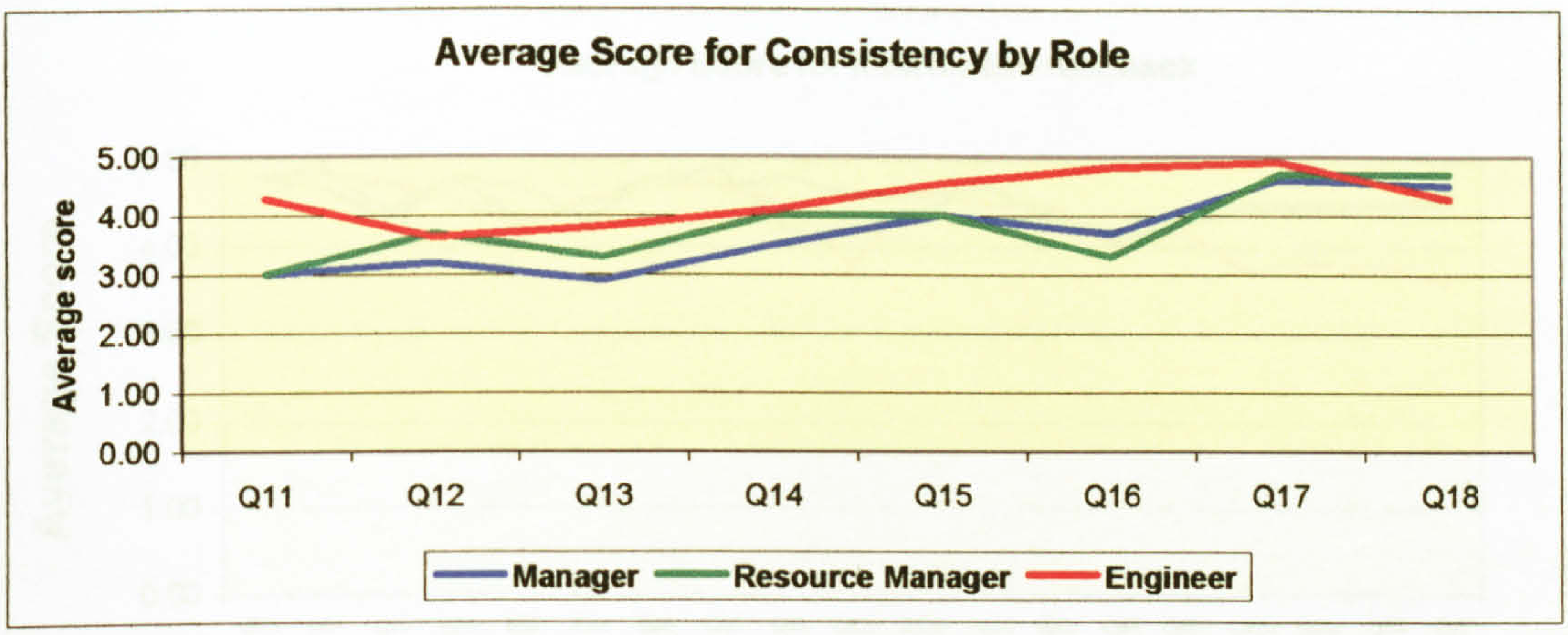


Figure 6-9: Average Scores – Consistency

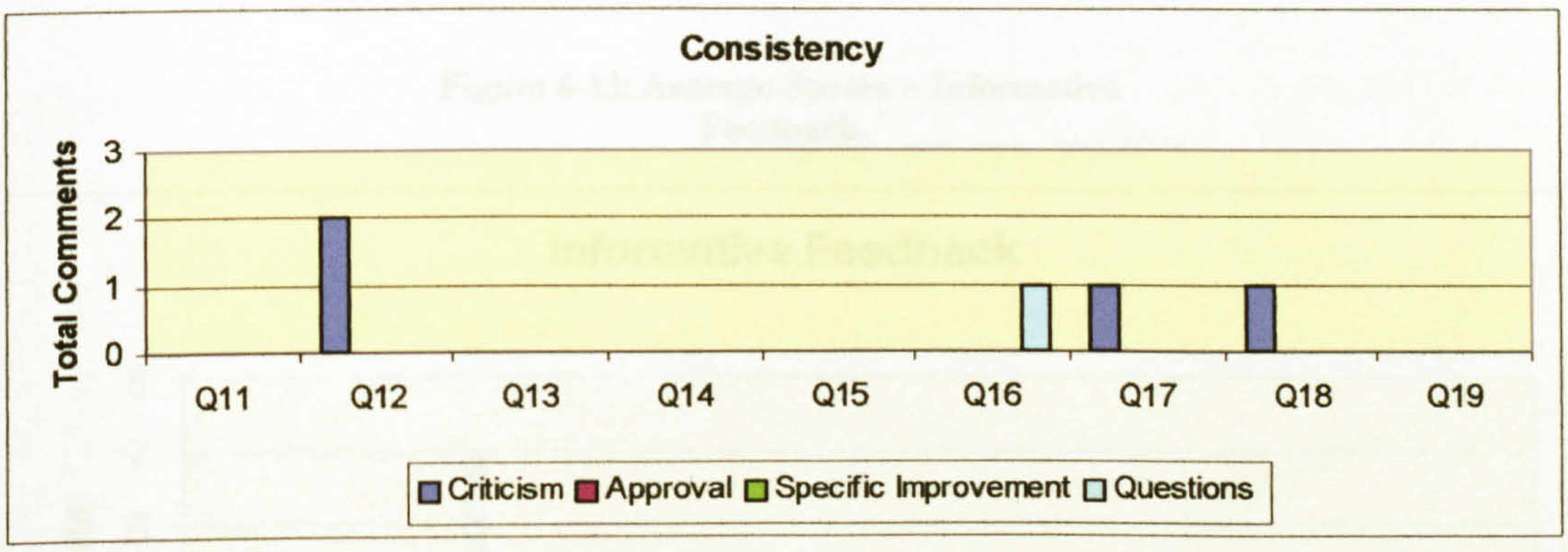


Figure 6-10: Consistency – Comment Feedback

[c] Compatibility

The marking between the three types of candidates is extremely similar in this graph too (Figure 6-12). In this graph the Engineers are marking more often lower than the other two groups but particularly on questions twenty-four and twenty-five, which reference the data formats used and the entering of that format. This element of the interface was in fact incorrect as the date format was programmed with an American format as opposed to a UK format. This was also picked up in the comments on these questions (Figure 6-11).

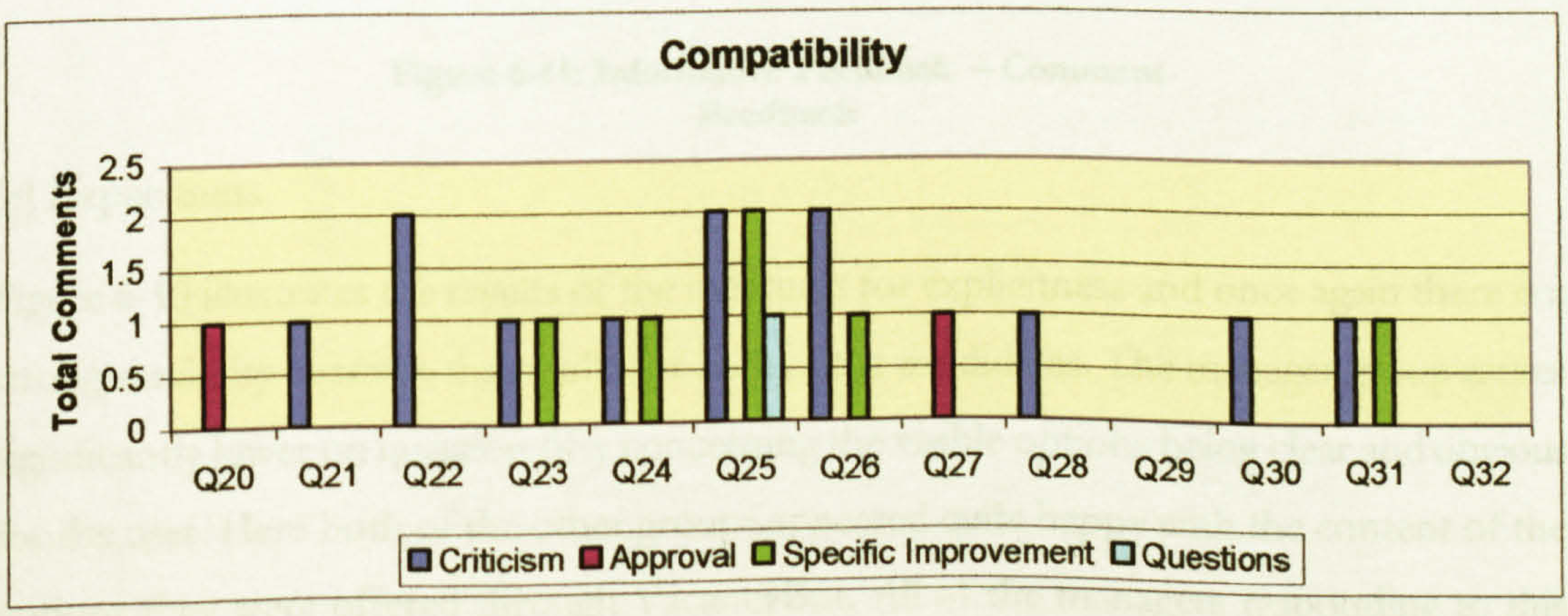


Figure 6-11: Compatibility – Comment Feedback

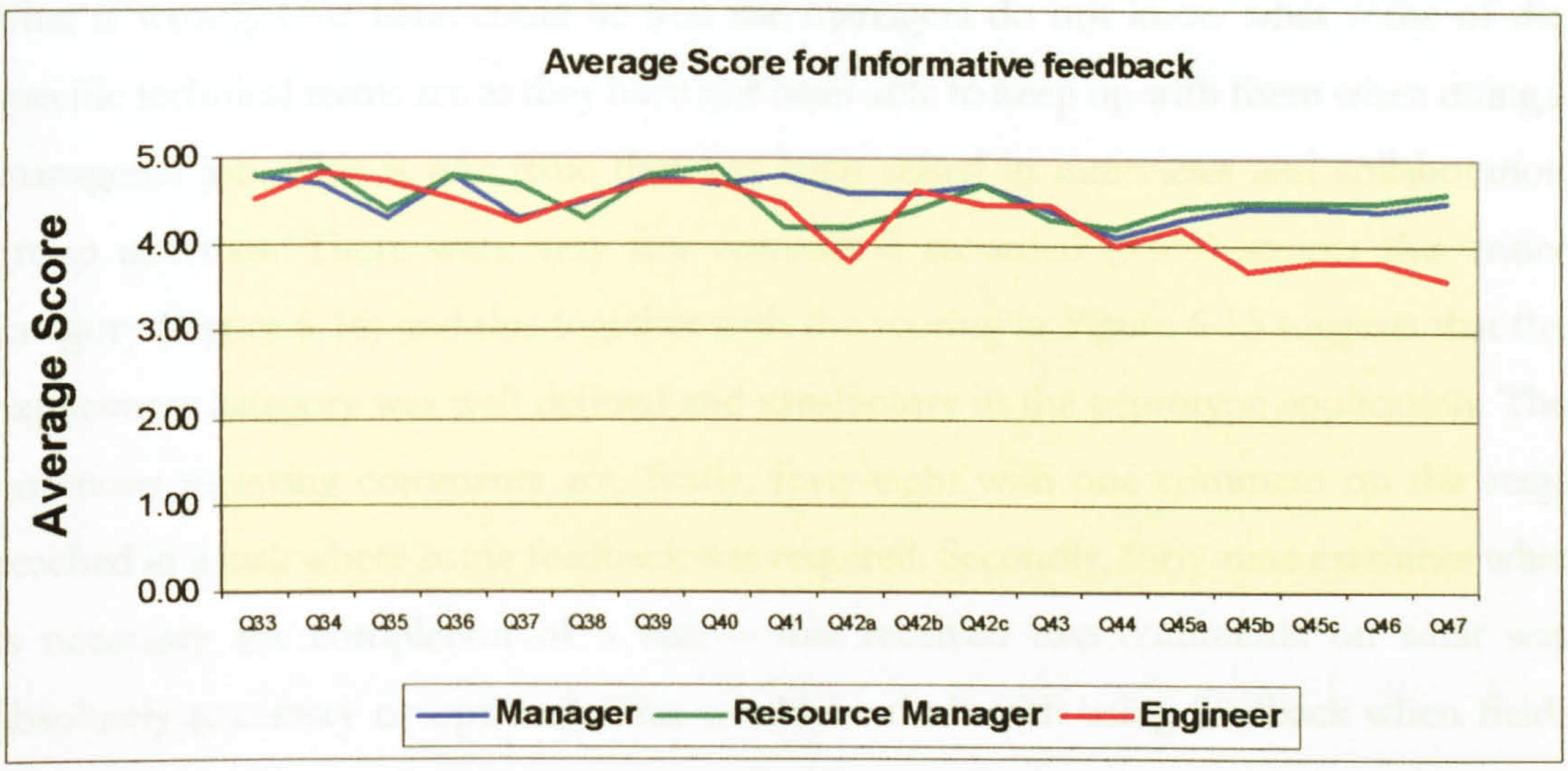


Figure 6-13: Average Scores – Informative Feedback

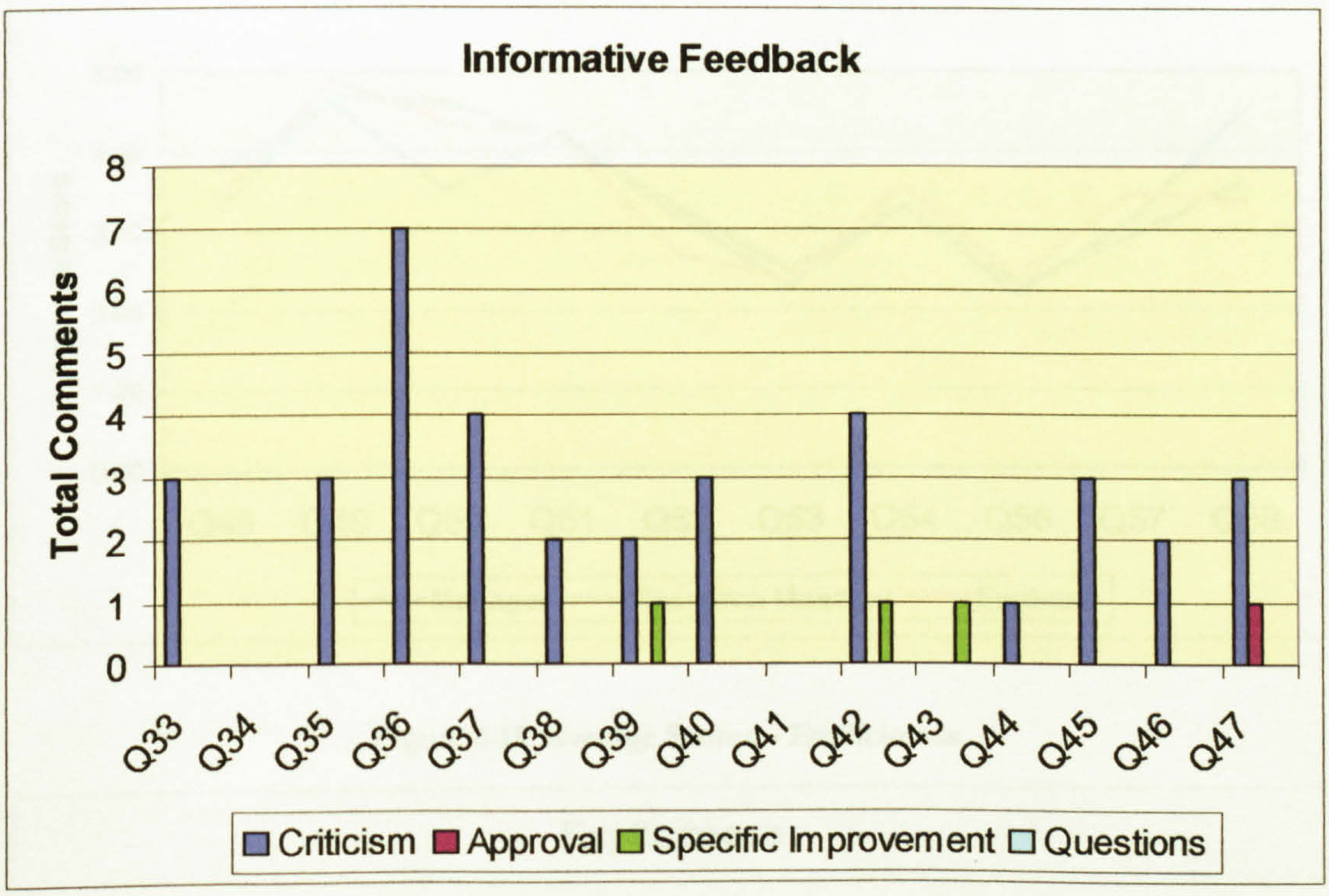


Figure 6-14: Informative Feedback – Comment Feedback

[e] Explicitness

Figure 6-15 illustrates the results of the measures for explicitness and once again there is a strong similarity between the results for each of the candidates. The manager group scores significantly lower on question fifty concerning the visible options being clear and obvious for the user. Here both of the other groups appeared quite happy with the content of the options they were offered through VacancyBot. All of the managers responding to this question did not raise any comments on their results, which does not assist me in knowing what is wrong. One issue could be that the managers do not know what some of the specific technical terms are as they have not been able to keep up with them when doing a managerial job. This is one issue that has been raised in interviews and collaboration group activities. There were very few comments recorded (9.6%) against this entire category (Figure 6-16) and this together with the scoring in Figure 6-15 suggests that the explicitness category was well defined and satisfactory in the prototype application. The questions receiving comments are, firstly, forty-eight with one comment on the stage reached in a task where some feedback was required. Secondly, forty-nine examines what is necessary for completion of a task – this received two comments on what was absolutely necessary or optional. This would be dealt with using feedback when fields were necessary in any future application.

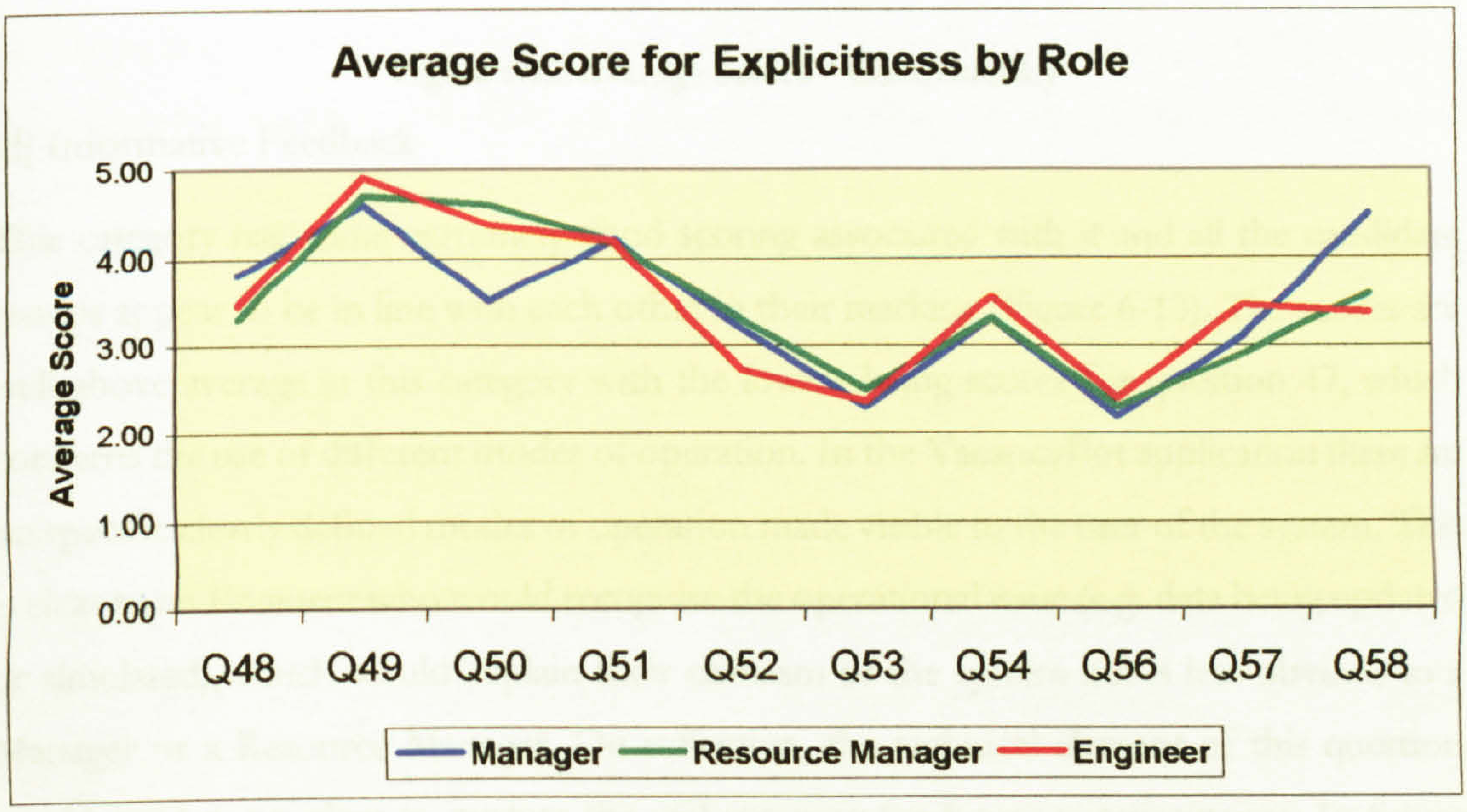


Figure 6-15: Average Scores – Explicitness

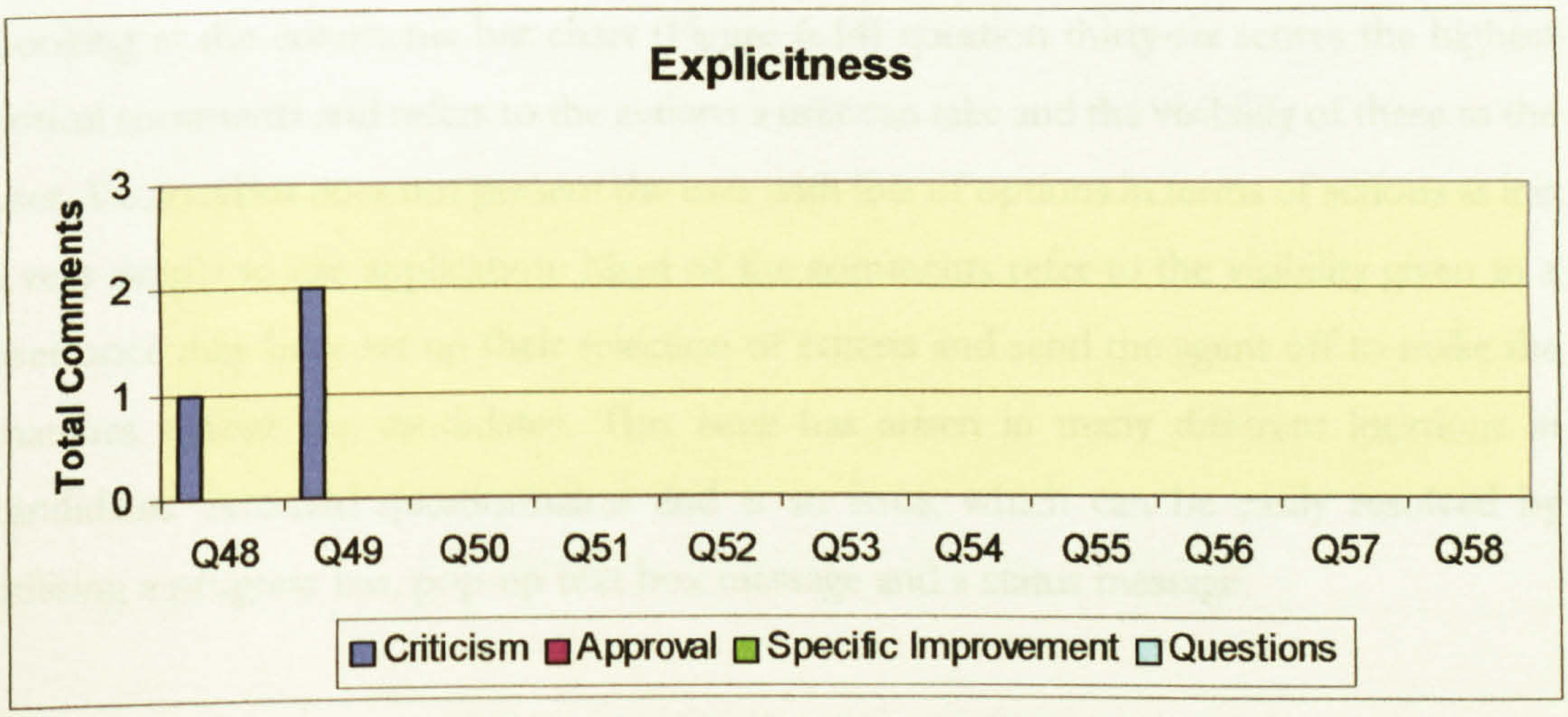


Figure 6-16: Explicitness – Comment Feedback

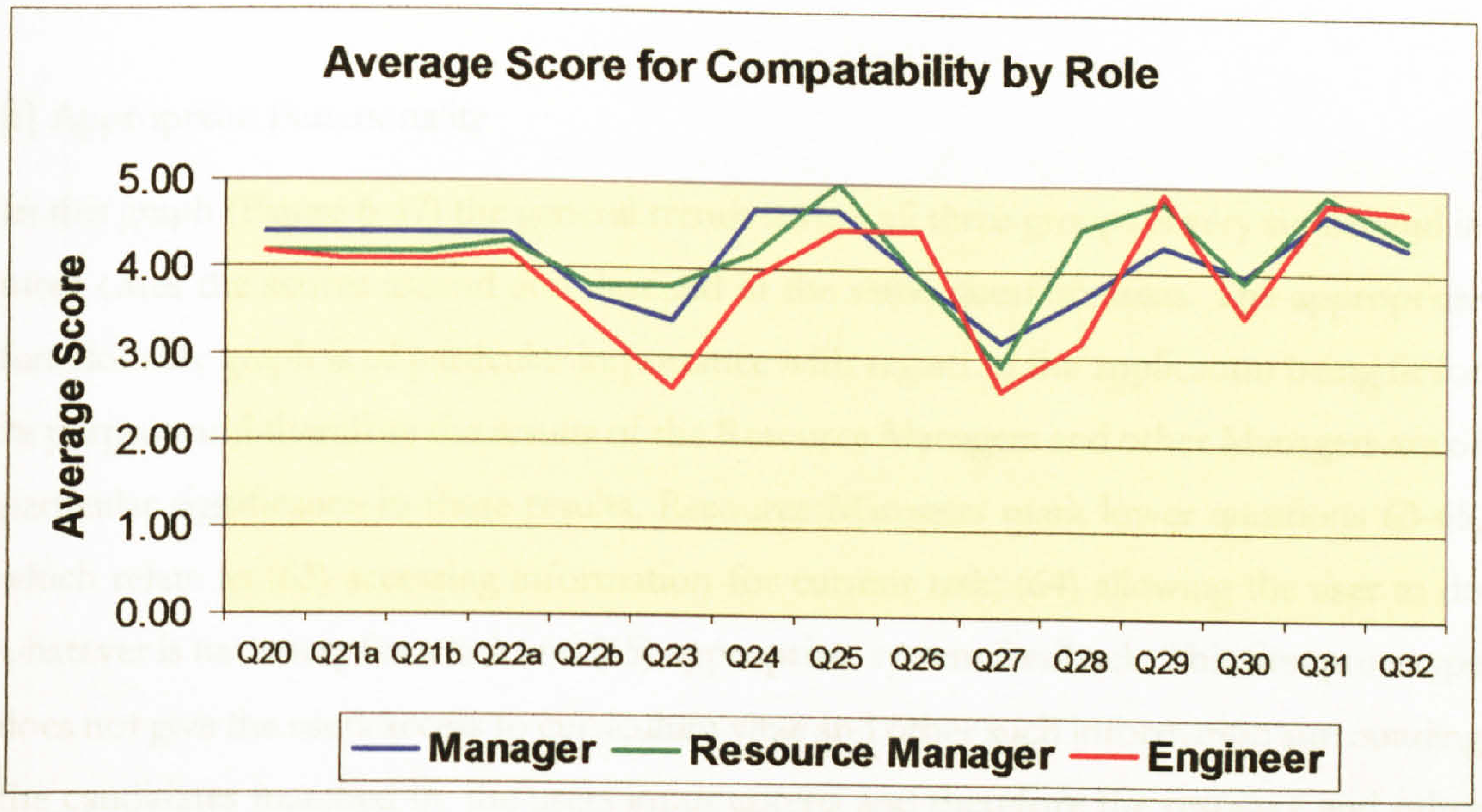


Figure 6-12: Average Scores – Compatibility

[d] Informative Feedback

This category has some extremely good scoring associated with it and all the candidate groups appear to be in line with each other in their marking (Figure 6-13). The scores are well above average in this category with the lowest being scores for question 47, which concerns the use of different modes of operation. In the VacancyBot application there are no specific clearly defined modes of operation made visible to the user of the system. This is clear to an Engineer who would recognise the operational issue (e.g. data being updated or simulated), which would explain their criticism of the system but is less obvious to a Manager or a Resource Manager. On reflection, the technical element of this question would need re-wording to capture the real meaning for future questionnaires. In future surveys I would ask the question differently.

Looking at the comments bar chart (Figure 6-14) question thirty-six scores the highest critical comments and refers to the actions a user can take and the visibility of these to the user. VacancyBot does not present the user with lots of options in terms of actions as it is a very simple to use application. Most of the comments refer to the visibility given to a user once they have set up their selection of criteria and send the agent off to make the matches against the candidates. This issue has arisen in many different locations in candidates' returned questionnaires and is an issue, which can be easily resolved by utilising a progress bar, pop-up text box message and a status message.

[f] Appropriate Functionality

In this graph (Figure 6-17) the general trends across all three groups is very similar and in most cases the scores ascend and descend in the same question areas. The appropriate functionality graph is of particular importance with regard to the application being fit for its purpose and therefore the results of the Resource Managers and other Managers are of particular significance in these results. Resource Managers mark lower questions 63-65, which relate to (63) accessing information for current task; (64) allowing the user to do whatever is necessary for a task and (65) appropriate system feedback. This first prototype does not give the users access to curriculum vitae and other such information surrounding the candidates matched by the users input criteria and therefore the resource and other managers may have had a certain degree of disappointment that this was not provided. With regard to question sixty-five this issue has been noted in several places and the users would expect some sort of feedback message to say that their information was being processed once they hit the search button on the application. These questions received minor comments based upon this expectation (Figure 6-18). Overall the scores for these questions are well above the average. The only other question which does not score as highly in the appropriate functionality category is sixty-eight which is concerned with the sequences of tasks and in most of these answers the neutral ("not applicable") category was chosen since this did not apply in the VacancyBot application. However, this caused a lower average to be generated in the results. Similarly there were no comments made against this question as it was not applicable (Figure 6-18)

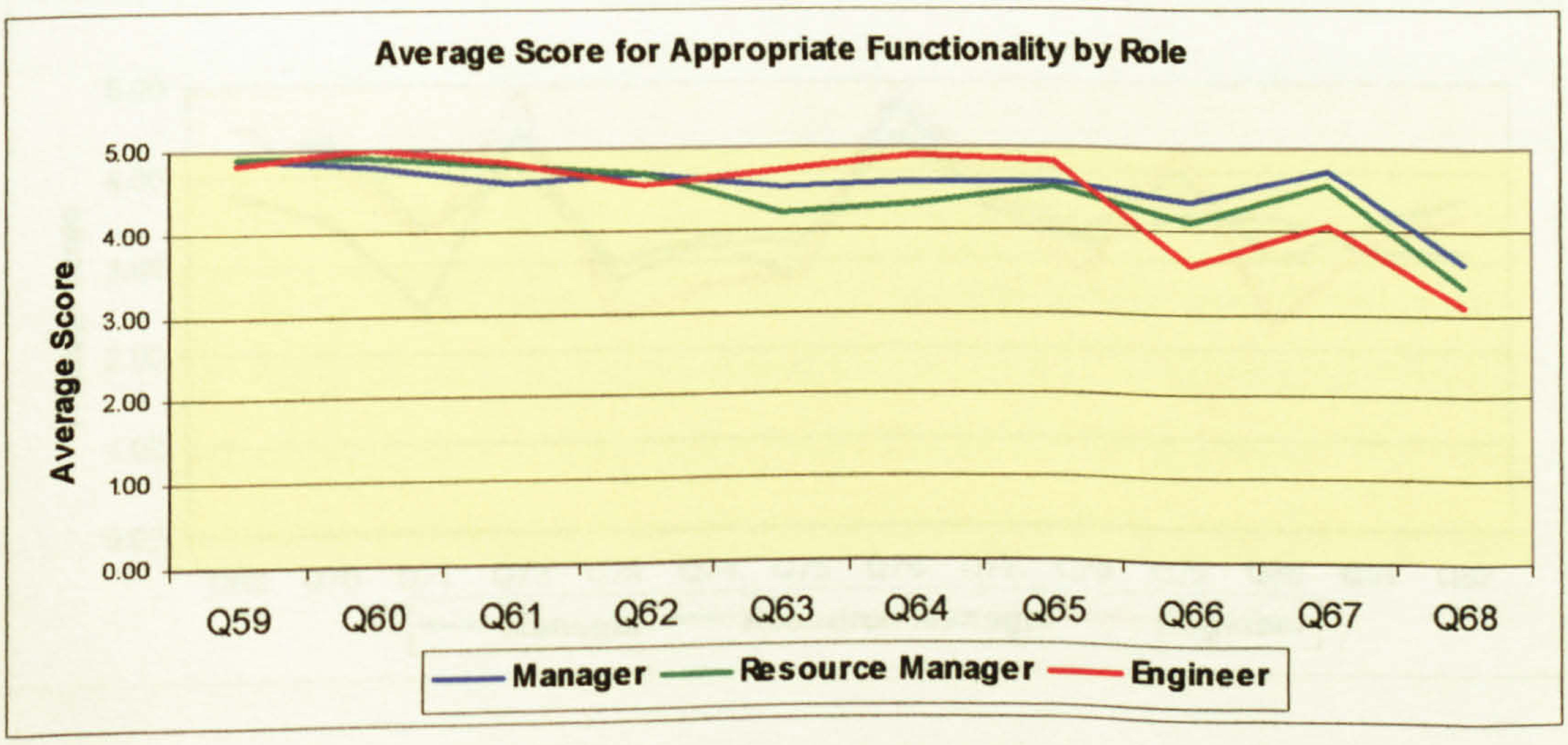


Figure 6-17: Average Scores – Appropriate Functionality

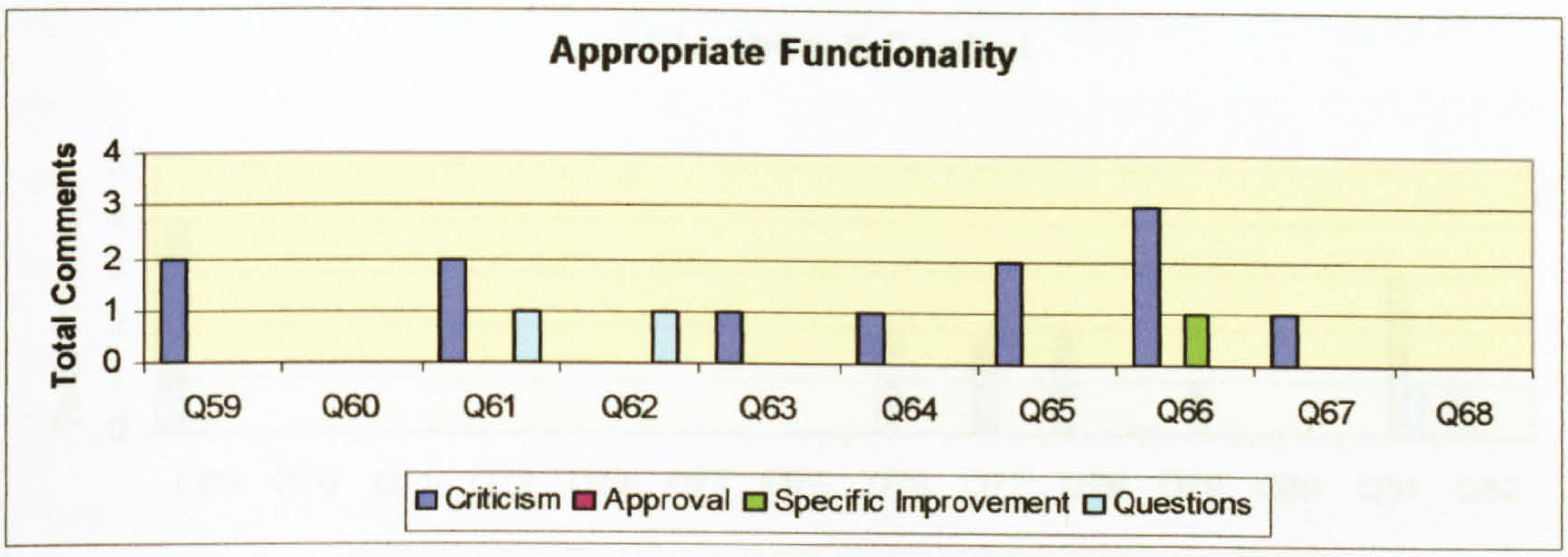


Figure 6-18: Appropriate Functionality – Comment Feedback

[g] Flexibility and Control

This graph (Figure 6-19) shows a general similarity in the trends between the three participating groups. In this section the Engineers view is one in which I have greater interest since this is a technical aspect of the functionality of this application. This refers to the behaviour of the application when there is interaction with the user. The Engineers appear to be extremely satisfied with the order of tasks requested by a user (question seventy-two); completion of data entry in a task (question seventy-six) and the user's ability to undo an action they have made (question sixty-nine). But the engineers are not so pleased with the user's ability to step back and forward in a task (questions 73 and 74), which were not user options in this demonstration. Another two low scoring questions relating to defaults (78) and rates for information to be displayed (80) were both marked as "not applicable" by many of the engineers evaluating them (Figure 6-20).

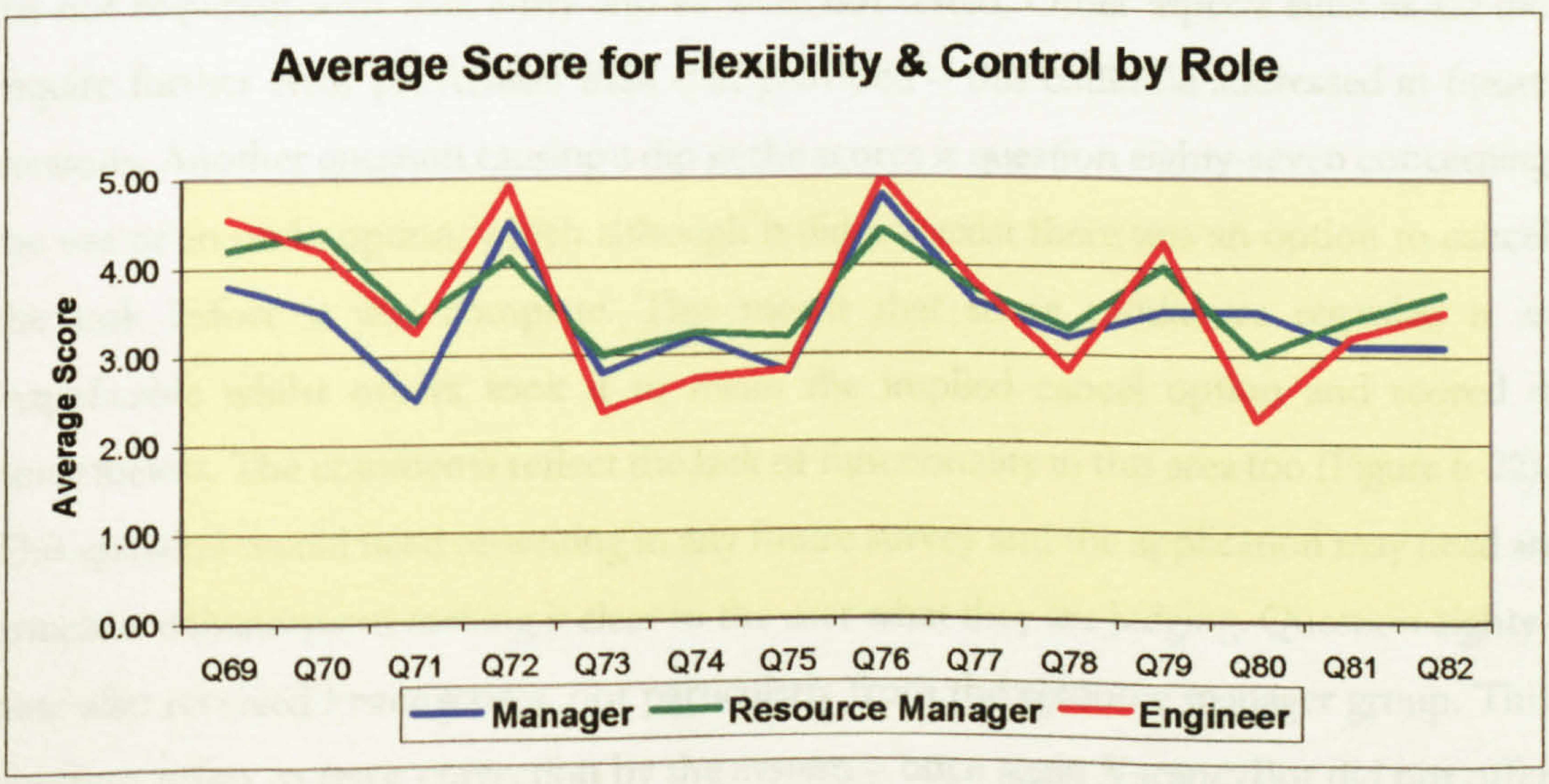


Figure 6-19: Average Scores – Flexibility and Control

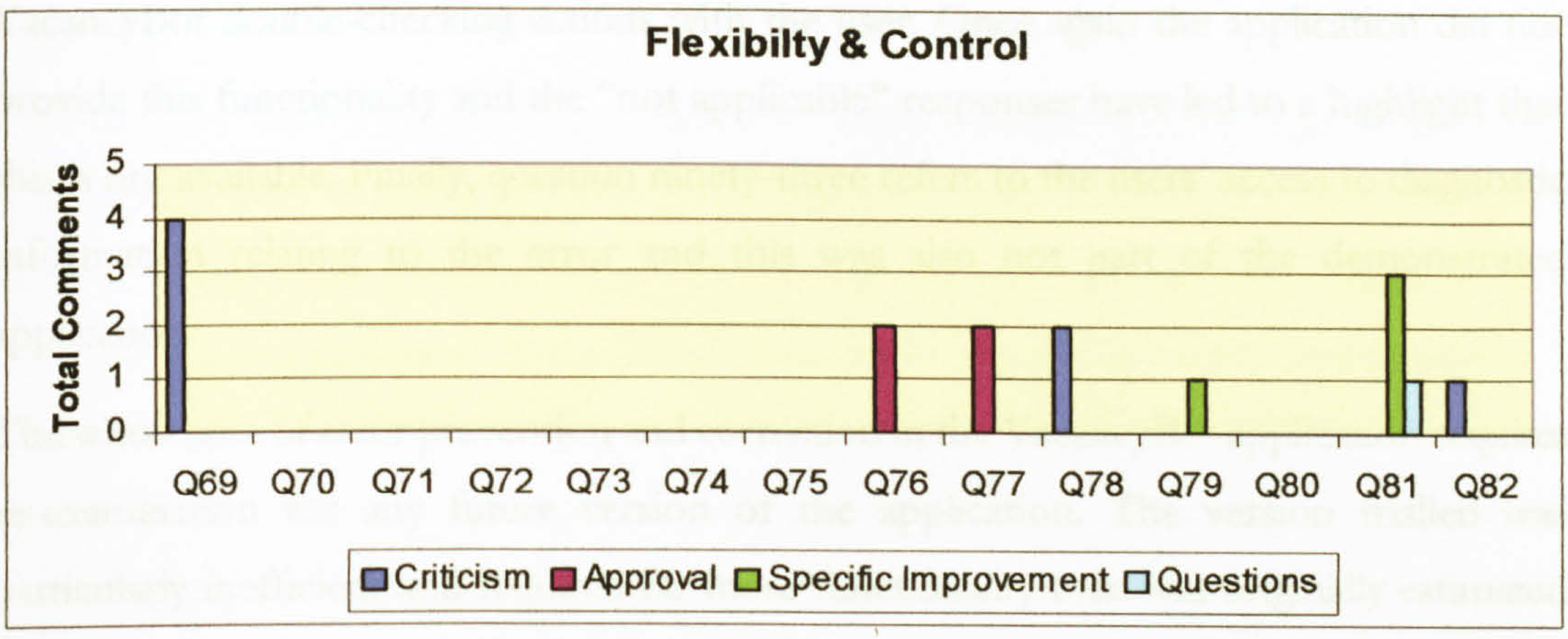


Figure 6-20: Flexibility and Control – Comment Feedback

[h] Error Prevention and Correction

This is another category where the engineers views are important as it once again relates to the technical behaviour of the application (Figure 6-21). The results in this category are lower than the other category average scores for all the candidate types and there are several scores well below average. Looking at the engineer's scores they are mainly between those scores of the resource and other managers group. The resource and other managers appear to be the least satisfied with this aspect of VacancyBot. All the candidates scored question eighty-five, concerning preventing users from entering the wrong data, as particularly low. In this question there were a lot of "not applicable" options made by candidates in all groups, which affect the average scoring. This may have been seen as not applicable because most fields were a set of options from a drop-down list not requiring such data entry and so were not tested. Other aspects such as ID did require further error prevention than that provided – this could be addressed in future versions. Another question causing a dip in the scores is question eighty-seven concerning the use of an undo option, which although it did not exist there was an option to cancel the task before it was complete. This meant that some candidates regarded it as inapplicable whilst others took it to mean the implied cancel option and scored it nevertheless. The comments reflect the lack of functionality in this area too (Figure 6-22). This question would need re-writing in any future survey and the application may need an interface enhancement making it clear to the user what they are judging. Question eighty-nine also received lower scores, not particularly from the resource manager group. This question refers to error correction by the system – once again VacancyBot did not offer an implicit correction but did occasionally (not in all cases) flag a mistake to the user and disallow that data entry. The question would need re-writing for future versions of the survey. The next low-scoring question is ninety-one and this is concerned with

VacancyBot double-checking actions with the user. Once again the application did not provide this functionality and the "not applicable" responses have led to a highlight that this is not available. Finally, question ninety-three refers to the users' access to diagnostic information relating to the error and this was also not part of the demonstrated application.

The whole area of error prevention and correction in the VacancyBot application requires re-examination for any future version of the application. The version trialled was particularly inefficient and required far more functionality than was originally estimated and developed. Users really need to be prevented from making errors in the first place and then if they make errors these should be captured and flagged up, stopping them from proceeding with their task without correction of the error. This can take time to create in order to catch a variety of mistakes and can only really be dealt with through proper testing procedures.

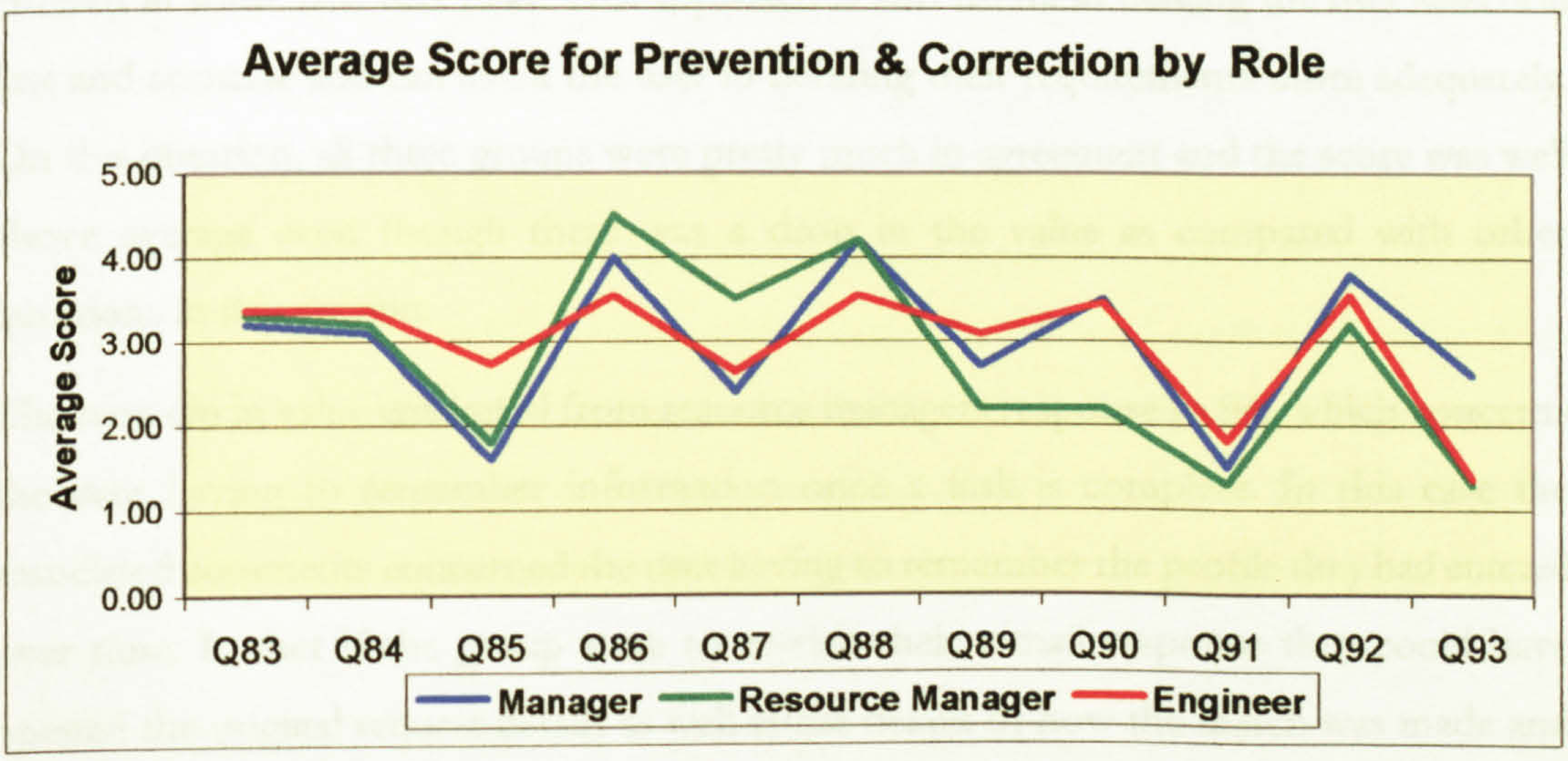


Figure 6-21: Average Scores – Error Prevention and Correction

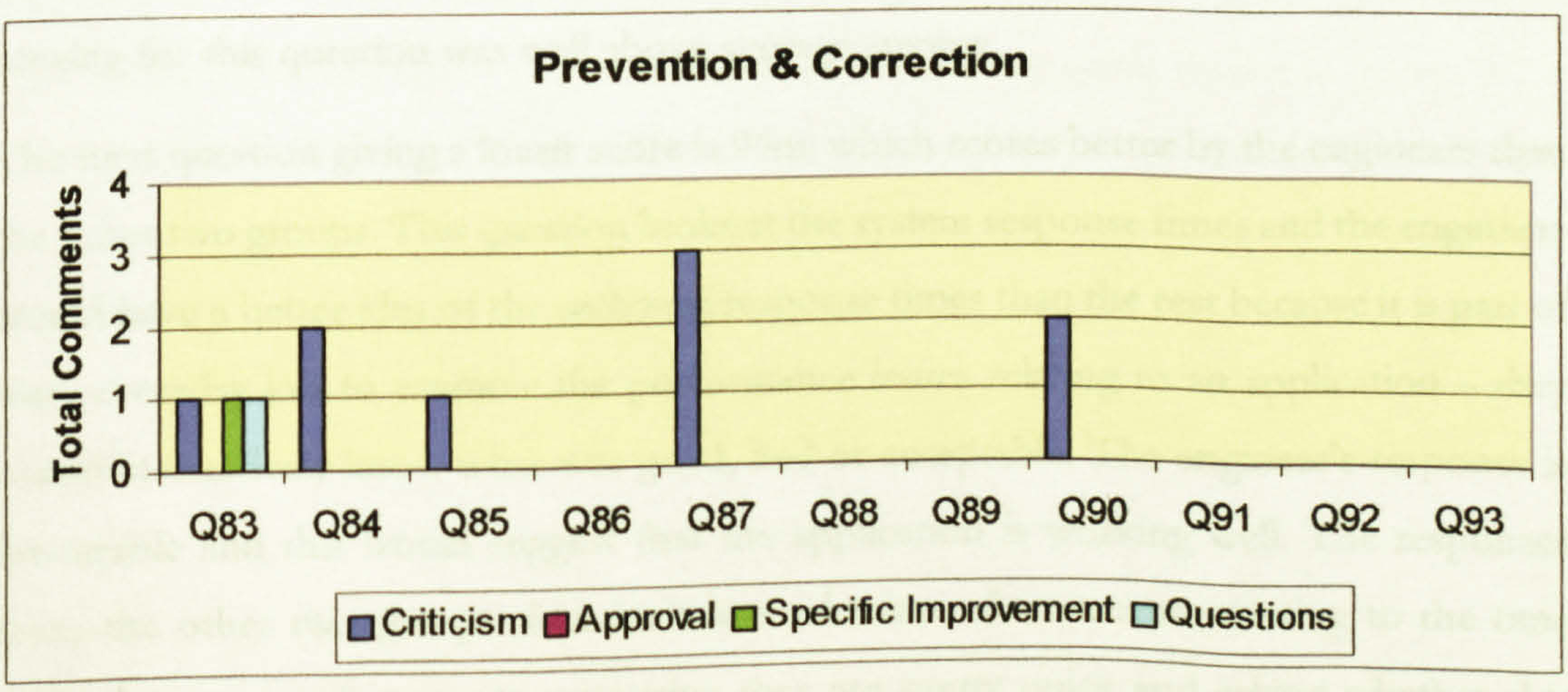


Figure 6-22: Error Prevention and Correction – Comment Feedback

[i] System Usability

This category has quite a strong correlation between the scoring of the individual groups (Figure 6-23) with all of the scores being significantly above average. The most significant drop in scoring is for question 94c, which refers to system documentation, which did not exist for the demonstration system and was therefore marked by many candidates with a "not applicable" scoring. The next lower scoring question is 94h, which concerns the rigidity of the system and gained some comments relating to the addition of new skills, roles and required experience. In this case VacancyBot was filled with a good range of possible choices for the purposes of the demonstration and has a great deal of flexibility for adding in new categories in these fields. However, this may mean redesigning the interface to accommodate the full extent of required skills and roles etc. The interface was deliberately made to restrict user input in the field selections since this would make the error prevention and correction a programming nightmare in checking every character entered in some free text field. This approach is also useful in making the user selection fast and accurate and can assist the user in defining their requirements more adequately. On this question, all three groups were pretty much in agreement and the score was well above average even though there was a drop in the value as compared with other questions in this section.

The next dip in value emanated from resource managers response to 94j, which concerns the user having to remember information once a task is complete. In this case the associated comments concerned the user having to remember the profile they had entered over time. In fact if the group were to re-visit their e-mail response they could have opened the original request details as well as the details of how the match was made and any other information on specific individuals e.g. curriculum vitae. Perhaps this was not entirely clear to all of the resource managers completing the questionnaire. Overall the scoring for this question was well above average anyway.

The next question giving a lower score is 94m, which scores better by the engineers than the other two groups. This question looks at the system response times and the engineers would have a better idea of the technical response times than the rest because it is part of their everyday job to examine the performance issues relating to an application – they would instinctively know what was good, bad or acceptable. The engineer's response is favourable and this would suggest that the application is working well. The responses from the other two groups does include a selection of comments relating to the time taken for an e-mail response suggesting they are pretty quick and asking whether this would be the case in the real system. In response to this issue the VacancyBot application would, in a real live system, be time dependent only from the point of view that a project need for personnel would arise and need to be filled within a certain period. The software agent would go off and do the matching and return as soon as it had a list of suitable candidates. It is extremely unlikely that the system would not respond in the time scale required. There could be an additional enhancement attached with every request stating what priority that search has which would enable a synchronising approach to the search. Alternatively a response might be received by a certain time or date.

The majority of candidates completing this questionnaire are completely oblivious to the manner in which the agents are completing their requests (and they do not really need to know) but it is important to note that the agents can be searching and matching overnight whilst everyone is at home in bed without affecting the Company's infrastructure. This makes the agents more efficient as well.

Another question scoring less is 94p, which relates to entering the right details. Once again this question still gets a well above average score overall although the resource managers score it less than the rest. Unfortunately there are no associated comments from this group to suggest why they score it differently. From the actual scores there is very little in difference in scoring with resource managers who are only one category lower in a few cases. This question would have to be specifically followed up with those scoring lower in this group in order to understand their choice. Finally, question 94s has lower scores, but overall is well above average again. This question refers to error correction, which has already been mentioned in detail earlier.

The bar chart (Figure 6-24) has been mentioned in some of the responses above where relevant, however it is important to note that in twenty-one questions answered by thirty-one candidates there were a total of eleven comments and one question. This implies that there was very little wrong with the VacancyBot usability as far as this set of candidates were concerned. This also ties in strongly with the average score results in Figure 6-23, which are some of the best in all of the categories tested in this questionnaire.

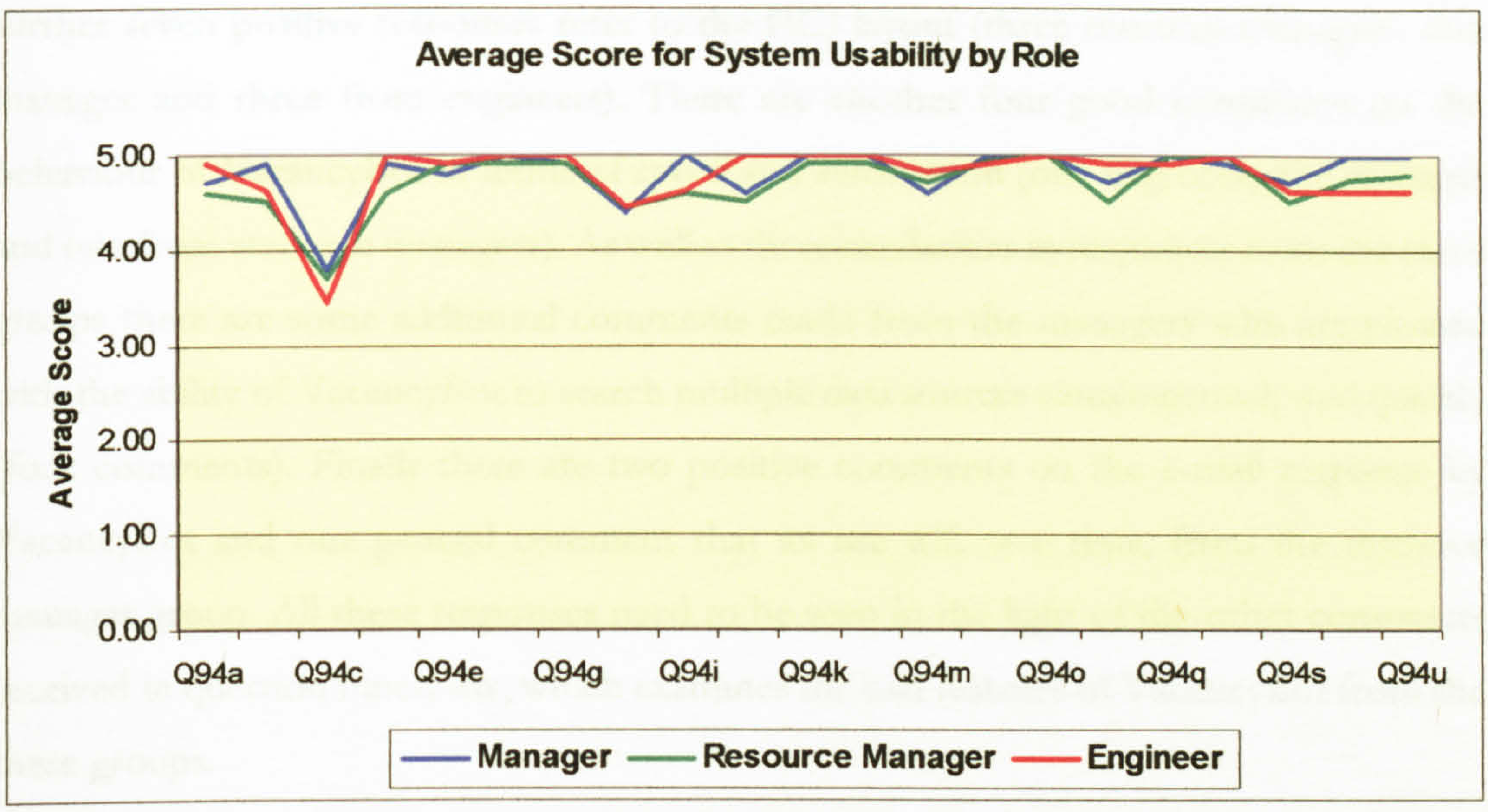


Figure 6-23: Average Scores – System Usability

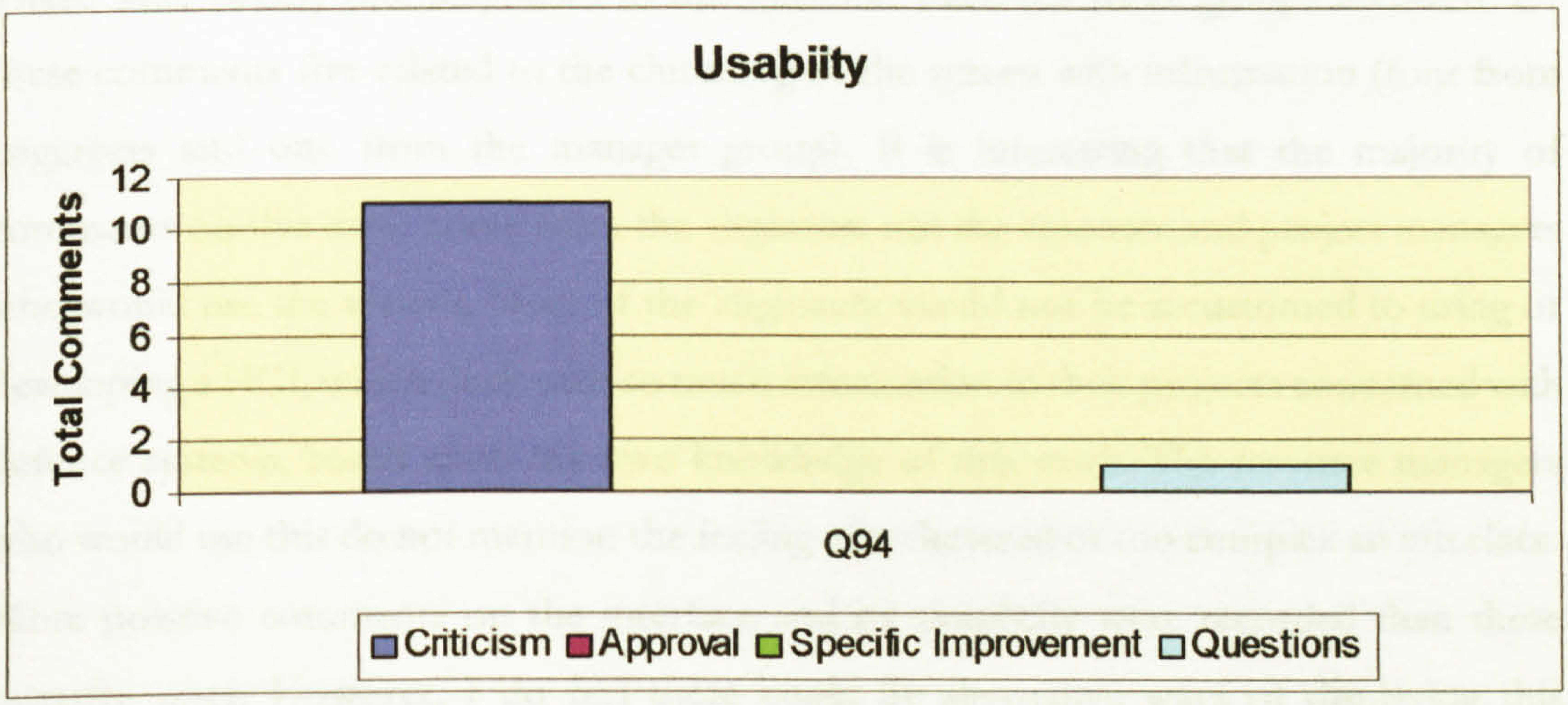


Figure 6-24: System Usability – Comment Feedback

6.10.2 Further Comments Analysis

There were nine additional questions at the end of the system usability section, which were used to capture any final comments on this aspect of VacancyBot as an application. These were captured and categorised according to the candidate groups: (1) Project Manager or pure Management role; (2) Resource Managers and Staff Managers and (3) Engineers. These results are available in Appendix H.

Q95. What are the best aspects of the system for the user?

This question received a total of twenty-five comments (81%) and from this selection there were eighteen responses noting that VacancyBot is easy, clear and simple to use: six from resource managers, four from managers and eight from the engineers. This is a pleasing response since one of the key aims was to have a very good usable interface. A further seven positive responses refer to the HCI layout (three resource managers, one manager and three from engineers). There are another four good comments on the behaviour of VacancyBot in terms of speed and automation (one engineer, one manager and two from resource managers). As well as these similarities in responses from the three groups there are some additional comments made from the managers who are pleased with the ability of VacancyBot to search multiple data sources simultaneously and quickly (four comments). Finally there are two positive comments on the e-mail response by VacancyBot and one general comment that its use will save time, from the resource manager group. All these responses need to be seen in the light of the other comments received in question ninety-six, which examines the bad features of VacancyBot from the three groups.

Q96. What are the worst aspects of the system for the user?

There were twenty-one responses to this question from the three groups involved. Of these comments five related to the cluttering of the screen with information (four from engineers and one from the manager group). It is interesting that the majority of comments on this topic come from the engineers not the resource and project managers who would use the system. Most of the engineers would not be accustomed to using or developing a HCI, which deals with so much information in their projects concerned with defence systems, based upon my own knowledge of this work. The resource managers who would use this do not mention the feeling of a cluttered or too complex an interface. More positive comments on the interface and its simplicity were recorded than these negative ones. However, I do feel there could be alternative ways of displaying this information especially since this is only a sub-set of the information likely to be required for a fully developed application. Another group of comments falls under the topic of the lack of full functionality in VacancyBot at the demonstration. Here there were six comments, one from the engineers and five from the resource managers, and these relate to either the need to see all the data in all the fields, or the fact that they wanted to be able to add or search for skills not included at the moment. In this respect there was never the intention to allow the users to add new skills because people have different terms for the same skills and it was felt that all skills would be added to after the resource managers and HR department officials made decisions on the detail. In this way additions are in a controlled and agreed manner. Secondly, the ability to do a search using a wildcard character may not be applicable since it is unclear from the comments the reason for such a search. Reflecting upon VacancyBot it may be possible in the future to categorise the skills within their main domain e.g. technical into a sub-set such as communications and networks, or real-time embedded etc. which would make it easier for staff to locate these.

The managers also commented upon the e-mail data available and wanted to see the output of the actual search as well as the details of a curriculum vitae etc. This was not completely available at the demonstration because of the timescale for creating the application. This would be fully functional in a proper working system. Finally there were three minor comments relating to the way the data was entered and displayed where there were errors in the application. These errors would be fixed in the real system and were not picked up during the pre-demonstration testing.

Q97. Are there any parts of the system that you found confusing or difficult to fully understand?

There were twenty-three responses to this question and these included eighteen 'no' responses (79%) which suggests that the majority of those replying were able to understand VacancyBot. These responses tie in with the earlier high proportion of positive responses to question ninety-five regarding the simplicity and ease of use of the application. The rest of the comments relate to minor changes in the interface that are acceptable and can easily be resolved for any future version of VacancyBot.

Q98. Were there any aspects of the system that you found particularly irritating although they did not cause major problems?

There were twenty-one responses to this question, of which fifteen of the respondents replied 'no' which suggests that they did not find anything irritating in VacancyBot, which is a strong plus. In addition there were three engineer respondents who stated that the date format needed to change. This aspect was already captured earlier in the survey results and is recognised as being incorrect. I agree that this should be corrected in any future version of the system.

Q99. What were the most common mistakes you made when using the system?

There were nineteen responses to this question and the majority (i.e. eleven) of these stated there were none. Four people (three managers and one resource manager) had difficulties with the Outlook e-mail – this issue had been raised earlier and was corrected in the demonstration version after the first session when it was noted. The rest of the comments relate to very minor changes that will be corrected in the future versions of VacancyBot.

Q100. What changes would you make to the system to make it better from the users' point of view?

All of the engineers' comments (eight of them) relate to altering the style of the interface and as such they are noted for future reference for the next version of VacancyBot. There were three comments from managers and one from a resource manager, which also reflect screen layout changes within the same kinds of parameters as the engineers, but in particular there was mention of the need of context-sensitive help by two participants. This was not provided in the demonstrator due to the simplicity of the layout and functionality. It is possible to add this to the next version but I personally feel that since context-sensitive help is only useful to a point where the user is happy with finding their way around an application there should be an option to switch off this functionality when the user is happy. The rest of the comments refer to the need to see the fully operational VacancyBot with all the functionality and data in it working successfully. This demonstration was never intended to be a fully working fully data-compliant system in the real environment but a test of the potential for such an application. From this perspective I understand the users' frustrations with wanting to see more but I also feel it is important to feedback the results of this survey in order to progress the application further in the future in the right manner.

Q101. Is there anything else about the system you would like to add?

This question is meant to allow the users to record things they did not think they had recorded elsewhere. It also acts as a safety net and has shown me what I could ask if I were to run another similar questionnaire. There were fifteen entries on this question from the three groups, of which two stated they had no comment. Two managers and one engineer requested that there should be the ability to investigate the e-mail response further e.g. viewing all CV's etc. This was mentioned earlier and dealt with there. There were also comments on being able to add more skills and more groups of skills (one comment per group). Other suggestions include the use of the employees' preferred location and a print function which are both enhancements that could be incorporated into future versions. Finally there were good responses stating that people were pleased with the application and could see uses for it in other areas of the business.

Q102. Are there any comments (good or bad) you wish to add regarding the above issues?

A second opportunity to capture anything missed, this section records eleven responses of which eight said 'no'. There were two very positive responses stating that VacancyBot had 'Tremendous potential for a wide variety of tasks' and was an 'impressive prototype' which were very pleasing responses from my perspective.

Q103. Are there any other comments you would like to make?

Most of the eleven responses refer to no comments or issues referred to earlier in other questions already discussed. Of importance are comments like 'Major step forward in avoiding resource managers to select the right candidate for the role - career progression, mobility etc.', which clearly indicates that the purpose for which I designed VacancyBot has been recognised and approved by a resource manager. Also notable is 'Need to develop a Business Case for using the technology', which suggests that VacancyBot is a good application that needs buy-in across the business. Finally 'Look forward to having this up and working' from another resource manager who is obviously impressed with what he has seen so far.

Q104 Comments on Interface

This is meant to be an open-ended question allowing a list of enhancements or improvements and changes as well as good positive feedback on what the group have seen. This question received twenty-five comments, some of which are in great detail. The main themes are that the interface is very good, easy to use and fine for its purpose (eighteen comments). There are some comments on the layout of the screen, which have been captured elsewhere e.g. cluttering and sizing (six comments). One resource manager was less happy with the e-mail response format.

Q105 Comments on functionality

The main comments suggest that the respondents would have liked to see the fully functional version (one engineer, two managers and two resource managers). There were five resource managers, four managers and four engineers who were very happy with the functionality that they witnessed and used in the demonstrator. This is a positive view that suggests that VacancyBot has been initially designed to do the right job for the staff as it was intended to. One particular comment which sums up some of the others made is "The ability for a vacancy to be posted intelligently to an employee is very useful. Resource managers will find this tool invaluable. The fact that additional Engineering skills or Domain skills can be added means that this application maintains the flexibility required in a company the size of BAE SYSTEMS. Negative comments related to the cluttering of the screen and possibly a need to restructure the information in some way (one engineer, one resource manager).

Q106. Comments on enhancements/new areas of use within the Company/ other functionality

There were twenty comments on this area. The new areas of use commented on include: identification of personnel for projects as early on in a programme as at the bidding stage; automated CV's; standards; papers and information on technology, or company developments; training and skills of staff; searching requirements or domain information; checking baselines, configuration control; library; equipment or supplies selection; performing searches for technical information on a topic; filtering of e-mails; Monitoring for changes on particular web sites; to maintain training base and use with Personal Development Review process to search on SPECTRUM ratings, analyse development needs, review aspirations against vacancies. These ideas all have some level of potential within the Company and need to be given consideration when the feedback has been passed on from this research. It is good to receive positive thinking on the ways in which software agents could be used in the Company. Another good comment is "The Company should do further work in this area - it would save loads of time and effort".

Q107. Comments on the improvement of process/workload/efficiency/other in using this technology

There were fifteen comments recorded in this section. A lot of positive comments referred to the time and effort savings for the people who would use the system (two engineers, three managers and two resource managers). Other comments include the fact that the data will require maintenance in order for the application to be effective (one engineer and one manager). This is a very good point and the software agents can assist to a degree with the maintenance issue – this is discussed later in this chapter. One suggestion is that the agent should automate the reading and data input of CV's as an improvement (engineer). This may be a difficult task that is dependent upon the use of natural language programming. An alternative method may be to have a pre-defined on-line CV format that new applicants must fill in. This information can be stored directly in a CV database without any further human input. One manager also points out that some staff may be suitable but their career aspirations are different from the role they match. This issue has also been raised previously and discussed.

Q108. If this demonstration has proven to you that this kind of technology could help you in the job you currently do please can you comment on its usefulness and how it could assist you in making your work more effective?

There were sixteen responses in this section. The suggestions for uses of agents include: a requirements capture and tracability tool; procurement; arrival of new technical publications on the web; for initial screening of job applicants; maintaining training records; manpower planning profiles; allocation/deployment of staff and managing customer contacts (See Harris, et al. 1985). Issues raised include the cost of creating a VacancyBot type application; the requirement for a more mature version to test; staff should be able to use this to search for vacancies they would like to apply for; and a need for maintained data throughout.

The responses were very favourable overall and the results seem to indicate that the VacancyBot application was overall a good demonstration of the usefulness of software agents in the area of resource management in the Company. There is room for improvement and the comments made which suggest changes and enhancements have been noted.

6.10.3 Timing Analysis

In cycle two I recorded the results of five meetings with HR representatives and a key Resource Manager in order to define an average time scale for the recruitment process (See Table 5-13 and Table 5-14 in Chapter 5). These tables also adequately identify the tasks and sub-tasks involved in the process. In the experiment I asked for five employees to run time trials after the initial survey was completed. The results are recorded in Table 6-2 below:

The results emphasise the fact that the whole CV filtering system (external recruiting) is reduced by 210 hours. The match is made quite quickly against the desired skill set and this then enables the Project Manager to make decisions on which candidates to interview in the first instance. The return of the e-mail response is less important as the process is highly efficient and the request can often be returned the same day. The process is dependent on interviewing in time for the project start date – this is a field entered in VacancyBot and the configuration can be altered to suit a time scale, which a specific Project Manager wants to use. The e-mails returned indicate the best matches against a specific candidate, which can be interrogated further by a Project Manager and any other member of staff with access privileges. This enables the Project Manager to see how the match is actually conducted. The matching criteria can be configured at set-up for a particular Project Manager or a particular set of vacancies. This means that the matches are made against a pre-defined set of weighted options. These weightings can be amended by the individual or can be left under the control of the agent with occasional feedback. The agents can modify their searching based upon a unique Project Manager's request and his acceptance or decline of a candidate. These agents then create a profile of the Project Manager's behaviours and decisions and can automatically suggest new candidates in the future as they are incorporated into the system based on the types of skills, which have been used historically by that Project Manager. In this way the agents begin to do the thinking and the work for the Project Manager, thus lowering the amount of administration and searching and filtering of information by him.

Task ID	Task	Time 1 (min)	Time 2 (min)	Time 3 (min)	Time 4 (min)	Time 5 (min)	Totals (Avg.)
1	Enter details of required skill sets	1.0	1.5	1.5	2.0	1.5	1.6
2	Send request	0.5	0.5	0.5	0.5	0.5	0.5
3	Time lapse to returned e-mail match	5.0	4.0	7.0	6.0	6.0	5.6
4	Continue using tasks from chapter 5.						

Table 6-2: Time Trial Results of VacancyBot Against Recruitment Tasks

So in examining the recruitment process described in Table 5-14 and Table 5-15 in chapter 5 it is clear that the VacancyBot application significantly improves the following tasks identified in the process (and in Figure 5-38 and Figure 5-39 chapter 5).

- All tasks related to reading and filtering of the curriculum vitae, because that data is already within the databases provided by the system. So in an external application process this equates to a maximum time of 4740 minutes (i.e. tasks 4.5 - 4.8 in Table 5-14). The internal recruitment figures are 6900 minutes (i.e. tasks 4.3 – 4.6 in Table 5-15).

- Partial completion of tasks concerned with the interview process since the technical, departmental and personnel interviews would aim to abstract details of the candidates' qualifications, experience and suitable skills for the role (i.e. tasks 5.1 - 5.4 in Table 5-15) which equates to 300 minutes but some of that time will need to be used to have a more specific interview. For the internal recruitment this is 180 minutes (i.e. tasks 5.1 – 5.3). This means that the interview procedure may need to be revisited in order to understand exactly what the group (HR, Project and resource managers) want to get out of it.

From the figures given above it is clear that a substantial time-saving is made in adopting the VacancyBot application even if it were restricted to the activities within its current functionality in matching the right personnel to the right vacancies. But from a resource manager's perspective he needs to make sure that all the data that is needed to make the match is defined in the matching algorithm at the outset and that changes can be made to that criteria set if the circumstances demand this. Providing the e-mail response with an opportunity to view how the match was made and how the set was defined by the user in the first place allows the user to use his own judgement as to whether the search is providing him with a successful outcome or not. It also enables the user to select further details of the candidates in order to see if there are other attributes or skills that may be useful to the particular vacancy. This reflects my view that the match is only as good as the data will allow, so poor data will give poor responses, this issue does not go away. Secondly, there is an issue regarding the suitability of a candidate based on the 'type' of person they are. For example, some candidates may not fit in with the local project way of running a team or the personalities on a specific project. This issue is one that needs to be judged through an interview process, which cannot be wholly removed by utilising VacancyBot. However, enhancements to VacancyBot to begin to deal with this could be to have every employee complete a Belbin which would help to determine the characteristics of a candidate to fit with the Belbin categories already represented in the particular team where the vacancy has arisen e.g. you would not want a team made up of seven 'Shapers' which would be a nightmare!

VacancyBot does not create a fully automated agent-driven resource management process, but it was never intended to remove the personal elements of the process. However, when examining the process and the issues that were raised earlier in this chapter there are several areas in which VacancyBot or an extended set of agents could potentially improve the identified recruitment process such as: -

1. The ability to search CV documents and to extract the data and use this to create the database input required
2. The mechanism to automate the interview with a candidate utilising up-to-date Outlook Calendars
3. To automatically produce the documentation required (e.g. letters, contract, safety, confidentiality, pensions, requests for interviews, requests for advertisements etc) for a candidate who is made an offer based upon a feedback form without human intervention. Data for the name and address could be automatically included in the offer letter and if salary and grade are agreed and recorded then these and all the rest of the data required should be used automatically. This is another large part of the process that could be reduced dramatically in time and effort on the part of HR and the resource managers.
4. To be able to search and provide short-term needs for skills in order that projects can benefit from the knowledge and competency in the Company.
5. The ability to create and update a competency database or table in a database. This could include experience, courses, membership of other organisations etc.

6. Automatically updating the forward load by using the candidate leaving data which is used in other areas of the business, e.g. the candidate leaving the Company means that HR receive a letter of notice. This could trigger the forward load updates. This could also allow an agent to recognise immediately the need for a new candidate in the role of the one that is leaving the project. This in turn could raise the right role description for the individual and e-mail some sort of message to the project or resource manager questioning whether this person is to be replaced by an equivalent or some other role is required. If this were added there would be no Vacancy identification or requisition process necessary as this would now be automated – this would reduce the time spent by up to 255 minutes.

6.10.4 Final interview feedback on agent technology

Six short interviews were requested where a set of pre-defined questions were asked relating to the demonstration that was prepared. There were two people from each category selected from the set that attended the demonstration and the results are recorded in Appendix H. The questions used were discussed in cycle three.

All six candidates in these further interviews responded well to the questions of the usefulness of the technology to them as individuals and to the company as a whole. Several candidates suggested areas for future application of the technology and areas of enhancement for the VacancyBot application all of which are valid. The majority of these candidates could see how the agents can handle mundane, boring and repetitive administrative pieces of work in order to make them more effective and help them to use their time more efficiently. They seem to suggest that this would also give them a more satisfactory role, which was more rewarding to them too. There were very few weaknesses expressed by the group. There was also a majority of responses looking to use a real live agent system as soon as possible.

The findings of these interviews suggest that the agent demonstrator was a success, which now needs to be built upon by the Company. The demonstrator showed the usefulness and capability of agent applications within the resource management and other domains.

6.11 Conclusion

This section deals with the summary of the analysis of the results recorded previously in this chapter.

One of the generic factors that this research has raised is the fact that the Company has plenty of information available but accessing it, getting the right bits of it, at the right time to the right people is a problem. This information is stored on multiple computers, accessed by an array of applications, kept at multiple locales, composed in a variety of formats, and accessing it involves complex communication protocols, challenging procedures, multiple IDs and security passwords, dependency on others, high levels of inconvenience. Turning this information into usable knowledge and appropriate formats is part of the work that software agents can do for the users. The term "knowledge" implies acquiring information, transforming it for its intended audience, and delivering it in some fashion.

So when is knowledge management required? When information is not easily accessible by everyone who needs it. Also when different departments need to view and work with information in varying ways. Particularly in this defence Company - when security is a prime concern; multiple locations are involved; when there is a high turnover in personnel as well as when information is exchanged with external organisations.

Software agents can gather, centralise and distribute information and knowledge and can use mechanisms such as text, web pages, XML, images, audio, video. In this way they can empower all employees in the Company through web browsers, desktops, databases, applications, and mobile devices to enable access features for every department in the enterprise.

An agent should be able to carry out the task we delegate it. However, there is nothing special about this ability if this criteria remains in this untouched form. What we really want the agent to do is to go away and do the task with as little input from us as is possible. We want the agent to think for itself. But an agent cannot do this without knowing particular information relevant to the person making the request and the overall context of that query, task or goal.

People use their initiative when performing a task and we would like our agents to perform the same level of capability. People tend to hold knowledge about different facets of any problem they face and they combine that knowledge when looking to solve a problem or achieve a task. Agents should do the same thing in order to be more than a scheduling mechanism or something that just fulfils a task. Instead a record of that task needs to be stored and accessible to the agent at a later date so that the agent can re-use that knowledge. The agent then builds up its own view of the world, just as a human being does when it is growing up. All of these features are useful characteristics of software agents.

6.11.1 The effectiveness and usability of the demonstrator interface

The results and comments relating to the VacancyBot user interface are mainly captured by the demonstrator questionnaire. Overall the feedback is good (See sections 6.11). The interface was developed as far as possible to meet the ISO 1942 (ISO 1942) standards and as such is only lacking in a few fundamental areas such as error prevention and correction and Help options, which are recorded in the feedback results. Other changes are mainly minor and low cost activities based on my own knowledge from the software engineering domain.

VacancyBot also supplies a desktop interface under the Windows Style Guide (Microsoft, 1995) as well as offering the potential for web interface, mobile devices, MS Office integration, and other similar avenues.

6.11.2 The usefulness and effectiveness of agents for performing knowledge management tasks

The kinds of tasks identified by the participants of the VacancyBot questionnaire are primarily information or knowledge management tasks and as such are capable of being performed by agents e.g. repeatable documenting tasks which may require some level of inference.

Software agents are particularly suitable to tasks where human-beings are repeating the same manual procedures over and over again; when careful decision-making is required that involves the balance of many complex factors; when pattern recognition or predictive capabilities are needed; where systems need to be monitored; and finally, when disparate systems need to be made to work together in harmony. In section 6.5.1 I discussed the criteria that determine whether a system is software agent based or not and in so doing I suggested that I felt that the demonstrator agent should illustrate delegation, communication, autonomy and intelligence. In re-examining the VacancyBot application the user is given the opportunity to delegate the task of identifying the staff required for their own project via the demonstrator interface. Secondly, the agent once primed then goes off into the infrastructure both to obtain information and data and intelligently translate that by making sense of that information. Finally the need for the agent to communicate with the user was achieved by notifying the user by an intelligent e-mail in response to the match requirements entered. There was then an opportunity for the user to investigate the responses, or to change the search criteria or examine other relevant documentation to look at other factors which they may be interested in. Therefore I have met the criteria that I gave myself at the outset of the experiment and meet the definition of a software agent system.

The capabilities and characteristics of agents (See section 5.5.1) are all useful in the development of a knowledge or information application. For example, the ability to search autonomously (based on a set of original user parameters) and locate experienced members of staff across the business is a useful knowledge management task because agents gather the information and making the inferences necessary to select a set of the most appropriate individuals. However, this process excludes all interpersonal tasks, which would lead to the correct final allocation of a member of staff. The effectiveness of VacancyBot was measured against the resource management process defined in cycle two (See sections 5.5.3.3 and 5.6) and revisited in cycle three. The calculations, although not proven absolutely, suggest that there is definitely potential to improve the time spent on specific areas of the resource management process. There are other areas of the resource management process that could also run agents in order to make it more efficient and effective (See section 6.15.6). These aspects are not trialled in the demonstration but would be relatively straightforward to implement based on the information gained in creating VacancyBot.

The software agent factors that enable VacancyBot to be effective include the intelligent ranking of suitable candidates; it uses fuzzy logic to determine suitability and there is always flexibility to determine these criteria and their weighting in order to improve the process (this could be implemented by another software agent or a human-being). VacancyBot operates quite happily without the need to make changes to the Company infrastructure (based on the simulation provided). It is locale independent and it will roam the infrastructure for its information with autonomous actions.

Software agent technology provides the following added benefits and capabilities:-

- Enhance performance levels
- Improve accuracy and reduce ambiguity of information or data
- Advise on real-time action – reduce time to appoint new recruits or get access to short term expertise
- Provide feedback in the system to improve maintenance
- Automate the availability of data through the interface – possibly based on individual employee or historical data of past employees' training needs.
- In the area of locating Resourcing and improving the process for getting the resource Manager up and running – using predictive logic. This should include the deployment of specialist knowledge/training and other needs. This will provide

Improved time scale and efficiency of the maintenance process. The resources should be allocated and sent out whilst the maintainer is looking at diagnosing the next fault in his list, for example.

- Use of the knowledge and intelligence in other areas of the application or in new add-on component applications thus providing increased capability and possibly a fully integrated solution.

The ease of development of software agents

Because the implementation environment was one that I was familiar with (i.e. Visual C++) the programming was reasonably easy so I could develop the application. The NQL part of the implementation needed support from the suppliers in order to run smoothly. Once knowledge of the NQL interfaces and functions was understood this was also relatively easy to create. It took a great deal of time to create the simulated environment including databases and the associated population with appropriate material, as I was unable to use existing staff information for the experiment.

VacancyBot was built on the NQL ContentAnywhere framework, which means that the second generation of development needs to consider if this is appropriate. Once development begins to follow this route the issue of licensing becomes important as well as contracts and support issues for the development.

6.11.4 The user's opinion toward software agent applications

This aspect was primarily recorded through the final questionnaire comments on VacancyBot as well as the six short follow-up interviews with candidates that had been involved in the original quasi-experiment. These results indicated that VacancyBot was successful and that there were several other opportunities to utilise software agents within the Company (See section 6.15.5).

6.11.5 The possibility of organisational-wide application of software agent applications

The following table (See Table 6-3) defines areas of potential for the use of software agents within the Company. These are described in detail in their usefulness to the Company in the right hand column. The central column refers back to the areas founded in cycle one of this research in order to examine how these agents could be used in other ways within the Company. This is clearly an area for future consideration by the Company.

Type of Agent Application	Reference to areas defined in cycle one of this research	Useful Application within the Organisation – Based upon earlier Research wherever possible.
Desktop agents – applications	Company Wide Web (including search engine technology). Newsgroups. Company Standards and documentation. Electronic Project File	Run automated downloads remotely – including providing an audit trail for system set up. Search engines on desktops Help/assistance with applications – regular activities automated
Desktop agents – operating systems	Estimating Metrics	Support – help desk automation in many cases. Including regular updates to productivity metrics
Internet agents – information filtering	World Wide Web, Expert (Technology) Groups. Newsgroups.	Using software agent applications to filter incoming e-mails thereby reducing the overload in information and allowing the important issues to be recognised and dealt with by the receiver Automated cataloguing / inventory/ directory as a background infrastructure process
Internet agents – information retrieval	World Wide Web. Expert (Technology) Groups. Newsgroups. Private Venture	Procurement. Competitor analysis for marketing. New technology updates and information. Push / Pull user profile driven Applications should also include 'wizards' to assist with processes and with information retrieval Automated cataloguing / inventory/ directory as a background infrastructure process All IT applications should include facilities for indexing and storing and appropriately sharing information derived from the application i.e. semi-automated XML
Internet agents – notifiers	E-mail. World Wide Web. Expert (Technology) Groups. Newsgroups. Private Venture	For competitor notification of updates to information e.g. for the procurement and marketing divisions of the company. Push / Pull user profile driven Applications should also include 'wizards' to assist with processes and with information retrieval Automated cataloguing / inventory/ directory as a background infrastructure process
Internet agents – mobile	World Wide Web. Expert (Technology) Groups. Newsgroups. Private Venture	For web searching on work related topics important to an individual. The updates and new information discovered by a roaming software agent would enable the latest information to be pushed to the individual's e-mail box. Marketing and procurement information could be called up to keep these 2 particular business departments up-to-date with crucial information Download of registration charged sites to a local database/repository to cut the cost of several employees getting the same bit of

Type of Agent Application	Reference to areas defined in cycle one of this research	Useful Application within the Organisation – Based upon earlier Research wherever possible.
		information and the Company being charged for every attempt. The agent would check the local repository first before connected to the on-line charged site. Financial savings gained. Quicker response for the employee too. Push / Pull user profile driven Applications should also include 'wizards' to assist with processes and with information retrieval Automated cataloguing / inventory/ directory as a background infrastructure process
Intranet agents – process automation	Company Wide Web (including search engine technology). Newsgroups. Private Venture. Resource management process.	Map current processes in order to automate tasks, thus making the processes more effective and efficient.
Intranet agents – collaborative customisation	Company Wide Web (including search engine technology). Newsgroups. Expert (Technology) Groups	Agents that can update and change the style, layout requirements to maintain data through allocation of web page ownership and responsibility.
Intranet agents – database	Skills Database. Resource Planning Module. Training. QUEST.	Refining information, updating information regularly, data mining and possibly building one central database by automated assimilation of data. Push / Pull user profile driven Applications should also include 'wizards' to assist with processes and with information retrieval Automated cataloguing / inventory/ directory as a background infrastructure process Infrastructure needs to be reliable, choices made on storage and replication.

Table 6-3: Other Application of Agents in BAE SYSTEMS

Areas discovered in cycle one which were determined in cycle two to be inappropriate for the use of software agents include Lessons Learned Log, Timesheet Entry System, Communication with Others. Culture, Best Practice, SAP, RDD-100 tool set, Team briefs, Role description and scope of job.

Other Areas for Potential Application of this Technology for the Business

1. Intelligent knowledge systems techniques applied to the resource planning tools available within the Company. When coupled with databases, intelligent systems can help to identify problems and suggest improvements for Resource Managers.
2. Intelligent knowledge systems, which will automate updates to any system application. Also a knowledge-based systems that rapidly identify and correct

problems, reducing the labour requirements and costs of finding correct information.

3. A knowledge-based system that automates the analysis of the reliability, maintainability, and supportability of currently available databases
4. Intelligent knowledge software systems, such as knowledge-based systems, can improve the effectiveness of management. In many industries and the government, the acquisition of resources require many complex steps that vary depending on the purchase type and size. Intelligent advisory systems that recommend and schedule appropriate activities for the use of funds, personnel, and time.
5. Intelligent knowledge systems that help Resource Managers determine whether replacement staff should be required from the pool of existing employees or external recruitment is necessary. In many cases, this could reduce procurement costs by competitive bidding through recruitment agencies.
6. A knowledge-based system for bid evaluation and vendor selection
7. Intelligent knowledge system for collecting data for the infrastructure databases. Often some systems can be problematic because of false data entry or no data entry at all. An intelligent knowledge system that can diagnose and decide if the data is valid or whether it is an inappropriate information or data could save valuable time and increase the Resource Managers' productivity. This allows Resource Managers to concentrate on real people issues and career development. Some conventional commercial systems smooth out the poor data and information before they reach the system. However, an intelligent knowledge system should use this data to refine the knowledge base (e.g. make inferences from the data, analyse unanticipated results etc). An alternative is to link the application to automatic tools that interrogate resourcing systems – this may be more cost-effective.

As agent technology research has developed, the number of products available has grown considerably and this will continue to be driven by the market forces as the technology becomes more recognised. Currently agents for information systems can be developed and maintained separately; they are capable of interrogating other agents and building a knowledge base that others can rely upon. Existing data sources can be converted into a simple information agent using current technology; this in turn simplifies the agents' interface because there is only one underlying language. Here each agent fundamentally models the agents it interacts with as well as its own area of specialism.

The agent application can do almost anything with the information it gets for the user. The user can have it filtered or combined with other information in order to enable the user to make decisions. Also the user may want to have sight of the factors in the decision before he actually makes it and this is also possible.

6.11.6 The Resource Management Issues Re-visited

The following common concerns were noted with regard to developing a software agent system for resource management tasks:

1. There is a need for systems that help in time critical, accurate, and consistent decision-making.
2. Resource Managers must deal with far more skill diversity than ever before.
3. Access to the right data, knowledge, and expertise at the right time is necessary to carry out project tasks effectively.
4. There are increasing amounts of data provided by internal systems development. Tools are required which aid in the integration and interpretation of data hence making it more useful.
5. Updating is a persistent problem, which can be partially incorporated utilising agent technology providing someone somewhere in the company has entered the relevant data. Alternatively the agent may interpret data based on historical analysis of some alternative source – agents can reason and determine an appropriate solution.
6. Significant savings could be realised through reduction in time-consuming tasks, replicated information. The system also facilitates appointing the most appropriate member of staff to their appropriate position within the Company in an effective manner.

VacancyBot through this quasi-experiment has showed that many of these issues have been addressed in order to make the resource management process and the resource managers themselves more effective and efficient. The first version of this software agent system has also illustrated some areas for improvement which have been captured elsewhere in this chapter. However, there is one issue that must remain clear at the end of this experiment: that agent software can only provide an accurate view of the data and information it has access to. If the data is not originally entered into the system then the agent cannot invent it, however it may make inferences based on an historical view. Also agents can be programmed to go and fetch the latest information e.g. share prices, and update a database and give a user a continual update on the share prices. Agents cannot deal with the social factors that influence the decision-making, which is one reason that I do not believe agents will take away all roles within the Company in the future. Agents cannot deal with the political and cultural issues that exist in organisations either. But these and similar social aspects allow personnel to interact with agents in order to provide a solution and this also encourages users to see the value of their own input into such an application.

6.11.7 Managerial Issues of Implementing Artificial Intelligent Systems

There are many factors relevant to any Company considering adopting and implementing an intelligent agent system. In terms of the cost-benefit and justification it is important to carry out research and to investigate the processes where it is anticipated that agents could be used. This cycle identifies the characteristics of agents and discusses example applications and suitable aspects that can be carried out by an agent. The measures have to be worked out through timing the processes though, the inference element will be difficult to gauge accurately. Managers need to be wary of heightened expectations because some agent development could fail through misunderstanding the processes and requirements, poor design, bad interfaces and other similar reasons. So it is essential to set accurate and realistic expectations and goals. Another issue with developing a knowledge management application is the acquisition of knowledge in the first place and it depends what that knowledge is and how it is stored. If it is comes from a person then motivational and reward systems may assist in this process. If it is inferred from information in existence then the logic and design of the application need a lot of thought from experts and specialists. The acceptance of the system by the users is influenced by psychological, social, technical and political issues and these can get in the way of deploying even the best application. Software agent systems have to integrate with many other systems and as a result can become complex, therefore the overall design needs careful consideration.

6.11.8 The Effectiveness Issues

One of the main goals in this research has been to improve the effectiveness of the Company through the application of a software agent application. This effectiveness resides in the issue of task competency, in that VacancyBot was able to carry out assigned tasks on behalf of the user and the results show that this is fulfilled. This allocation of part of the recruitment process thus enables staff to devote time and energy to achieving other tasks without being required to divert their attention to administrative, decision-making and skills-matching tasks for the recruitment process. The agents have also allowed for role-clarity and skills based on matching individual skills to the assigned tasks and the opportunity to build new competencies. VacancyBot will also allow the resource manager the freedom to pursue his job as he sees fit, knowing that the application is dealing with particular aspects of his role. Agents provide the resource manager with the tools to do the job effectively too. VacancyBot also gives access to information and knowledge that are relevant to the job or specialisation being provisioned. There is a knowledge exchange between the agent and the user of the system and a genuine transmission of information up, down and sideways in the organisation.

6.12 Summary

This chapter has captured the development and implementation of the VacancyBot software agent system. It covers the full software lifecycle management and deals with the implications and issues raised during the development. A quasi-experiment was satisfactorily conducted and the results have been fully analysed using a variety of techniques.

The concluding sub-sections lead to an understanding of the applicability of software agents to a knowledge management and an information management domain. Other extensions as to the usability of such applications to other specific areas of the Company practice are also offered as future alternatives.

DISCUSSION

7.1 Introduction

This chapter deals with the re-engagement with the literature based upon the research that has been completed within this thesis. This begins with a set of the findings from this research and follows with a discussion of the literature associated with the key areas of exploration.

7.2 Research findings

The following list represents the majority of findings made during this research thesis. Each point is discussed in more detail in the following sections of this chapter and interacts with the literature in these domains.

The Defence Industry

1. With the changing defence market forces and the nature of the new contracts, there is a need for the Company to become more effective and efficient in order to initially win and then be successful at delivering projects
2. Defence contracts tend to be asynchronous with new technology capabilities
3. Defence domain knowledge is critical for retention by the Company

Organisational related Findings

(a) People

1. The nature of defence contracts makes the effective retention of knowledge (that is essential for success) difficult to manage

(b) Knowledge Processes (sharing, capturing, creation and valuing)

1. There is a failure to communicate and disseminate the knowledge acquired across the organisation
2. There is no co-ordinated and successful mechanism for storing knowledge within the Company
3. The Company fails to learn from its previous successes and failures
4. There is no co-ordinated and successful method for capturing knowledge within the Company
5. The Company is unaware of the knowledge it possesses

6. On the basis of the research data collected the available information within the Company is under-utilised.

(c) Systems

1. The Company's mechanisms for managing both information and knowledge is ineffective
2. On the basis of the research data collected it is apparent that the Company is not using its knowledge assets in the most beneficial manner

Resource Management Process

1. The division of employees into management and engineer streams is counter-productive and does not provide an appropriate baseline for roles and responsibilities
2. The resource management process takes a lot of time and effort but it is not effective at isolating and using the skills of the employees within the Company.
3. The lack of clearly defined roles and responsibilities within the Company is detrimental to the effectiveness and efficiency of the organisation.
4. The resource management process fails to capture information that could make recruitment more effective
5. There is a lack of visibility, identification, utilisation and nurturing of experts and their expertise in the Company.

Technological Issues

(a) General

1. BAE SYSTEMS have invested heavily in a vast amount of technology but this is failing the employee population in many different ways.
2. There are a great many problems associated with the failure of the technology being provided within the Company.
3. Much of the technology available for use in knowledge management systems fails to provide an adequate solution to the practical problems of everyday business needs
4. The use of usability criteria for the assessment and creation of user interfaces is a successful aid to design for future Company applications.

5. Technology alone cannot create a successful knowledge management system as there are many criteria that influence this e.g. social, cultural, process and organisational environment. Technology is an enabler.

(b) Intelligent Software Agents

(i) Within the Resource Management Process

1. Even though software agents have been researched in the past they have primarily been utilised in the web technology domain and not to improve effectiveness in a defence company recruitment-specific arena

(ii) Potential Elsewhere in the Company

1. Many of the current technological ways of developing and using knowledge are still not effective (e.g. central data repositories, Intranets) whereas software agents improve that effectiveness due to their nature and capabilities.
2. Software agents can contribute to making the organisation more effective and efficient.
3. Software agents can provide more functionality (e.g. predictability algorithms) and flexibility for organisations in order to make their knowledge management systems more effective.
4. Communities of practice and expert technology groups can be created through the use of software agents as an add-on to the VacancyBot application.

7.3 The meaning of knowledge management

There are a significant number of definitions of knowledge management (Angus, et al. 1998; Frappaolo, 1998) and still much ambiguity surrounding these with no clear consensus (Scarbrough & Swan 2001). Scarbrough and Swan (2001) researched the reasons for this ambiguity and suggest it is deliberately misleading because consultants and providers of knowledge management solutions have the opportunity to gain financial advantage. There are limitations to the published works on knowledge management especially where mechanistic all-encompassing solutions are advocated. In much of the technology related literature the issues pertaining to the limitations are simply glossed over or mentioned in passing (Bukowitz & Williams, 1999; Devlin, 1999).

When this research began there was also some degree of scepticism from the Company regarding the definition, terminology and benefits of knowledge management to the organisation. There were questions about the differences between 'knowledge management' and other similar areas such as information management and organisational learning (Argote, 1999) by some staff in the Company. Knowledge management can be differentiated from information management by the way people apply and use it (Davenport & Prusak 2000) but it is still sometimes difficult to see a clear division of when information becomes knowledge and vice versa. There are many facets to the subject area of knowledge management and undertaking this research has illustrated that it is not that easy to separate out all the pieces into distinct and isolated aspects. For example there are three areas of process, people and technology which all influence any development of a knowledge management system. In developing the demonstrator for this thesis it became very clear that there was a need for all three elements. At the outset of this research my own definition focused upon the processes involved in knowledge management and the end goal of creating a more effective organisation. This focus developed in cycle two of this research to include the use of technology as an enabler of that goal and in cycle three the implementation tested this achievement. However, it was soon recognised that the people aspect and social issues of knowledge management were also vitally important to the success of this research.

Much has also been written about the intellectual capital aspect of knowledge management and generating income for the organisation (Lloyd, 1996; Drucker, 1993). This aspect has been used intensely for the sales and marketing of packages developed for other purposes than knowledge management e.g. tools for business re-engineering and process improvement (Bukowitz & Williams, 1999; Tissen et al., 2000; Davenport, 1993). Another key area for much of the literature is in the technological aspects of providing a solution and very often these books promote various toolsets and applications (Tirwana, 2000; Bernard, 1996; Bukowitz & Williams, 1999).

The subject matter of knowledge management has been divided in the literature into several different categories including common areas such as knowledge creation, capture, storage and technology. However, when dealing with the whole issue of knowledge management within this research these clear-cut boundaries are not in place. Many of the examples cited in this research have several elements of each category within them when examining them in a holistic manner.

7.4 Knowledge capture and storage

Intra company communications including databases, specialised toolsets, e-mail and the Intranet, although highly technical are failing the employee population examined during cycle one of this research. No single factor was deemed solely responsible for this failure of the Company information technology or infrastructures. The clustered problem themes identified in this research include: -

1. Poorly maintained data (e.g. inaccurate information and out of date data, as well as misleading information)
2. Time-consuming and long-winded Company processes.
3. Users felt that they did not have enough time to find information due to workload constraints.
4. Usability Issues relating to the user interfaces of the technology being used by the Company including: -
   - Poor user interface including poorly displayed material
   - Tools are not intuitive or easy to use – thereby making it difficult for employees to use them or want to use them
   - The applications are not easily navigable by the employees
5. It is difficult to find or to locate information or data
6. Data and information are poorly structured in the technology applications being used by employees (e.g. illogically structured information or data)
7. Often there is no filtering of information available within the applications
8. Information overload

Many of these items are related to the capture, storage and the dissemination of information together with issues concerning the interfaces and usability of applications. Alternatives for knowledge management offered in the current technology climate include Intranets, data warehouses, databases including: lessons learned and best practice (O'Leary 1998; Dick, 1995). The knowledge management technology that is currently available addresses the issues of retrieval, collection and storage of knowledge (Salton & McGill, 1983) and is illustrated in Figure 7-1.

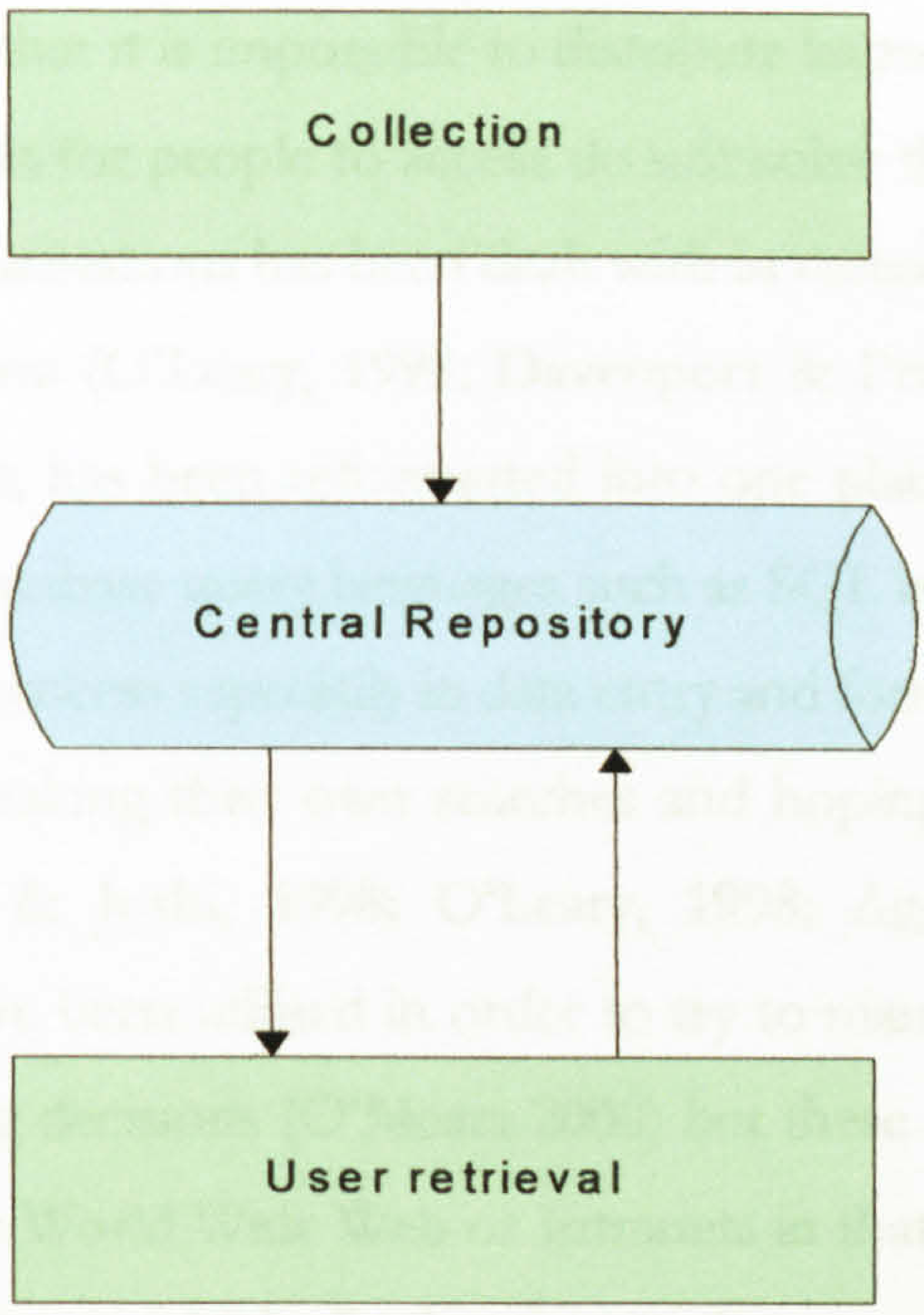


Figure 7-1: Recent mechanisms in knowledge management

In this example the user has to go and get that information and this includes reading through material and filtering it themselves (Godbout, 1999; Foltz & Dumais, 1990). This process is inadequate, for example in the knowledge asset aspect of cycle two the Company's very simple process applied to utilise this information failed, since the collection, storage and dissemination mechanism did not work (See Figure 7-2). When employees in the Company find information they still fail to store it in places where all other employees who need it can easily find it. There are still issues concerning duplication, maintenance and out of date information. The most up-to-date mechanisms for resolving these issues include improving the navigation mechanisms and incorporating search engine facilities (O'Leary, 1998; Chu & Rosenthal, 1996; Sullivan, 2001). These mechanisms also fail because there is the overriding issue of getting the right information to the right person (Fister, 1998).

According to Hildebrand (1999) it is impossible to ensure that the right information gets to the right person using knowledge management technology available at that time. This argument is based upon the fact that it is not possible to predict what someone may want at a specific time. However, software agents can use predictive algorithms to make inferences and send information to a recipient (Gaines & Shaw, 1997; Nakamura & Iwai, 1982). Software agents are also reasonably flexible in nature because they can change their understanding based on the monitoring of the recipient and altering their inferences. By storing the historical data of the original retrieval for an individual the agents can also go back to an older requirement for information if the individual reverts to some previous manner of requesting information (Aradhye & Heger, 1998; Belew, 1989).

Hildebrand (1999) states that it is impossible to distribute knowledge effectively and that central repositories of data for people to access do not solve this problem. The issue of collecting data within organisations has been dealt with in recent years through the use of central repositories of data (O'Leary, 1998; Davenport & Prusak 2000), which over a period of time and effort, has been reformatted into one place. In this way the data is made available through database query languages such as SQL in order to access it. Firstly this can be an expensive process especially in data entry and format conversion. Secondly, it still inherits the user making their own searches and hoping to access what they are looking for (Holsapple & Joshi, 1998; O'Leary, 1998; Agrawal, 1993). Document management systems have been utilised in order to try to manage corporate knowledge and assist users in making decisions (O'Meara 2000) but these systems are inherent with the same problems as the World Wide Web or Intranets in that the user has to find, read and interpret that information which all takes time and is open to a little luck rather than judgement in locating the right piece of information.

There is also a problem with keeping the central repository up-to-date once it has been base lined (Newell et al., 1999). After an experimental case study one company realised that all that they had created after the implementation of a central repository was a database full of old information that actually had little value. They had also paid consultancy fees and the cost of translating everything in their legacy system into electronic format. Another problem this company experienced was the fact that because the consultants had the technical knowledge but not the domain-specific knowledge the completed information structure was not easy for the user community to use or locate information on (Newell et al., 1999). Domain knowledge is a key area for capture in BAE SYSTEMS. Other skills like Java programming can be brought in from outside, but it is the application of these technical skills to the defence domain and the understanding of the specific system that are the area where the company cannot really afford to lose its knowledge.

Defence companies in particular have an extended product lifecycle as compared with the commercial software industry in general. The defence projects I was involved with were all over ten years in duration with ongoing support and maintenance lasting another five years after the in-service date. Because these contracts are so long there is a recognised turnover of staff during the contract, which has the affect of taking the knowledge out of the project, particularly the defence specific domain knowledge acquired during employment on the contract. This is a problem that is particularly important to the defence industry. In order to combat this dissipation of the knowledge there is a need to capture that knowledge and make it available to replacement recruits. This aspect of knowledge management has not been given coverage except in consideration of factors affecting recruitment and provides an area that could be considered for investigation in future research. It may be beneficial to consider the roles that software agents could make in capturing defence contract domain knowledge during long-term projects.

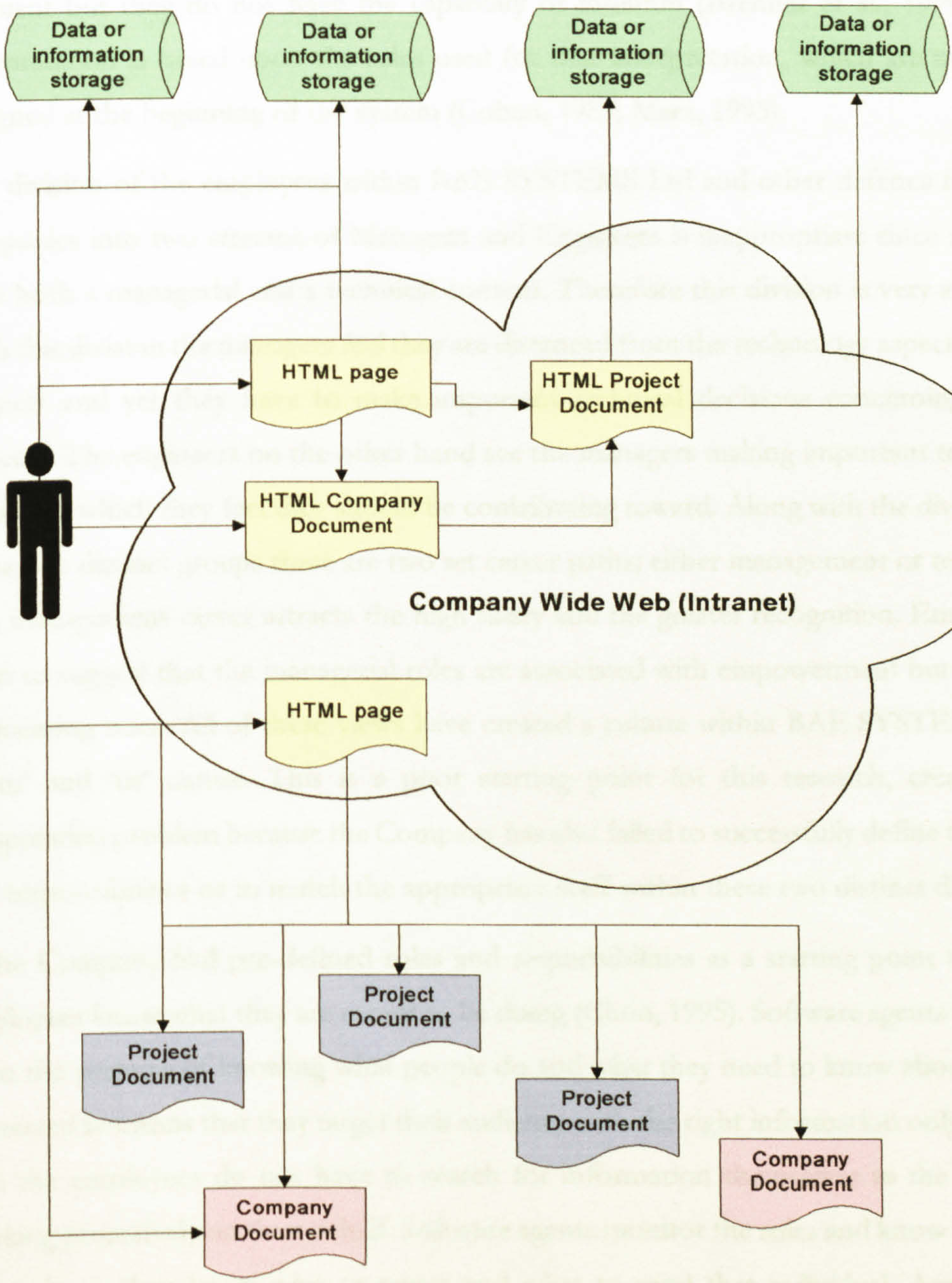


Figure 7-2: Current Company Information Access for Employees

Software agents offer the advantage of not being concerned about the format or location of that data no-matter-what the legacy systems are within a company (See Figure 7-3). Agents communicate heterogeneously, through cross-platform barriers and independent of the technology used (Bigus & Bigus, 1998; Bradshaw, 1997; Genesereth & Ketchpel, 1994). In this way the data in the corporate system can remain in the same formats, old legacy systems and databases so long as the agent is told what and where it will go and collect the information and format it if necessary on the fly. Therefore there is a large effort and cost saving in contrast to the central repository offering. Hildebrand (1999) also suggests that people interpret information differently dependent upon that recipients' view of the world. Software agents can filter and interpret information on behalf of a recipient but they do not have the capability of intuition (Brenner et al., 1998). Any interpretation is based upon the rules used for that interpretation, which are normally designed at the beginning of the system (Cohen, 1989; Maes, 1993).

The division of the employees within BAE SYSTEMS Ltd and other defence industry companies into two streams of Managers and Engineers is inappropriate since all roles have both a managerial and a technical content. Therefore this division is very artificial. With this division the managers feel they are distanced from the technology aspects of the projects and yet they have to make important technical decisions concerning those projects. The engineers on the other hand see the managers making important technical decisions, which they feel they should be contributing toward. Along with the division of these two distinct groups there are two set career paths; either management or technical. The management career attracts the high salary and the greater recognition. Employees seem to suggest that the managerial roles are associated with empowerment but not the engineering ones. All of these views have created a culture within BAE SYSTEMS of a 'them' and 'us' nature. This is a poor starting point for this research, creating an exasperating problem because the Company has also failed to successfully define the roles and responsibilities or to match the appropriate staff within these two distinct divisions.

If the Company had pre-defined roles and responsibilities as a starting point then the employees know what they are meant to be doing (Choo, 1995). Software agents working from the premise of knowing what people do and what they need to know about or are interested in means that they target their audience with the right information only. In this case the employees do not have to search for information themselves as the agent is working proactively on their behalf. Software agents monitor the roles and know who is in that role so they know who to target and what to send that individual. Agents also monitor the data sources and send regular updates of data, notifying the right employee whenever necessary (Bradshaw, 1997; Bigus & Bigus, 1998). In this way the agents are working on the employees behalf and doing the work more effectively and efficiently. To establish this way of working applications like VacancyBot form the foundation of ensuring that the right person is doing the right job within the Company. Secondly, they are monitoring and keeping the data up-to-date so that if roles change then the information required changes to match that.

The research carried out in both cycles one and two indicate that it is quite likely that the Company does not know what it knows from a knowledge management perspective. This would suggest that there could be no baseline of the knowledge at this moment in time. Suggestions by interviewees include the fact that they cannot find information and that people are under-utilised in their expertise. The Company human resources managers and administrators have also stated that they do not know who is an expert in a particular field and that they have little view of employees capabilities and competences. The Company needs to understand what it knows in terms of employees skills, capabilities, expertise and ability in order to be much more effective and efficient. This understanding would allow the Company to identify gaps in knowledge, particularly domain knowledge and re-skill or recruit to fulfil that gap. If this employment profile were understood across the organisation it would enable the company to utilise its skill base more effectively.

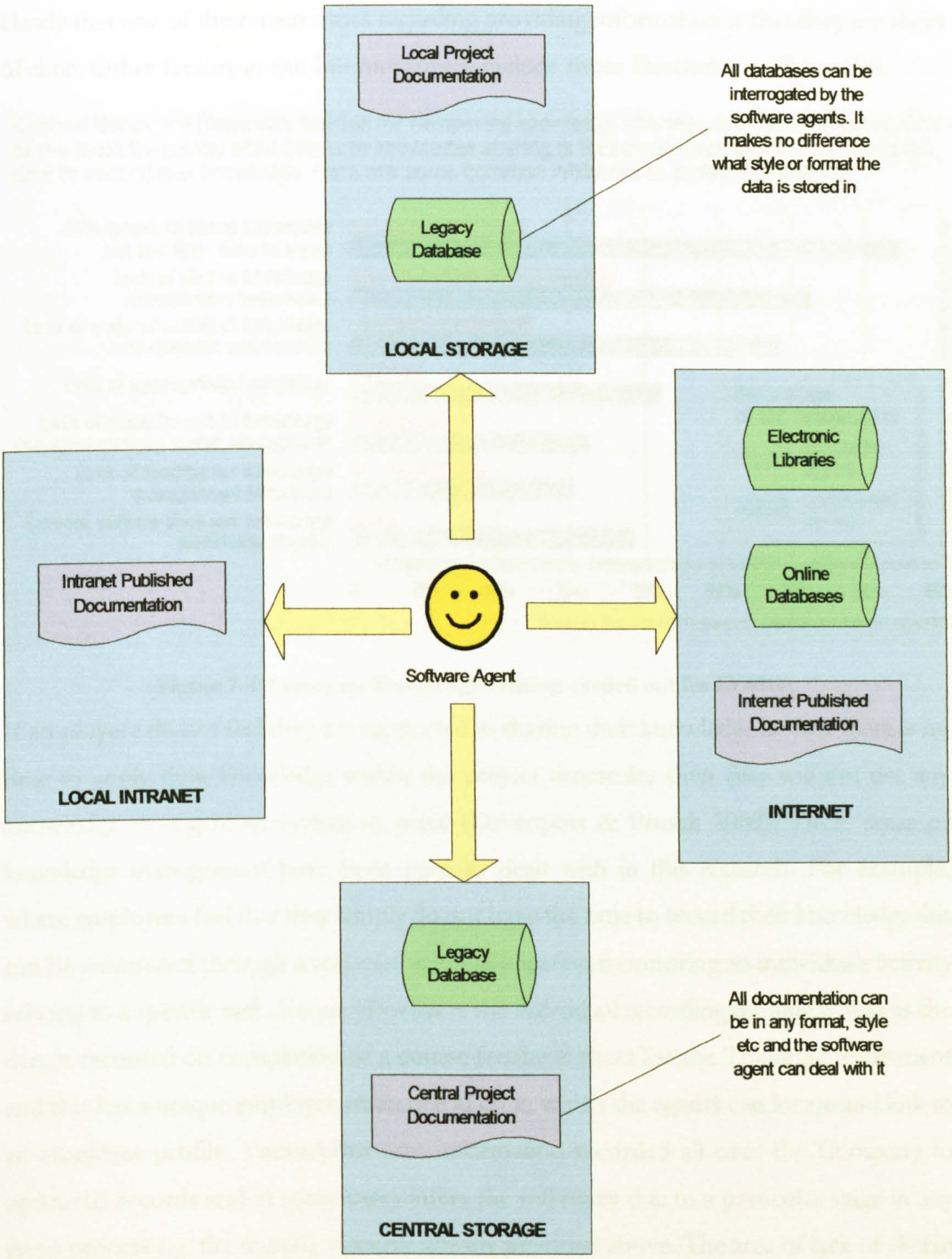


Figure 7-3: Software Agent Interaction Across Multiple Locations and Platforms

7.5 Knowledge sharing

Another key literature domain surrounds the sharing of knowledge and the creation of a suitable organisational culture to facilitate that flow of information and knowledge Mullin, 1996). In one survey carried out and recorded on the World Wide Web the results suggest that people do not share their knowledge because they do not have much time to devote to doing this. During this research cycle one some managers interviewed stated quite clearly that one of their main issues regarding providing information is that they are short of time. Other factors in the Internet survey include those illustrated in Figure 7-4.

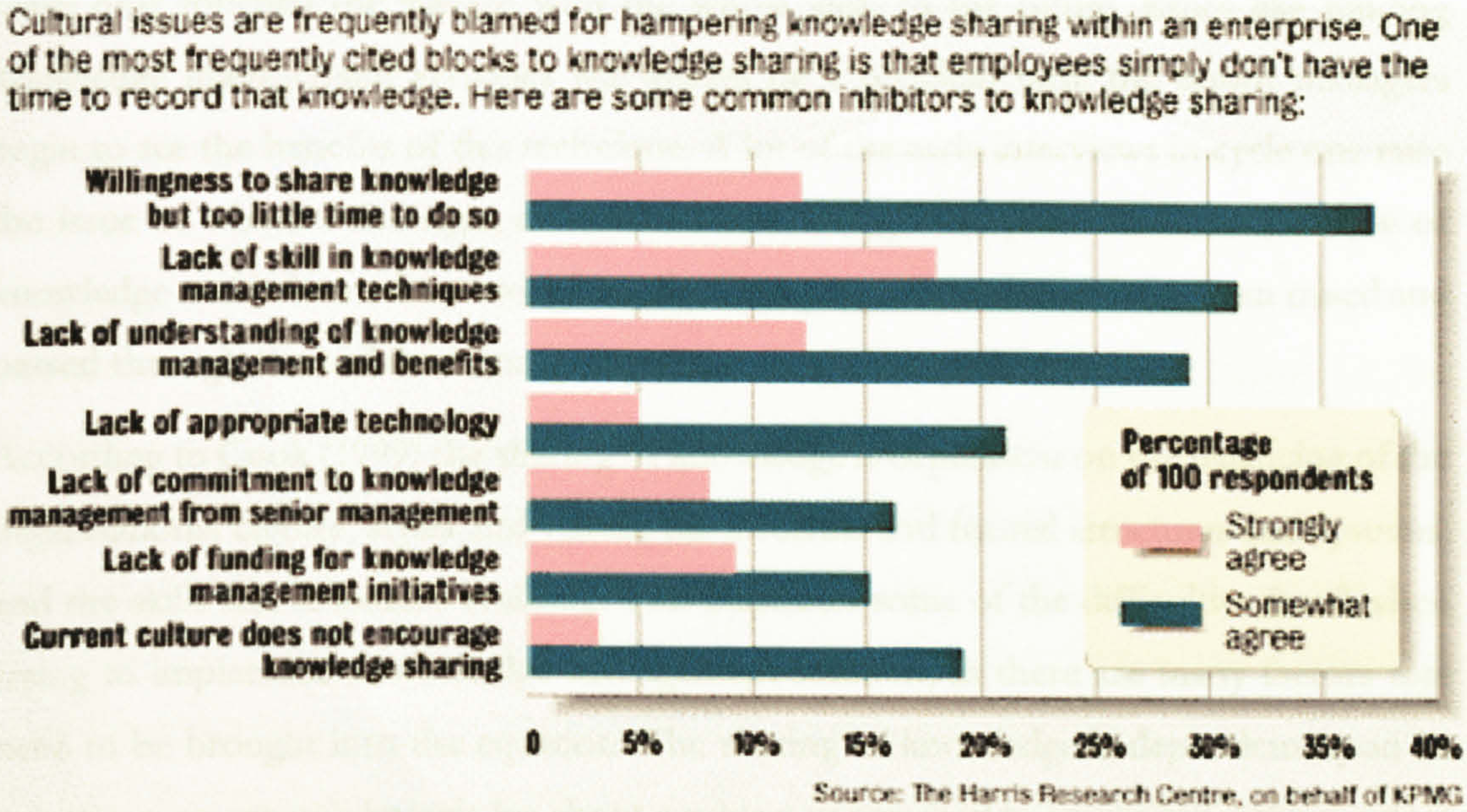


Figure 7-4: Survey on Knowledge Sharing carried out for KPMG[3].

If employees do not feel they are supported in sharing their knowledge or that there is no time to apply their knowledge within the project timescales then they will not use any knowledge management system in place (Davenport & Prusak 2000). These areas of knowledge management have been partially dealt with in this research. For example, where employees feel that they simply do not have the time to record their knowledge this can be automated through a software agent application monitoring an individuals activity relating to a specific task. VacancyBot saves the individual recording training details as the data is recorded on completion of a course feedback sheet for the Training Department and this has a unique employee reference id on it, which the agents can locate and link to an employee profile. VacancyBot uses information recorded all over the Company to update its records and in some cases infers the reference due to a particular stage in any given process e.g. the training example already provided above. The area of lack of skill in knowledge management is not really an issue for the VacancyBot application as it takes the material it is provided with and uses it to develop an understanding of it. The issue of understanding the benefits of knowledge management has been addressed by interaction with the Company through collaboration groups and invitations to speak at meetings as a method of communicating the results of this research. This allowed the researcher to illustrate the potential benefits of knowledge management and software agents for the

[3] http://www.it-consultancy.com/extern/index

Company. There is still an overall lack of understanding in the Company as a whole concerning the usefulness of knowledge management to the Company and this research really only touched the surface with the whole idea. In the future, issues like funding knowledge management activities will always be a problem until the senior managers begin to see the benefits of this technique. A lot of the early interviews in cycle one raise the issue of whether the right culture and technology is in place to allow the flow of knowledge and information throughout the Company. These issues have been raised and passed through the collaboration groups.

According to Cook (1999) the sharing of knowledge is dependent on the balancing of the organisational culture, styles and values; the informal and formal structures and systems; and the skills and resources available. This illustrates some of the difficulties faced when trying to implement a knowledge management solution, as there are many factors that need to be brought into the equation. The sharing of knowledge is dependent upon its nature e.g. an expert's knowledge about a subject as opposed to an explicit written report (Constant et al. 1994; Dixon, 2000). Sharing is affected by the attitudes and the associated ownership of that knowledge as well as the personal social characteristics such as the need to express oneself (Buckman, 1998). There were some early indications in cycle one that there was not a suitable culture for employees to share their knowledge and that these individuals were reluctant to share for several main reasons including the fact that they felt that this is very often a one-way channel and that some individuals within the Company take the credit for knowledge and ideas that were shared with them. Kelley and Thibaut (1978) distinguished between the sharing of two employees acting alone and between two employees who are influenced by their social and organisational context. When the two detached individuals dealt with one another it was on a kind of bartering system but there was a breakdown in communication when one party withheld knowledge. In the latter case the negative withholding of knowledge is sometimes overcome for the sake of the organisation or a team objective. Constant et al. (1994) found that employees who had been refused help or assistance in a need for knowledge were far more reticent to share knowledge with the non-reciprocal offending employee. Individuals like to keep knowledge to themselves (Cook, 1999) and these types of scenario were recorded in the early cycle one set of original interview data. People are also a product of their own background, experiences and views of the world - all of these and many other social aspects affect their willingness to share their knowledge too.

Employees may feel that sharing knowledge is for the benefit of the whole organisation, no-matter how unpleasant that experience may be (See Constant et al. 1994; Marshall, 1997). In this case there is a motivation to share that knowledge. If this is a correct view then the organisational environment and the satisfaction with their teammates will influence this type of employee. Obviously these are not the only issues that govern the sharing of knowledge within an organisation. If employees feel that it is normal and correct behaviour to share knowledge even against their own personal feelings about a situation or another employee then they may also share that knowledge (O'Reilly & Chapman, 1986). When employees create explicit knowledge assets such as reports or software or other key items it is implied that these products are owned by the organisation. In this case employees may be less reticent to withhold this knowledge. But when it comes down to tacit knowledge this becomes an area where the individual controls the access to this and the ownership is with that individual. There is nothing to prevent an employee leaving an organisation and taking his expertise with him no-matter–what the organisation expects that individual to do with that knowledge they cannot force the individual to share it (Constant et al. 1994). Sharing personal tacit knowledge is likely to be influenced by personal gain in some manner or another.

The Company fails to fully utilise the knowledge assets it has available through the private venture (i.e. research and development) activities. There is a significant financial cost of the development of knowledge assets for the Company. The potential value of knowledge assets as a resource for use in the Company is unlikely to be achieved based upon the research carried out in cycle two. Research and development activities are intended to enhance the knowledge and understanding in the Company (particularly in new technology, in this case) providing innovation for future business and markets. There is no refining of the knowledge contained in the knowledge assets created, for example, by bringing together the expertise in the area concerned and discussing the way forward for this work. There is also a failure to disseminate knowledge asset information across the company but the reason behind this is not fully explored in this research. However, there was some indication that it is due to time-constraints upon some managers involved in the study. This research suggests that when information and data are brought together in creating a knowledge asset the mechanism for communicating it needs to be correct and to the right people. Distribution of the knowledge asset was not achieved at a local level on one site let alone across a multi-national organisation. This is considered important since the technology exists to communicate and distribute information more rapidly and easily now than ever before. This lack of distribution and communication raises the potential for duplication of effort and output in some other part of the business elsewhere and a failure to co-ordinate what knowledge the Company has within its entirety. This would suggest that there is a failure to enable employees to draw upon what knowledge it has. How can the employees do this if they do not know the knowledge exists?

It is no good if the organisation is so rigid in its processes and procedures that there is no room to access the expertise when it is required (Cook, 1999). The Company does have this strong structure and there is rigidity and to some degree an element of competition between projects particularly with trying to keep a hold of resources who are recognised as contributing to the project success e.g. when I tried to leave project X and move to project Y there was internal resistance from the former. Another problem witnessed within the Company is that an individual employee who has the tacit knowledge and expertise and is willing to share it becomes overburdened with requests, so much so that he eventually becomes drained and unwilling to continue at such a pace. This kind of drain makes this individual less productive in his own daily tasks, due to assisting everyone else with what they need to understand.

According to Ireland (1999) when an individual creates information and then distributes it the onus is upon all of the recipients to spend effort in dealing with what they have received. Individuals all have a saturation point for the amount of information they can physically and mentally deal with and the rate of receiving information rises exponentially. Ireland suggests that that information that has been pushed out to the recipients is a poor way to manage it because it can often be sent to the wrong people whilst those who need it never get it. This view agrees with the findings carried out based around e-mail in cycle two but it is a matter of getting the process right if the Company stays with this technology. Managers are now dealing with significant amounts of information, which utilises a great deal of their time (Kemp, 1999; Walker, 1997). Ireland (1999) goes beyond this to state that it is better if people go and search for the information they need themselves, which will reduce their workloads. But this is also a naïve view of the whole problem since the problem is moved from one of information overload (Kemp, 1999) to one of information retrieval, which was recognised by many of those interviewed in cycle one of this research.

Increased sharing of knowledge can increase organisational efficiency, learning, innovation, and flexibility (Walton, 1989; Malone & Rockhart, 1991; Nickerson, 1992) but the Company needs to evaluate its requirements for the future and how it will plan to meet those objectives. The literature appears to suggest that there are many alternatives available and that due to the complete uniqueness of any organisation there is no pre-defined solution which is right for each one (Dixon, 2000; Tirwana, 2000; Bernard, 1996; Bukowitz & Williams, 1999).

7.6 Knowledge creation

Meek (1999) emphasises the importance of creating, storing and retrieval of knowledge for the entire organisation. There is a business need to create knowledge assets and make them widely available to those in the organisation (Meek 1999) and this aspect has been covered elsewhere in this chapter. The literature surrounding the creation of new knowledge mainly concerns tacit as opposed to explicit knowledge (Nonaka & Takeuchi, 1995; Polanyi, 1966; Reber, 1996; Von Krogh et al., 2000; Horvath & Sternberg, 1999). This thesis does not address all the issues relating to tacit knowledge (Hall, 1993; Horvath & Sternberg, 1997; Teece, 1998) and its use by BAE SYSTEMS due to the time constraints in developing this thesis and the way that the problem areas were identified as the research moved through its cycles. However, some of the reflective practitioner chapter is dedicated to views that some employees feel under-utilised and their capabilities have not been recognised or put to good use within the Company. Certain individuals mentioned in the discussions within this section obviously felt under-valued and that their true capabilities were not being used at a project level which is the perspective that I have undertaken this section of my research. This view fits with various authors including Bertels and Savage (1998), Smith (1987) and Bridges (1994). All of these authors recognise and advocate the business benefit in developing a culture where tacit knowledge is used to great advantage.

There is one danger encountered during this research concerning knowledge creation, and this is the desire to filter and channel information to enable decision-making, however some new technology has in fact exacerbated the information overload e.g. e-mail, Intranet and Internet technologies (Levine, 1999)

Unless companies see the value they gain from this kind of transformation and accumulation of knowledge they will fail to participate in the extraction process. BAE SYSTEMS has not seen the benefits of utilising explicit knowledge at the time of writing this thesis. This thesis does introduce the Company to both the tacit and the explicit domains of knowledge management but extends the explicit as this is perceived to be more suitable for the demonstration of software agents in the first instance.

Software agents can be used to enable the creation of appropriate community of practice groups and technology groups and this is an aid to the creation of new knowledge. This aspect is covered in more detail elsewhere in this chapter.

7.7 Knowledge management and technology

Knowledge management is as much about technology as it is about managing the people in the business (Davenport & Prusak 2000). Technology plays a very critical role as an enabler of knowledge management for global communications and speed of delivery (Meek, 1999). Various types of technology can vastly increase the opportunity for sharing knowledge e.g. e-mail, databases, www, wireless application protocol and many more. However, as discussed earlier although technology can provide suitable mechanisms they can also have significant limitations for example, swamping the wrong members of staff with irrelevant data. BAE SYSTEMS is a testimony to technology that is failing the employee population at the Company's Christchurch site and the data recorded in the research cycles illustrates this quite conclusively. Technology is only a mechanism for knowledge sharing and is dependent upon whether it is actually used by the employees or not. Secondly, employees may not be willing to share their knowledge as widely as technology allows them to or as much as an organisation may wish it to be the case (Constant et al., 1994).

The defence industry bears specific problems when it comes down to the use of technology firstly because of the typical length of a contract. Most military programmes now rely heavily upon commercial off the shelf products. These typically have a product lifecycle of around eighteen months, thus there is a large mismatch with large military programmes, which last several years or more. It is virtually impossible to capture requirements at the beginning of the programme since technology will have moved so far ahead by the time the solution is implemented. For example, Project X was based upon a set of requirements that were defined before the latest e-mail technology but by the time the programme was into its stride it was out of date. Another problem faced by defence companies is that it was once the case that a large proportion of commercial technology resulted from spin-off innovations from military research. Today basic military research programmes are far smaller and they are also more reliant upon commercial products so it is inevitable that they now lag behind current technology rather than lead the way as they did in the past.

This thesis examines the specific application of the latest technology in the domain of software intelligent agent systems. Software agents have been developed mainly in the area of web technology (Cheong, 1996; Etzioni & Weld, 1995; Finkel, 1999; Hubms & Singh, 1997) in the form of web crawlers (Ordille, 1996; Belgrave, 1996; Cheong, 1996; Pallman, 1999), profiler agents (Pagonis & Sinclair, 1999; Dent & Boticario, 1992; Mitchell & Caruana, 1994; Sheth & Maes, 1993) and search engines (Lieberman, 1995; Koch et al., 1996) and have not really been exploited in the handling of allocating appropriate resources to appropriate roles within the Company for the exploitation and management of the available knowledge. Software agents are useful in the development of practical applications in management of knowledge and information.

So what is it about software agents that make them suitable for the kind of knowledge management that has been explored in this thesis? Software agent technology is a technique that can be used to develop a system whereby tasks can be automated intelligently giving the user the potential for a more effective completion of the tasks required (Mueller & Wooldridge, 1997). Agents work well in a distributed, heterogeneous and dynamic environment (Jennings, 1993; Bradshaw, 1997). Here distribution refers to the fact that the data is not from a single source therefore fragments of data need to be combined (Chang & Lange, 1996; Finkel, 1999). Heterogeneity equates to the ability of agents to use different sources of data and information that may be using a different access language or protocols e.g. different words may refer to the same concept such as, staff and employees (Bradshaw, 1997; Jennings & Wooldridge, 1997). Software agents can also deal with the instability of existing sources of information that may change in nature e.g. their formats or content. In this very dynamic world of information software agents can locate and retrieve sources of information, format them, filter them and integrate them into sources that are suitable for a certain recipient. Agents can customise the view of the same underlying data to suit the recipient of that data (Jennings, 1993; Bradshaw, 1997). Software agents can be programmed to react to their environment when changes take place, thus making them flexible in their capabilities (Franklin & Graesser, 1996).

Information spaces are filled with problems including the fact that the information is very rich because it comes from so many different sources. Secondly, there is so much information that it can create an overload problem for the individual. Thirdly, there are often complex distributed environments and a significant cognitive overhead (Bradshaw, 1997; Maes 1997; Borchers et al. 1998). Software agents are suited to assisting users in resolving these issues because they can perform duties, train or teach, hide the complexity of tasks and can monitor and notify on behalf of the users (Maes 1997). Other characteristics that enable software agents to provide solutions where other technologies have failed include the fact that they are multi-modal, that is, they can support interactions using different input mechanisms e.g. typing, speech or touch screen interfaces (Muller & Pischel, 1994; Dömel, 1997). They are also often adaptive so that they can learn from their interactions with humans and that they are cooperative which means that they can assist the user in defining their real needs (Belew, 1989; Ferguson, 1992; Maes, 1995).

Agents have to communicate with other agents or the environment in which they exist in order to transmit or receive information. The communication protocol is hidden in the language that they use to do this. In this research the product NQL (Natural Query Language) was used to develop VacancyBot and this provides a development environment with a scripting language to create software agents. Agents need to represent knowledge and in NQL this is achieved by sets of rules in algorithms. Implementing agents requires some programming in order to build an application. In the case of NQL a large part of the coding is carried out using the knowledge framework software environment provided with the licence.

Part of the success of any knowledge management system includes ensuring that the information contained in the organisation is removed when it is out-of-date or of no relevance any more. Software agent systems can assist employees in this role if a system is designed to have all material dated and holds a historical record of modifications as well as an owner and a manager to whom that owner is responsible. In this way the agents can monitor and notify owners of the need for update or destroy the material stored.

The relevancy of knowledge being passed to an individual is extremely important. If the software agent system is based upon an extraction of the details of a scoped role and responsibility there is still no guarantee that the piece of information sent out will be relevant at that moment in time. This is also a failing of the search engine results when an employee is searching for specific information because there is just so much information available, of differing standards and search engines are still a developing technology, which do not always provide the results expected by a user. In both these cases there is a requirement of human intervention and assimilation of that information that has been received by the recipient. The difference between the two technology providers is the fact that the software agent technology can build up its understanding of the users needs and possibly infer relevancy from usage, but if not that then it can build up a better view of what it believes is relevant or more suitable to that user. The search engine is not sophisticated enough for this kind of role and was meant to serve the user as a generic filtering method to isolate a sub-set of information on a users behalf.

Agents may not need to send any documentation since it may be better to notify the recipient of the change and a direct shortcut to the changed document. This was done in the VacancyBot application when the list of potential clients was reduced to a top-ten then the resource manager or project manager was able to view any of the documentation or employee records he is permitted to view (since the agent is programmed to deal with security and confidentiality levels of access to the stored data).

VacancyBot was used to demonstrate and examine the ways in which software agents can contribute to knowledge management in the area of resource management in the Company. The quasi-experiment carried out in cycle three included the examination of: -

1. The effectiveness of software agents in a specific area identified from the previous two action research cycles
2. The user's opinion of the use and appropriateness of software agent technology in the identification of staff for Company projects
3. The ease of development of software agents (including cost and effort)
4. The user's opinion of the usability of the particular interface of the solution provided
5. The user's opinion of software agent applications
6. The potential organisation-wide deployment of software agent systems in order to resolve other areas of knowledge management within the Company.

This includes the goals: -

i. To cut down the amount of time a resource manager would use to identify the right match of a vacancy with a member of staff.
ii. To allow diversified and disaggregated data sources to be used in order to make a match (saving time and effort in identifying, locating and extracting data from so many sources)
iii. Provide the Resource Manager/Personnel Manager access to summarised information easily and effectively
iv. Create an interface that is easy to use for all staff (e.g. intuitive, familiar)
v. To select the best matches for a vacancy with a member of staff (internal or external)

The Company has many projects in operation at any one moment in time. The main business is the development and integration of software and systems for the defence industry. Several issues affect the success of a software project including the personnel appointed to do the work required for that project. The area of successful resource management across the whole business presented many problems, raised in the earlier research:

1. The fact that the resource planning profile (using RPM) is rarely up to date because Project Managers do not follow the process properly or because they do

not know their needs until the contract has been accepted and this is often not on time. This makes the data used to predict the future trends in the need for resources also out of date and inaccurate. How can the business be effective unless it resolves these issues? Project demands change quite rapidly and are sometimes unclear depending upon the contract award and the time taken by the customers to give responses to contract timescales. Due to this more fluid situation sometimes recruits are not put with the project they were originally interviewed for and can wait several months before the role is in place. Alternatively the role may not exist after the initial wait. This has a negative impact on the employee.

2. The security clearance process can be very slow. This is outside of the Company's control.

3. The fact that Project Managers are less likely to want to let good candidates move on to other projects or in other career directions. Therefore they can make it difficult and make the process longer or impossible for the individual to move projects.

4. The project manager may speculate the continued growth of a project which then fails to happen thus leaving resources without a project to move to.

5. The project manager may request the skills required for a role on his project but no member of staff has been identified with that skill set so the project success is delayed.

6. Although several methods have been applied and failed the process of identifying and capturing individual skills has been unsuccessful.

7. The entire recruitment management process can take a very long time from beginning to end. This can be applied to both internal and external recruitment e.g. the time taken to filter the CV's by (1) Personnel; (2) Resource Manager; and then (3) Project Managers is a duplicated and it is a subjective view of any candidate. Firstly, the external recruitment process can take up to a maximum of 166.25 working days and an average of 117.96 working days. Whereas the internal recruitment process is able to take a maximum of 57 working days and an average of 43.5 working days.

8. Another factor this research discovered affected the recruitment process where there was little recognition of qualifications and senior managers in charge of technical decision-making lacked the knowledge to make these essential decisions.

9. Employees often feel that they don't get the opportunity of career development that they expect. The engineering population have stated that they have skills that are not utilised for a project and therefore the business suffers by not appointing the appropriate person to the appropriate role. Projects are also failing to release individuals in order for them to fulfil their career aspirations in favour of the project needs. The Project Managers are less likely to want to let good candidates move on to other projects or in other career directions. Previous personal experience of employees obviously being in the wrong position within the Company (e.g. Project X Development Manager, previously discussed in reflective practitioners sections). Previous personal experience of staff feeling undervalued and under used on projects where they feel they have the technical or managerial skills to do more within the projects.

10. The Company resource management process is inefficient.

11. The survey showed that skills matches were required but difficult to ascertain from the current process adopted

12. Some information may not even exist – e.g. internal staff Belbin results and similar results showing details from surveys from team Leader courses for example – although these have been carried out for the individual but the Company fails to record and use this information in the future.

13. No domain competency testing is carried out when making a match for a vacancy

14. Vacancies can be based solely upon the opinions of resource group managers and the wider spectrum of employees should be included. Resource Managers only have limited personal experience of an applicant for a role and as a result they cannot rely on this knowledge to make any decisions.

15. Poorly trained interviewers

16. Vacancy can often be filled with a "who you know" rather than the right person for the job. This has a negative knock on effect to individual employees throughout the Company

17. CV data tends to be out of date

18. Past achievements and competencies of the individual are rarely available to the interviewing project manager

19. The vacancy list is not as up to date as it could be. There are still vacancies advertised at individual Intranet web sites that are not in the central vacancy list

maintained by HR. Some vacancies do not get advertised as they should and seem to be filled before they have come into existence for people to apply for them. Vacancies can go unadvertised because a Project Manager or someone with rank has already chosen a candidate they know and want. This makes the process poor on equal opportunity. Not all vacancies are advertised on the vacancies lists for open applications (e.g. someone can recommend a candidate who is then appointed) and therefore the wrong member of staff can be appointed for the vacancy and the project then pays the price.

20. Data and information on individuals is distributed ad hoc in many formats across the site
21. It is hard to get hold of the resources with the right skills in the current employment market
22. There is no room in the Company resourcing process to achieve short-term requirements for projects, such as a short-term need of an expert in a particular field in order to meet a deadline.
23. At the time of writing there are very few official job descriptions for the type and level of candidate a project requires. Often there is a failure to create such a specification and merely a few ideal skills are listed or verbally passed on to the HR department. This makes it difficult to get a good candidate match.

Main issues

a) Data being out of date
b) Data diversified and scattered throughout the Company
c) Time-consuming tasks
d) Often cannot identify specific skills because it is not known where to find them
e) A high reliance upon a usable interface for interaction with the system

As a result of the quasi-experiment carried out in cycle three of this research VacancyBot addressed the issues marked above: 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 19, 20, 21 and 22. But the limitations of software agent technology (as discussed elsewhere in this chapter) mean that they are unable to resolve issues: 2, 3, 4, 14 and 15 mainly because these are social, cultural or process related obstacles. All of the main issues (a) – (e) are also addressed. However, software agents can be used in resolving items 1, 16 and 17 as an extension of the functionality already provided by VacancyBot. It is therefore clear that the

VacancyBot application significantly improves the resource management process that exists in the Company today. There are proven time savings based upon the data collected and there are recognised improvements recorded in both the questionnaire and the after experiment interviews. In the latest market resource managers must deal with far more skill diversity than ever before and here the software agent application is able to deal with this expansion

From the knowledge management perspective the information is captured and stored as well as being analysed to match the employee to the vacancy. The trialed application allows for the re-configuration of the inference algorithms in order to provide for improvement of the process for the individual manager using the system. VacancyBot provides the functionality of working in the background and even overnight to produce its results. Managers can also view the inference mechanism and scoring technique that has been applied thereby dealing with the issue of trust and belief in the system. If the manager wants to select further details of the candidates in order to see if there are other attributes or skills that may be useful to the particular vacancy then he can.

VacancyBot can bring together all the information available and provide the manager with a more up-to-date view of the candidate but it cannot force new data to be input into the Company infrastructure. Therefore the picture may not be as clear as it should be however, the agents are providing a better view than the one the Company currently has. This issue of data input needs to be reflected in any attempts to improve the Company process in the future. VacancyBot still offers the Company an effective solution because it makes the current resource management process more efficient. If employees were to be deployed according to the matching process illustrated in VacancyBot then a lot of their needs would be met and as such the Company projects and the business as a whole would run more effectively. The employees would be matched to what they are best suited to and would probably be in a better position to be rewarded and recognised for their expertise. The employees career desires and preferences are captured in VacancyBot but they may not be given the highest priority because of the project needs – this kind of issue is a cultural and social need and cannot be resolved through the agents unless the Company takes a view on this need as a part of the VacancyBot application algorithm with a certain weighting level. If the Company ignored these career desires and preferences then they are not being true to the Company vision under the 'People' category, which says the Company will support career paths and individual desires. The other offering that VacancyBot provides is the ability to deal with the short term need for expertise on projects but it cannot deal with the project opposition to the release of that individual or the funding of that expertise. The Company needs to consider the practicality of such resourcing.

Considerations for implementation of agents include the fact that NQL provided an excellent programming environment with a simple scripting language with which to develop the agents. This environment provided a comprehensive library of functions that were used to create the application.

As well as examining the software agent technology much time was devoted to understanding, designing and developing a suitable interface for the VacancyBot application. There were several reasons why this was a necessity in this research. Firstly, if the user interface was incorrect, not easy to use and did not meet the requirements for a users needs then there may be difficulty in the user being able to use VacancyBot and therefore the evaluations carried out would be less than reliable. Secondly, the interface on other areas of technology captured in the early cycle one interviews suggested users would not use a poor interface. Thirdly, the knowledge gained from this type of user interface design were passed on to the Company as a method for use with other interfaces for projects within the business.

So when is knowledge management required? When information is not easily accessible by everyone who needs it. Also when different departments need to view and work with information in varying ways. Particularly in this defence Company - when security is a prime concern; multiple locations are involved; when there is a high turnover in personnel as well as when information is exchanged with external organisations. Software agents gather, centralise and distributes information and knowledge and can use mechanisms such as text, web pages, XML, images, audio, video. In this way they can empower all employees in the Company through web browsers, desktops, databases, applications, and mobile devices to enable access features for every department in the enterprise. The kinds of tasks identified by the participants of the VacancyBot questionnaire are primarily information or knowledge management tasks and as such are capable of being performed by agents e.g. repeatable documenting tasks which may require some level of inference. Software agents are particularly suitable to tasks where human-beings are repeating the same manual procedures over and over again; when careful decision-making is required that involves the balance of many complex factors; When pattern recognition or predictive capabilities are needed; where systems need to be monitored and finally, when disparate systems need to be made to work together in harmony. As agent technology research has developed the products available has grown considerably and this will continue to be driven by the market forces as the technology becomes more recognised.

Agents are not the omnipotent answer to knowledge management. Knowledge management is made up of more than technology since it includes people and process issues as part of the equation. Agents cannot really create new knowledge because they can only combine the information from various sources and make an interpretation and that means that this inference may not actually really be new after all or it could be an incorrect assumption. Since the human brain is far more capable of using its full functionality to join with others and assimilate and truly create new knowledge it will be some time before software agents could ever do that because artificial intelligence research has yet to mature. Secondly, it is questionable whether this is the real value of software agents in attempting to mimic human thinking because the role that they are playing now is sufficient to add significant value to an organisation in managing its knowledge. Software agents can assist companies in getting the right experts to belong to the right forum based upon skills, expertise, preferences and past experience and VacancyBot can certainly be extended to provide this functionality. However, the issues of whether and how those individuals are to interact cannot be addressed by the software agent system. The implementation of VacancyBot also illustrates the need for the interpersonal interaction in the matching of a recruit to a vacancy and also the need to determine if the character of the recruit is suited to the project team personalities in place at the time. Another person can only assess these issues, as agents do not possess the capability to understand these personal issues in order to base a correct decision on them. Software agent systems do not deal with political and cultural aspects of information within an organisation for the same reasons.

There were many potential applications for software agents identified during cycle three, which are described in Table 6-3 of this thesis. These were linked back to the original themes identified in cycle one and to the outcomes discussed in cycle two wherever possible. The potential for further effectiveness within the Company using software agents is particular encouraging.

Finally, in the early part of this research a three-part model, consisting of the following basic elements: the interface, the inference engine and the knowledge base, was recognised as an appropriate method of viewing the system being developed through the research (Stroulia & Goel, 1994; Turban & Aronson, 2001; Harmon & Sawyer, 1990). This model still holds true at the conclusion of this research and the development of VacancyBot fits well into this model. Each aspect of the model was produced through the demonstrator and equal precedence was given to the three elements.

7.6 Social aspects of knowledge management

This research using software agents does provide some added benefits from a social perspective that also benefit the Company, the individual and the group forums. For example, being recognised for ones expertise in the Company can boost morale and encourage further participation by individuals and groups Recognition for knowledge transfer can lead to an individual being used in areas where the Company has the need for that knowledge and therefore the result may be a more effective or efficient Company but there are these other benefits too. Recognition of ability may mean better career prospects in the area of interest too. Also the culture of an organisation may change in order to facilitate the transfer of knowledge and this may benefit the Company in retaining staff or encouraging new staff to join the Company. Software agents can identify the expertise but the mechanisms need to be in place within the Company to deal with the rewards and recognition as well as career preferences and paths for all employees. Meek (1999) emphasised the need to reward and recognise individual employees for their contributions to the organisation knowledge base. There should be proper reward and recognition for employees who contribute by sharing what they know rather than being rewarded for personal knowledge (Newell et al., 1999; Davenport & Prusak 2000).

A lot of knowledge is shared through social interactions, people have many reasons for not wanting to share the knowledge they have including personal reasons through to a poor organisational culture or no incentive to share the knowledge. Research that has already been carried out illustrates that communication and information sharing is highly influenced by the social relationships that have been built up by people and to a lesser extent their commitment to an organisation (Kraut et al., 1990; O'Reilly & Chatman, 1986). According to Finholt and Sproull (1990) employees are willing to share knowledge to assist others, particularly in problem solving situations and sometimes even help organisational strangers. In this situation the transmitter of that knowledge is possibly gaining an awareness of their own usefulness and a boost to their self-esteem. The interviews carried out in cycle one of this research illustrate the lack of the willingness to share for a number of different reasons and the researcher has experienced the withholding of important information by members of staff on Project X. This is one problem that agents cannot resolve but they can act as an enabler of the meeting of employees through the link to their expertise (e.g. to start communities of practice (McDermott, 1999; Dixon, 2000; Adams & Freemen, 2000; Cothrel & Williams, 1999; Kruizinga & Kouwenhoven, 1999). The other aspect of this research that can help in the sharing process is the use of some of the techniques founded in the realms of action research. In the collaboration groups it was clear that there were changes in attitudes to the sharing of information through the building of understanding, trust and interpersonal contact.

According to Levin (1999) organisational learning is facilitated through process management, knowledge management and technology. Organisational learning has been discussed in the literature for some years now particularly in the areas of double and single loop learning (Kolb, 1984; Argyris & Schon, 1996, Argyris, 1976), know-how (Gladstone, 2000) and adaptive and generative learning (Senge, 1994). An organisation that promotes learning examines its culture, capabilities and environment and the processes in place and seeks to make improvements based upon its findings (Schein, 1997). There is still some area of ambiguity between the scope and content of this subject and even a difference maintained between the 'learning organisation' (Schein, 1997) and 'organisational learning' which has allowed a number of consultants to come to businesses rescue with a whole host of applications, processes and expertise.

Having a technological solution available or even a guiding process does not guarantee that people will use it. Secondly, no technology solution can make up for bad practice or substitute for inadequate understanding of fundamental practices (Levin, 1999). It is important to keep records of information around the decisions being made in order to learn from these especially where there is a recurring or repetitive theme. The records need to be coherent with assumptions and any uniqueness captured and the process for carry out this record needs to be streamlined and coherent. This information then needs to be available for further reflection (Levin, 1999).

The Company does not appear to learn from its successes and its failures. Often politics get in the way and budgets are not provided to undertake a proper analysis of the successes and failures of a project. There is no mandated process or owner of this analysis either. It is also important to note that it is often difficult to remember when reflecting back over a very long project exactly why certain decisions were made and the assumptions that are associated with them. From the reflective diary implementation most of the knowledge and learning came from the regular input into the diary and this seems like a more adequate solution. The Best Practice and Lessons Learned Intranet web sites have very little entries on them and those that are present are quite minimalist and only from the managerial element of the business. There are several explanations of why this may not be working including the fact that employees may not feel that they are responsible for adding information to these web sites or that they do not understand what constitutes 'best practice' or 'lessons learned'. The biggest barrier is likely to be that individuals would like recognition so they have no incentives to add information to the sites. Firstly, if there were mistakes they may feel that they will be blamed for the outcome and second, if there are successes then if they share them others will learn and become successful too. In the latter case these individuals are provided with less competition for career promotions if they do not share their knowledge. The Company is still in a stage of looking at learning from a single loop perspective (Argyris & Schon, 1996) whereby everything that is learned is purely viewed at a superficial level and is not questioned or reflected upon in any way. Most of the processes and the projects within the Company fail to provide the employees any time or cost with which to carry out any lessons learned or changes and improvements at this single loop level. The views captured in several of the managerial interviews suggest that if the Company cannot charge the customers for this then it will never be included in a contract in the future. This view is missing the point that if the Company allowed the lessons learned and best practices to be developed then the benefits and the value is for the customers and the business. From the step of single loop learning the Company could plan to move to double-loop learning (Cope, 1998; Schein, 1994; Kolb, 1984) where the changes and outcomes from projects can be questioned along with the assumptions and any underlying issues. This second type of learning would give the Company the understanding and learning about the reasons why some practices work and others fail within the company and possibly provide new solutions to problems. Double loop learning is a more costly task than single loop but the benefits are greater.

Simply leveraging knowledge is not an end in itself. Many organizations have publicised the fact that their success in knowledge management strategies is linked to the Company's business objectives (Dixon, 2000; Davenport & Prusak, 2000). However, having a more knowledge management centric organization and providing the technological infrastructure certainly does not guarantee the behavioural and cultural changes that enable greater use of knowledge. The existing organisational culture will impact the implementation of new strategies and new technology. Due to these factors and other social issues raised in this chapter the culture, views and values of the employees in an organization need to be given consideration before adopting any strategy (Cope, 1998). According to Davenport & Prusak (2000) culture shapes the assumptions of what knowledge is and how it should be managed, captured and distributed and it provides the context for social interactions. Culture influences the organisational success of any new knowledge management initiative e.g. employees in a defence company that is downsizing may equate their knowledge with their job security and thus be unwilling to freely share it.

According to McDermott (1999) there are three dimensions to communities of practice (CoP) that need to be developed: (1) the kind of knowledge to share, (2) the amount of connection between members and (3) how this knowledge is related to the Company. In examining these three aspects the VacancyBot has determined what knowledge exists from an individual perspective (e.g. personal skills, expertise, preferences and past experience). By extending the functionality of VacancyBot it is also possible to link the like-minded individuals thereby creating the connections required. However, the Company needs to consider what CoPs' will benefit the Company the most and encourage these areas in particular. It may be just as important for the Company to allow all types of groups to form whether they are directly linked to project tasks and roles or not, since this is part of the cultural development of the Company. Some Company intervention is necessary if the Company wants added value. The CoPs operate in a very similar manner as the research collaboration groups formed during this research and the outcomes can be very good if they are facilitated and enabled appropriately (McDermott, 1999; Dixon, 2000; Adams & Freemen, 2000; Cothrel & Williams, 1999; Kruizinga & Kouwenhoven, 1999).

7.7 Organisational effectiveness

Today's organisations exist in an environment that has undergone considerable change and now focuses on areas such as increased customer influence, more intense competition, unbounded globalisation shorter product life cycles and dynamic, accelerated technological change (Newman, 1997; Porter, 1990; Probst & Buchel, 1996). These kinds of challenges affect an organisation's competitive ability in the market therefore there is a requirement to make them more effective and efficient (Newman, 1997). Organisations become more efficient and effective by capturing and utilising knowledge. Therefore knowledge management is a logical and natural response to the changes in this market environment and the demands of future competitive advantage. According to Godbout (1999) it is not the knowledge itself, which provides organisations with their competitive advantage but it is the ability to convert that knowledge into competencies and then replicate that know-how. As the market becomes more competitive, more fluid and less predictable, so organisations are realising that their core asset, which will enable them to continue to prosper in an increasingly uncertain and risky environment, is what they know, and their ability to deploy it quickly and effectively for competitive advantage. Organisations require both a cultural and a technical infrastructure in order to provide the necessary mechanisms for the flow of knowledge throughout the company.

Inside any organisation are tremendous amounts of knowledge, know-how and best practices that are actually untapped (See Dixon, 2000). By locating and utilising these resources organisations can gain more effective and efficient processes and production that can lead to increased profits, faster time to market, customer satisfaction and improved organisational competence. Organisations are independent of their workforce because the processes (including policies, values, mechanisms etc) that they use exist whoever is in the organisation (Levin, 1999). But in order to learn, these organisations are dependent upon the people within them and their creativity. The inability or ineffectiveness of transferring information, knowledge and best practice has been observed and recorded in the data collected from this research within the Company. In the researchers' experience it was difficult to transfer one new process across a business unit within the same site. It was also recognised in the interview data collected that projects and business units continue to reinvent or ignore solutions as well as repeat mistakes. The process of identifying and transferring practices, processes, knowledge and information is more time-consuming and difficult than anticipated. The literature in this area captures several constraints responsible for these failings

(1) The lack of employee motivation to accept and adopt the new process, knowledge or information

(2) The employee has inadequate training or information to adopt the new process, knowledge of incorporation of the information.

(3) There is a lack of support at the appropriate level of the project or business unit. There is also a lack of skills or resources or no time and cost set aside to implement the changes.

Much has been written about the use of benchmarking techniques to capture the processes, understand them, adapt and re-use them to improve performance (Drew, 1997; Chase, 1997; Johannessen & Olaisen, 1999; Kaplan & Norton, 1992; Roos & Roos, 1997). External benchmarking, examines the huge amount of available knowledge outside the organisation and looks to use this internally by marrying it up with existing practices or knowledge. The aim is to create a significant amount of value and exploit that knowledge. Companies that have utilised internal knowledge and best practices to create competitive advantage include Chevron, Texas Instruments and Kodak (Dixon 2000). For example, Chevron has saved millions through sharing practices across its business (Dixon, 2000). TI recently avoided the cost of building a $500 million wafer fabrication plant by exploiting internal knowledge and best practices (Dixon, 2000). This suggests that it is possible to take advantage of knowledge and make significant savings or profits but does not indicate why this type of process is not more widely successful (Brown, 1999). Many explanations of why employees in the Company fail to share their knowledge, best practice, and improved techniques were captured in this research. The subject of reward, recognition and incentives to encourage sharing knowledge were discussed earlier and these can prevent the business gaining benefit. The Company culture values personal technical expertise and knowledge creation over knowledge sharing and there is reticence to share because of this. The cultural barrier is the "not-invented-here" syndrome was also mentioned in interview transcripts. Employees also noted that there was a lack of opportunity for them to gain experience by learning from outside their own small group. Other issues raised include the lack of contact, social relationships, and common viewpoints among people who do not work on the same projects. The majority of important knowledge employees need to implement a practice cannot be codified or written down since it is a sharing of experiential knowledge and probably needs to be illustrated to them or needs expert dialogue and interactive problem solving. Creating databases, for example, will not cause change to happen. Polanyi (1966) and Nonaka (1991) both have pointed out the importance and value of recognizing and trying to capture tacit knowledge—the know-how, judgment, intuition that constitute the knowledge that is not codifiable but can make the difference between failure and success in the transfer. According to Savage (1996) there is a need to create and catalogue the organisation's expertise and abilities so others can build networks and new solutions together. However, the research data records the fact that employees do not know where to go to find the information they need or who they should speak to as an expert or even whether either exist.

Another aspect that is widespread in the defence industry is the lack of a job specification including role and responsibility details. Very often a job title is the only detail provided to employees. This is extremely detrimental to functional teamwork on projects and can result in friction, rivalry and the inefficient and ineffective use of individuals on a project. In my experience there are several reasons that explain why this is the case:

(1) Employees joining the Company were given titles such as 'software engineer' and in this role they may be asked to do whatever the project deemed to be within this role with the employee unable to have any recourse. This approach is particularly short-sighted and short-term in its view because employees eventually leave when they never end up doing what they expected to when they joined the Company; or they do not give their best effort to the role and finally they may not be very good at that particular task because their talents are in another aspect of the role.

(2) Is historical in that the original early defence contracts were measured at cost plus and the ethos was that the contracts could be continually extended with more fees. In this scenario the defence companies never faced 'survival of the fittest' constraints. In this case there was no impetus for the Company to refine its processes or become more effective and efficient. Now there has been a radical swing in the market forces affecting the defence industry in general. There is less government defence budget available and therefore the contracts with the Ministry of Defence (MoD) are fixed price with a maximum profit margin.

(3) These defence company contracts now often come with monetary penalties for late delivery.

(4) Another factor affecting the Company way of working is the fact that the defence market is dominated by a handful of large players and the MoD are tending to examine performance and capability before placing new contracts fairly amongst the players.

Companies like BAE SYSTEMS have found it difficult to adjust to this new way of working. Because defence companies are in the market where they can lose business and not be able to make so much profit as they could (Based upon past contractual arrangements) there is a desire to improve processes and become a more effective and efficient organisation. In this change BAE SYSTEMS can benefit from the advantages provided by software agent applications like VacancyBot which enable them to begin the process of knowing the capability, competence and skill base within the Company and then to utilise this to the best business benefit in a more demanding defence market.

One of the main goals in this research has been to improve the effectiveness of the Company through the application of a software agent application. This effectiveness resides in the issue of task competency, in that VacancyBot was able to carry out assigned tasks on behalf of the user and the results show that this is fulfilled. This allocation of part of the recruitment process thus enables staff to devote time and energy to achieving other tasks without being required to divert their attention to administrative, decision-making and skills matching tasks for the recruitment process. The agents have also allowed for role clarity and skills based on matching individual skills to the assigned tasks and the opportunity to build new competencies. VacancyBot will also allow the resource manager the freedom to pursue his job as he sees fit knowing that the application is dealing with particular aspects of his role. Agents provide the resource manager with the tools to do the job effectively too. VacancyBot also gives access to information and knowledge that is relevant to the job or specialisation being provisioned. There is a knowledge exchange between the agent and the user of the system and a genuine transmission of information up, down and sideways in the organisation.

Technology has an enabling role to play, but is not the driver of sharing knowledge because (1) all the important information is not explicit some is experiential and cannot captured electronically, and (2) the incentives for and the barriers to sharing are not technical. In BAE SYSTEMS the incentive to produce several repositories to create and store data has been put in place however, this research illustrates that these repositories are not necessarily used by employees even if they are aware that they exist (as in some cases they did not). Chevron Corporation created an internal electronic database which they expected employees to use to enter information, practices, processes, knowledge and to be able to contact others. Chevron experienced good access initially, but then usage began to trail off completely. They realised that there were no incentives or rewards for employees using the database and so they assigned all employees the responsibility of finding and entering data. The information then started to be entered more prolifically. Other companies with more successful outcomes include Arthur Andersen, Andersen Consulting, Price Waterhouse, McKinsey, Ernst & Young, and KPMG who have recognition and reward incentives in place that have proved quite successful (Dixon, 2000). The tacit domain is not so easy to deal with by organisations because it is hard to capture this knowledge. Most literature focuses upon the use of communities of practice.

Using software agents the Company can save money through local caching of information off of servers accessed by Company officials e.g. the LEXIS-NEXIS legal documentation server. These servers are a source of information for the business and the Company is charged a fee for access and downloading information from them. But because the Company is across a number of sites it is quite possible that the same information is being downloaded several times and the Company pays for every download and online time. Agents can be programmed to pull the data off when someone accesses it and store it on a local server, then notify the appropriate individuals of the location and details e.g. an abstract could be sent of law cases locally cached and the shortcut to the server storage location provided to the appropriate person. Also if someone is searching for that information their software agent will search the local cache first before going to the information provider service thus saving costs to the Company.

During the literature review the epistemology of knowledge models offered by Von Krogh & Roos (2000) was examined in more detail. As a result of this research the Company has been determined as having a cognitivistic view of knowledge, information and data. This is the case for several reasons: firstly the Company does not in my view offer the practical mechanisms for abstracting tacit knowledge and the views of the expert or technology groups and particularly the engineering community relating to the sharing of their expertise suggests that this is the case (Wiig, 1995; Wiig, 1997b). The interview transcripts also suggest that the Company information infrastructure is a system made up of many applications that deal with information alone. But even though the Company is in this category it has not really created an open and central system for storing its information. The continuous changes that have taken place in the Company during its growth and development have meant that it has been impossible to set this up and the current situation means that the information and data are scattered in different systems across a number of sites. Other reasons include the continuous mention of the founding leaders of the Company throughout the Company literature, vision, value plans and publicity. The senior CEO still makes important decisions and is seen to do so which is one of the criteria identified by Von Krogh et al. (1998). Another factor that the Company exhibits in Von Krogh et al. (1998) view is the top-down vision through the value plans which is then adapted for the lower layers of the organisation. The Company has also developed a tremendous amount of procedures, processes, documentation and other hard data for use across the business that they feel gives employees the information they need. Because this information is available across site then it is seen as accessible by all staff on the site. This view is questioned in the interview data from cycle one in several areas of information sources that are available to employees. Another pointer toward the cognitivist view is the fact that the Chairman's Awards for Innovation (CAI) are given a wide audience and lots of publicity as a way of stating that the Company is innovative and forward thinking. However, statistical analysis of the CAI results show that the number entered each year is progressively dropping. The participation percentage rate for 1999 was 1.263% and in 2000 dropped to 0.779%. When examining the last criteria in Von Krogh et al. (1998) list the idea that "*truth is equal to the amount of information available to an employee*" seems somewhat disjoint. The information could be incorrect or out of date then where is the truth then?

Formulating a process to collect and utilise explicit knowledge within the Company will only take it so far down the path of learning and staying ahead of the competitors. This kind of process is repeatable and open to being copied by competitors and at that point any advantage is lost. Tacit knowledge stored in the individual employees head and transferred in specialised ways is far more difficult to copy, here competitors can only head hunt for individuals or set up their own tacit knowledge management processes (Dixon, 2000; Tirwana, 2000; Nonaka & Takeuchi, 1995). Managing the external sources of knowledge will also provide the Company with a short-term gain until competitors get wise to that too. By monitoring and managing the changes in the industry, technology and market competitors this will also provide the Company with some more advantage especially in prioritisation for winning big contracts. Because the defence market is different to the commercial one it is possible that the advantages provided, even by these short-term opportunities to manage knowledge will actually provide the Company with many years of work on long contracts of high value. These finances could be used to invest in other aspects of knowledge management in the meantime to provide further contracts in the future. Knowledge management can provide new innovation and better decision-making opportunity by having up-to-date information on which to base both business and technical decisions. It also enables processes to be more effective and efficient making the time to deliver shorter.

Some problems associated with the management of knowledge include the fact that knowledge is qualified and valued by its relevance and purpose according to Godbout (1999) and that it needs to go to the right people to whom it is relevant. This research attempts to address this issue in the demonstration of software agent technology but the determination of who is the right person in this case is based upon the personal employee information and their role within the Company. There is also a time relevancy of knowledge – if information arrives in a timely manner then it has far greater value and this affects the Company when there are decisions to be made. Newell et al. (1999) stated that there were always problems with the supply and demand of information and the fact that it was very often out of date. There can be a lack of synergy across project and organisational levels within the Company which means that very often employees are unaware of what is known in other areas of the business and who to contact when they need some expertise (See: Newell et al., 1999). Finally, Godbout (1999) suggests that there is a greater problem, which has yet to be overcome by technology and that is the effects of contradictory information. As a human being we deal with this by verifying the source of that information, making our own judgement and taking account of any bias that may have been added to it prior to us receiving it. This aspect has not been addressed by any research literature that has been identified in the course of this thesis and may provide a suitable extension of this research for the future.

7.8 Theory and practice

There has been a great deal of hype about knowledge management prior to and during this research (Davenport & Prusak, 2000; Dixon, 2000; Gladstone, 2000; Tissen et al., 2000; Tirwana, 2000; Von Krogh et al., 2000; Bukowitz & Williams, 1999; Cook, 1999; Devlin, 1999). There have been studies carried out on the increasing amount of research in the knowledge management domain that has highlighted the intensity of this research literature (Scarbrough & Swan, 2001) This work has one particular flaw and that is the increasing rate of literature in other fields such as organisational learning will of course peak and then decline because there will be a saturation point for this written material. Secondly, just because a new trend in the literature is now in the field of knowledge management it does not automatically mean that the previous literature in organisational learning will be lost forever. Readers and researchers have the sense to take what they deem appropriate from the literature. This literature indicates the manner in which consultants and certain businesses can make financial gain by selling their knowledge of bridging the gap of ambiguity surrounding knowledge management (Scarbrough & Swan, 2001).

There is no one universal theory of knowledge management that applies to all organisations. Every organisation is so unique and individualistic, as well as complex, that the successful application of key knowledge management principles can only act as an aid to implementation. For example, the successful application of the theories of knowledge management is influenced by the organisational environment, culture and management stances of the company. Equally the right cultural climate and the receptiveness of the organisation to adopt these knowledge management principles are required.

The theories together with the people, techniques and tools combine to make the organisation successful in knowledge management. This research illustrates the ability of software agents to be utilised to enable the organisation to access and deliver more of its knowledge but it is also dependent upon the complexity of the organisation. All knowledge management theories have elements of the social, process and technology arenas that influence the practical success this is why one theory does not fit all. BAE SYSTEMS is no exception since the entirety of the complex organisation needs to be considered in the design of a bespoke knowledge management solution using both theory and practice.

In looking at the literature on knowledge creation (Nonaka & Takeuchi, 1995) for example, it is clear that the context and setting of the work carried out is in Japanese industry and culture. The literature covers in detail the Japanese reliance upon tacit as opposed to explicit knowledge and covers the detail of how the knowledge is shared in the Japanese businesses discussed. However, when looking at the value of this research for BAE SYSTEMS or other western organisations it is hard to see how these companies can make the cultural changes and create the environment for tacit knowledge sharing in the same manner described. The literature does help with the definitions of explicit and tacit knowledge and some of the ideas presented have the potential for application in other companies. However, there is incompleteness in the detail that would be required by BAE SYSTEMS for example, in order to decide whether it is appropriate to apply some of these ideas. This is also true for some of the other literature read during this work (Dixon, 2000; Davenport & Prusak, 2000; Bukowitz & Williams, 1999; Despres & Chauvel, 2000) which provide adequate illustrations of examples of failures and successes in knowledge management techniques but fail to enlighten the reader to the detailed context and environments that are the basis for assessment.

Some of the literature focuses upon the act of knowledge management and provides a significant number of case studies and examples that have been successful or have failed (Meek, 1999; O'Connor, 1999; Bukowitz & Williams, 1999). This literature provides an insight into techniques and principles that could be applied by an organisation and from this stance they do provide some usefulness (Meek, 1999; O'Leary, 1998). However, each technique applied has specific cultural, social, ethical characteristics that make it appropriate for that particular organisation. Some of this literature is purely based upon common-sense views and adds very little in assisting an organisation investigating the potential for knowledge management (Hildebrand, 1999; McDermott, 1999; Bukowitz & Williams, 1999). Many others provide an incomplete coverage of the detail required to assess the compatibility of application to another organisation. All of these factors indicate that there are currently no universal theories of knowledge management that will lead an organisation to a successful implementation (Hildebrand, 1999). These theories can offer a guide and assistance in determining the options for an organisation during the development of a knowledge management system (Meek, 1999; Dixon, 2000; Tirwana, 2000). The use of technology and processes or procedures can provide such a system with the enabling ability to create it but they cannot guarantee its successfulness either (Newell et al., 1999; Dixon, 2000; Bukowitz & Williams, 1999).

There are numerous sources of literature concerning the development of software agents (Belgrave, 1996; Franklin & Graesser, 1966; Genesereth & Ketchpel, 1994) and some which examine their usefulness for information management. None of the literature read during this thesis address the issue of the practical application and testing of such an application in a defence organisation seeking to implement agents for knowledge management (Bigus & Bigus, 1998; Bradshaw, 1997). Neither are there any extensive guidelines or rules for developing a knowledge management system using agents, which has proven to produce a successful system that could be reused in a Company such as BAE SYSTEMS Ltd (Coen, 1994b; Haddidi, 1994). In the majority of the literature I have read there is a great deal of theorising and potential future usage of software agent technology but very little that has been developed and tested with outcomes (Belgrave, 1996; Ferguson, 1992; Bradshaw, 1997; Chang & Lange, 1996; Brustoloni, 1991; Brenner et al., 1998; Finin et al., 1994; Jennings & Wooldridge, 1997). Another aspect addressed by this research is the usability of any such software agent package in order to ensure that there is testing of the underlying agents, which are utilised via an interface (Nielsen, 1993; Galitz, 1997; Microsoft, 1995).

7.9 Credibility

The findings in this research are trustworthy from the perspective that the interpretations expressed have been agreed with employees within the organisation particularly those participating in the collaboration groups. This group, through their participation, have also contributed to the content of these findings and have consequently assisted in the validity and credibility of the outcomes. In several aspects of the research those involved in these groups, or other departments influenced by the outcomes of this research have changed or improved processes in place within the Company. The use of action research has allowed the discussion of the outcomes with individuals and groups in the Company who have agreed with the findings made.

Reliability of the findings is difficult to prove using pure scientific research because much of the study has been carried out using qualitative analysis. Human beings have their own views and never say the same things in the same way twice, their perspectives are also transitory and they often express how they feel at a particular moment in time – these kinds of factors do not make it easy to prove irrevocably that the findings here are completely reliable. However, there are specific areas of the quantitative research that have illustrated correlations of the data and examined the issue of reliability e.g. some of the surveys carried out in cycle two and three. Once again employees interacting in close proximity to the research as well as those influenced by it through the collaboration groups acted upon the content of those findings and by so doing infer that this research is reliable, credible and trustworthy.

The issue of the validity of the findings made in this research is very much related to the kinds of methods used throughout the research. Issues such as the size of the Company, extent of the data collection, the techniques used, ethical considerations and the level of participation from those involved in the research all affect the valid outcomes of this work. There are qualitative arguments that all data collected has some degree of bias but I believe that I have made every attempt to ensure as little bias as I can in all the data collection mechanisms used and where I have felt on reflection I could have attempted this more successfully in the future this is recorded and the learning is incorporated into other aspects of this thesis. Action research has integrated theory and practice. Therefore when I am trying to educate the Company through my research it makes it difficult to show generalisability and repeatability through sets of rules or guidelines. It is possible, from the details recorded relating to the collection of data in this research, to repeat any aspect of the research carried out. A similar study with the same methods and methodology in another defence Company may reveal different results because these are different people in a different culture and environment. This may imply that the research is unreliable but it is not because there is a reasonable level of face validity in that those involved have taken the research learning and applied it in other areas of the Company (this is illustrated elsewhere in this thesis). Here personnel have understood, made sense of it, agreed with it and used this research.

The collaboration groups enabled both positive and negative feedback during the sessions whereby those participating were given an opportunity to express their opinions and perspectives of the items under discussion. This had the effect of providing a learning environment where all participants, including the researcher, can understand the issues. These meetings also enabled us to plan, as a group, the action to be taken as the next step.

The reflective diary also provided a mechanism for validating my own views and changing ideas throughout the research and enabled me to better understand my research and myself. Some diary extracts cross reference literature read and my thought and ideas surrounding that literature at the time. Where suitable such ideas have been captured in this thesis. I have also tried to bring retrospective ideas into this thesis when looking back at the historical record of my experience in this research.

A certain level of rigour was applied at the start of cycle two when the word search patterns were identified in NVivo in order to establish what positive, negative and neutral word usage was made. These show that there were some areas discussed at interviews that were better candidates than others for further investigation within cycle two. The data collected and analysed in cycle two was partly quantitative together with Likert scale questionnaires and several open-ended questions. This data was analysed using SPSS (statistical tool) and NVivo and other secondary data was called upon to make comparisons wherever possible. When looking back at the surveys carried out each one reported areas for further improvement and these are captured in the appendices. At the end of cycle two the data collection and interpretation led to the action of taking the area of resource management on to be tested with the agent technology in cycle three. Cycle three was reliant upon the software agent and usability questionnaire, which had been validated against graphical user international and commercial standards as well as being validated by a human factors expert within the Company. Finally, the literature was called upon during the final analysis and this chapter fully re-engages with this in order to examine the areas that were raised through this research. Therefore this research has used multiple methods and methodologies, many types of data collection and analysis, as well as using available secondary data (including the literature) to compare and contrast with that collated in this thesis.

Another point relating to the rigour of this research is the fact that in all the interviews and other data collection mechanisms used more and more of the staff at the Christchurch site were involved since once a member had been part of the research they were excluded from the set for the next phase. Thus opinions and views were stretched as diverse as possible across the organisation -around 156 members of staff took an active part in some aspect of this research. Involving staff in areas such as the collaboration groups actually increased their commitment to the research and to taking action themselves. They can actually take on the role of co-researchers in the manner in which they can challenge the findings at these meetings, even interpret the output and raise issues with the data collected by me. The group assisted in determining which assumptions made should be tested in the later research cycles.

This thesis has also led to a significant amount of transferring of knowledge from the research domain into the Company in the following areas: -

Methods

- Developing surveys and questionnaires, including their pros and cons and how to use them successfully
- The role of quantitative and qualitative data collection
- Analysing the results and examining inferences including the use of tools such as NVivo and SPSS
- Using reflective diaries, their advantages and disadvantages

Action research

- What it is
- As a method for investigation and discovery
- Developing a collaboration team
- Getting buy-in and joint problem-solving

- The reflective process

Knowledge management

- What it is and its relationship to other similar concepts
- How it has been used in other organisations
- Why it is important to organisations
- Knowledge assets – what they are and how they can be used
- Creating networks, communities of practice and similar knowledge flows

Software agents

- The overview of artificial intelligence and where agents fit in
- What they can potentially do for an organisation
- Practical implementation of software agents
- The applicability of them to a defined area of research
- Other agent software available off-the-shelf, including the strengths and weaknesses

Company

- The difficulties that employees feel they face in trying to get the information they need for their roles
- The types of problem recognised by employees within the Company, across many domains
- The issues still left unresolved within the Company
- Insight into the Company culture and social aspects
- Insight into Company processes and procedures
- Perceptions of the way the Company currently functions

Much of the applicability of knowledge management from this research has led to the creation of key fundamental points that should be considered by the Company in order to implement a knowledge management process. However, as discussed previously it has been made clear that the Company is a complex organisation that has many factors, which will influence the success or failure of that process. When considering developing any knowledge management solution the analysis and design of the requirements for the Company need to be carefully considered and these should take account of the complexity issues mentioned in the discussion above. Some factors that influence the successfulness of such a solution include:

- The right environment and culture – e.g. one which is open to change, as well as recognises and accepts that knowledge management is a necessary part of the business
- Processes that facilitate the free flow of both information and knowledge (including social, technological and procedural options)
- Buy in and practical demonstration of buy-in by the senior management
- Individual and organisational level receptiveness to knowledge management
- A planned design and strategy to know what kinds of knowledge are required by the business and how to set about providing a solution

All of the research carried out in this thesis has been captured using proportional representation samples. All the quantitative data has been analysed using the SPSS v.10 tool and all of the qualitative data has been investigated by using NVivo. The data analysis and original data is available in evidence but all identities of individuals and any security-restricted information is not presented.

Designing and implementing software agents to enable knowledge management within the organisation has proved to be reasonably effective using the NQL toolset and some integration with home-grown software implementation. The key points for future developments include the high profile of the user interface and its associated usability as a key to the successful use of agents. Secondly, there is once again the need to fully analyse and capture the requirements for the system at the outset in detail before commencing any implementation. The data capture required for such a system may be time consuming, however the return on that investment can be the difference between the success or failure of the application being created.

Technology for knowledge management offers organisations the freedom from the resistances of time and locality. It does not provide an alternative to face-to-face social interaction but supports it instead. Technology provides a more immediate access to information and saves effort for most employees utilising the information systems in place (Sproull & Kiesler, 1991). In some earlier research by McKenney et al. (1992) it was shown that although managers could use information systems in a lot of their well-defined tasks they still had a need for face-to-face interaction for discussing problems and solutions and for personal welfare issues. There is richness in interaction with other people which technology does not offer even in the software agent dimension.

The software agent development process and the user-interface usability analysis can be applied to any other organisation using the methods detailed in cycle three of this research. The problem areas relating to a specific organisation may overlap those discovered in this research however there is a need to confirm this by that organisation. The agent characteristics identified in this research and the potential areas for application would need to be assessed by other external organisations in order to determine the potential usefulness for managing the knowledge in that organisation. Agents can be utilised as an enabler for any knowledge management process in any organisation.

7.10 Limitations

This research was limited by the fact that the organisation was unable to permit the experiment using VacancyBot (cycle three) to be tested in the Company's existing environment because of the security problems that this would have created. Thus although the true environment was created as realistically as possible this was a quasi-experiment which has not been fully integrated within the current BAE SYSTEMS Ltd. infrastructure. The data used for replica databases was a copy of the original material in the current system but all names and some security details were removed for ethical and confidentiality reasons.

Using action research provided a great wealth of rich data and consequently introduced a significant amount of effort in data transcribing and analysis.

7.11 Further development

This research is the only work I am aware of that has taken a holistic approach to the examination of the problems within this Company and taken account of the changing defence market in order to provide a knowledge management solution using software agent technology. The internal Company views within BAE SYSTEMS all seem to be held in isolation to each other and often lead to incorrect strategic decision-making at a high-level. These decisions have recently led to BAE SYSTEMS Christchurch making a number of redundancies and losing staff without replacement. In my view how can the Company have successful projects when the processes are still ineffective and the employees are not matched against their expertise and skill set to meet the needs of projects? As an employee I witnessed many new members of staff being trained for roles on one project where their skills were inappropriate for that role, when in another project in another building there were suitably skilled and trained personnel.

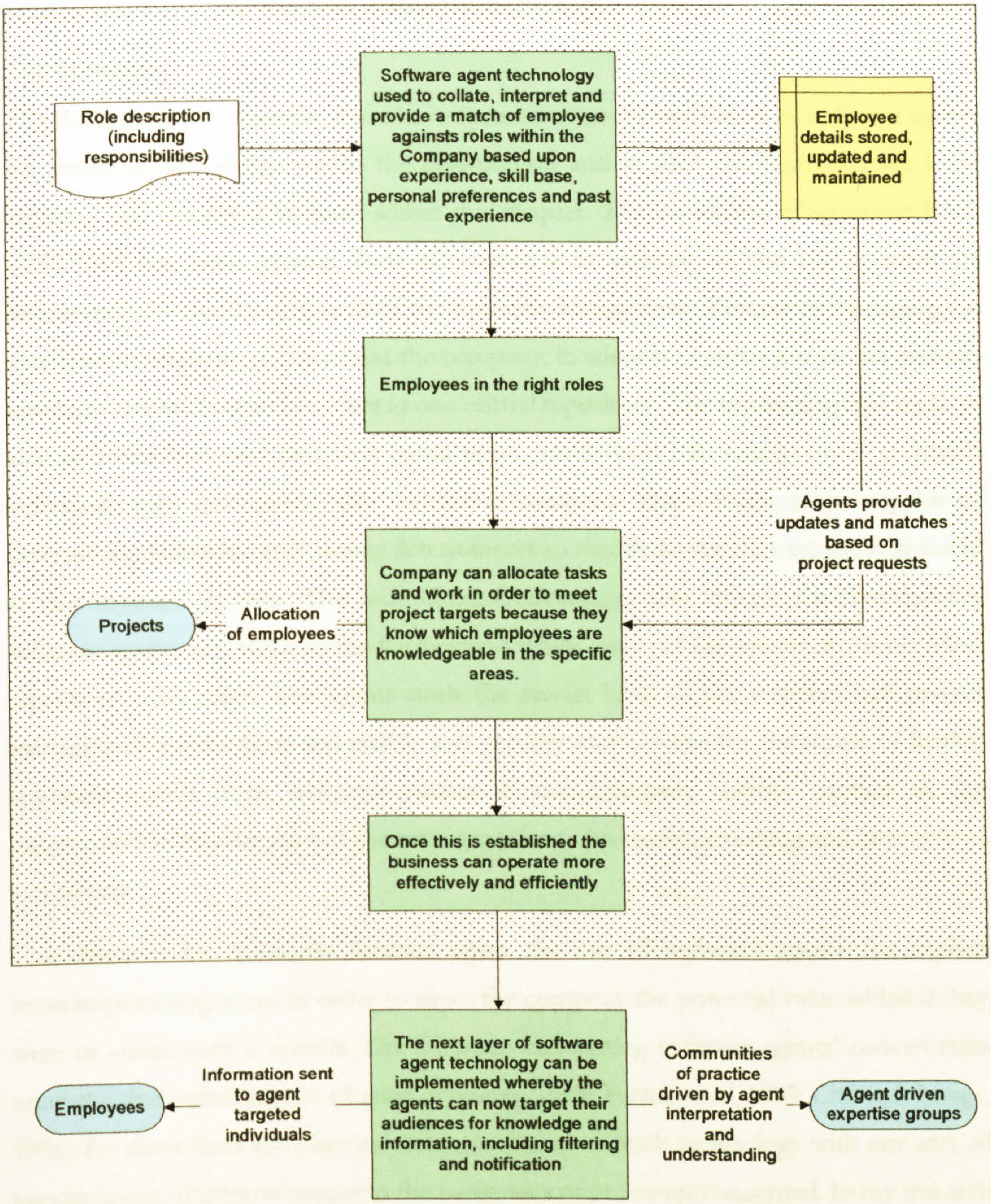


Figure 7-5: Scope and enhancement of current research

Figure 7-5 illustrates the scope of the findings within this research thesis indicating that everything within the large shaded box is covered but that the rest is the extension of this research using software agents. This latter piece of work involves incorporating another set of agents to target the individual roles within the Company with the information that is pertinent to their role. This information can then be extended to include personal preferences. The content of this research indicates that this latter extension would be quite easy to implement and would assist employees and outcomes of projects generally. This is based upon the fact that the Resource Managers and Project Managers receive the knowledge they need from the agent inference and understanding in order to select suitable employees for vacancies within the Company.

7.12 Summary

The findings of this research above have focused upon the usefulness of software agents for managing knowledge within the organisation and as such the benefits have been captured and discussed in detail within this chapter. The usefulness of agents to BAE SYSTEMS has been proven their effectiveness in assisting in the management of information for the development of the Resource Management Process by managing the data from multiple locations across the company, in whatever format it is stored without having to re-structure and re-store in one central repository. The software agents are then able to make best case decisions based upon pre-defined rule sets in order to match individuals with appropriate roles within the Company. The software is also capable of determining individual and project determinants so that these matches are the best suited at that moment in time. The technological advantages also include the fact that the software agents can work in the background whilst users of the system work on other aspects of their roles. The agents push the results back to the resource and project managers via e-mail alerts and enable user security mechanisms for the access of further applicant details from whatever source in the Company thereby putting all the information at the fingertips of the manager prior to his decision-making and interview of a candidate.

This research has primarily focused upon the use of software agents for explicit knowledge management in order to show the company the potential value added if they were to adopt such a system. The literature concerning software agents' concentrates upon the theoretical aspects (Russell & Norvig 1995; Turban et al, 1999; Chang & Lange, 1996) far more than the practical implementation of such technology with any sort of measurement of improvements to the businesses or processes concerned. In my research I have overcome this by utilising action research methodology and a pluralistic approach in order to understand the original problem domain and the subjective views of Company individuals in understanding their perspectives of this. I have also examined the weaknesses in software agents (Russell & Norvig, 1995; Genesereth & Ketchpel, 1994; Bradshaw, 1997; Caglayan & Harrison, 1997) and knowledge management aspects (Scarborough & Swan, 2001; Hildebrand, 1996; Godbout, 1999; O'Leary, 1998; O'Meara, 2000) of the Company.

My findings are set in context with the fact that the social, cultural and other philosophical aspects of the environment affect the success or failure of this software agent solution and can only be included in a minimal way to the application developed. As such it is important to consider these aspects during any analysis and design phases before implementing such a solution to assist in the success. Because each organisation has such a varied mix of such environmental factors this has made the pluralistic methodology a good one, which does capture these elements as part of the research.

Most commercial organisations have had to reduce their costs and have developed much flatter management structures as the norm. In most defence-based companies there is still a tendency to have very large bureaucratic management structures. Management overhead has led to some of the redundancies within the industry within the last twelve months. This is tied into the need for these defence companies to compete for a smaller number of contracts and to change their processes and old way of working to meet that challenge. Knowledge management has the potential to offer this Company, and others, the ability to understand and utilising the knowledge that exists within them. There is no single solution to creating a generic knowledge management system for all companies, because they are so bespoke in their requirements and due to their unique cultures and environment.

In considering the applicability of software agents, these have been shown to be a suitable alternative to enabling knowledge management, offering increased capabilities and efficiency. Software agents have the potential to assist with management tasks and make processes more efficient and effective. This has been demonstrated in the domain of resource management within this research yet, there is far greater potential across the entire business, that is also captured in this thesis.

THE REFLECTIVE PRACTITIONER PERSPECTIVE

8.1 Introduction

This chapter examines my reflective learning experiences throughout the development of this action research thesis. This reflection is based primarily upon the use of a written reflective diary from which extracts have been examined in detail where incidents, behaviour and learning are relevant to the research being conducted. This reflective practitioner diary also includes several mind maps and drawings, which are valid methods of reflection in action research (Coghlan & Brannick, 2001; Dickens & Watkins, 1999; Greenwood & Levin, 1998; Griffiths, 1990; Kemmis & McTaggart, 1988; McNiff, 1997). I also make a great deal of use of the collaboration meeting minutes recorded for the Company at the time. The chapter examines reflection from the perspective of process, outcomes and my own personal experience in order to depict the research accurately.

8.2 Reflection as part of action research

Reflection is an appropriate framework for my research because it is the important connection between my real experience, interpretation and action. It enables me to understand and discover what is happening in my research and my own thoughts feelings and reactions to those events. By making my reflection visible through discussion in the collaboration groups allows me to illustrate how I came to conclusions or thoughts and how I have learned through the process. It also means that I have opened myself up to comment, criticism and alternative views from within the group and this is shown to improve my learning in this research. I chose to use this research mechanism because I wanted to know and understand myself, and the people within the Company and how we think, feel and act in practice as part of understanding how any solution can be applied.

My research relies upon my reflective diary for these aspects of my study. Diaries are an effective mechanism for recording reflective learning and are advocated by several key references e.g. Kemmis & McTaggart (1988) and McNiff, et al. (1996). In this context diaries assist people capture their thinking and responses to incidents as they occur. In this thesis there are diary excerpts, which are shown in pale yellow boxes and italic font for readability.

The main emphasis in my diary has evolved around answering a number of questions based upon key incidents happening in the research environment. The format followed was to answer some or all of the following questions:

1. What happened?

2. How do I feel about what happened?
3. Why do I think the situation happened?
4. What did I learn from the experience?
5. What, if anything, would I do differently next time?

Following this template of questions any insights yielded are recorded. For each incident the key points of the incident are described, some explicit learning is drawn from it, and what will be done differently in future as a result of this learning. These point are represented wherever possible. This enables me to reconstruct and make sense of an experience and is particularly useful when reviewed at intervals after the incident(s). The reflection is the part where I spend time looking inward at why I did what I did, or they said what they said. In going through this process I gain insights into new knowledge, new skills and possibly new attitudes relevant to my research and me. The diary records the learning process, implementing the changes that are recognised and the new knowledge that has influenced the researcher's practice in their own field, work or role.

The process for developing the reflective diary is a completion of the Kolb (1984) learning cycle. The critical incident is the action and the reflective diary takes me through each of the other three elements of the cycle. The reflective diary is assessable and it complements the other research findings within this thesis. It allows me to contemplate on subjective and creative issues such as, my personal feelings; interpersonal interactions links between my experiences and prior learning; acknowledgement of new understandings and how I think particular problems can be resolved. Initially I was sceptical about the learning or insights I would gain from such an activity. However, over time I came to see how capturing and reflecting on events enhanced my learning and gave me new insights.

Action Research Related Findings

1. Action research techniques such as the reflective diary and collaborative methods can assist a company with organisational learning.
2. Using the reflective diary has assisted the author in assessing the research process and her role within it in a more holistic manner. This has led to learning and understanding, which may otherwise have been absent.
3. I learned that it can be difficult to deal with some reactions by the Company to uncovering problems and issues within the organisation based upon the research findings.

8.3 Reflection on Process

The research involved collaboration with members of staff in order to develop a joint approach to resolving knowledge management issues.

The collaborative process enabled problem solving, decision-making and the generation of new knowledge and understanding for those involved in the research. At a higher level of abstraction this process is fundamentally that described by Lewin (1973) and Dickens & Watkins (1999). At each phase the joint decision-making allowed me to collaborate, discuss and to interpret the way forward for the next phase of the research. My reflective process is shown in the lower part of Figure 8-1.

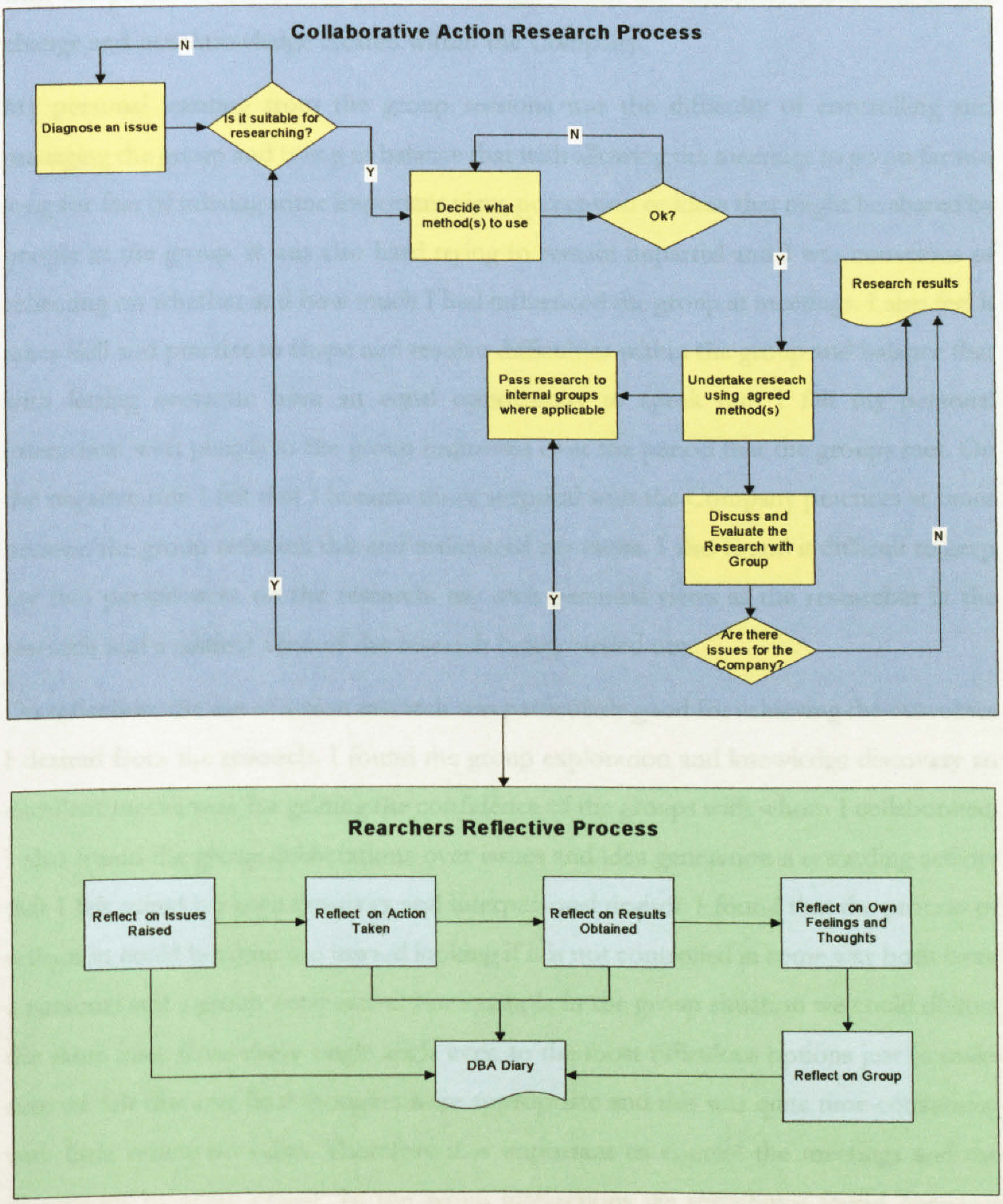


Figure 8-1: The Collaboration and Reflection Process

The research I carried out was always agreed through the different group forums I was involved with (See the upper part of process in Figure 8-1). The issues shared were about the research method used, the problems and strengths of those methods, the research results obtained and my own thoughts on all of these. The groups came to see how learning from one setting could be used in other business contexts. At least seven group members utilised some element of the research in their own business area of the Company. The research was also communicated to a much wider audience within both the Christchurch and other Company sites. I delivered presentations and shared information on my research. By presenting my research material to these other groups with the power to make decisions and changes within the Company I was able to see change and new knowledge created within the Company.

My personal learning from the group sessions was the difficulty of controlling and managing the group and trying to balance that with allowing the meetings to go on far too long for fear of missing some important view, perception or ideas that might be shared by people in the group. it was also hard trying to remain impartial and I was conscious of reflecting on whether and how much I had influenced the group at meetings. I also feel it takes skill and practice to shape and resolve difficulties within the group and balance that with letting everyone have an equal opportunity to speak out. I felt my personal interaction with people in the group improved over the period that the groups met. On the negative side I felt that I became more sceptical with the Company practices at times because the group reflected this and influenced my views. I also found it difficult to keep my two perspectives on the research: my own personal views as the researcher in the research and a distinct view of the research being carried out.

On reflection, the use of action research was particularly good for achieving the outcomes I desired from the research. I found the group exploration and knowledge discovery an excellent mechanism for gaining the confidence of the groups with whom I collaborated. I also found the group deliberations over issues and idea generation a rewarding activity that I felt suited my own creativity and interpersonal desires. I found that the process of reflection could become too inward looking if it is not controlled in some way both from a personal and a group perspective. For example in the group situation we could discuss the same issue from every single angle even to the most ridiculous options just to make sure we felt that our final thoughts were appropriate and this was quite time-consuming with little return on value. Therefore it is important to control the meetings and the discussions to some extent. In the group interactions we sometimes found ourselves devising extremely subjective interpretations for why something did or did not happen and I found this less rewarding. This also happened in my personal reflections sometimes with the same sort of results and I found myself so inwardly focused that I sometimes lost sight of the issue I had been reflecting in the first place. I think it is essential to become experienced in this type of reflective method and I certainly learned these points through my own research, which will help me in the future. If I attempted to carry out any action research in the future I think I would try to make it a bit stricter in terms of the action research learning cycle, which I think I would use as a guide (e.g. an agenda) for every meeting to keep the meetings more uniform. This could lead to less free speaking but I do not know this for sure. There must be a balance because in my research group I erred on the side of total freedom, which may have led to less valuable contributions at some meetings.

8.3.1. Learning examples

To illustrate the ways in which the Company responded to the kind of learning feedback I provided I have picked two examples for illustrative purposes and these are discussed here.

8.3.1.1 E-mail

One example of my research influenced the company was the response to the e-mail survey, which facilitated the repetition of e-mails to individuals giving them a problem with information overload. In this example the results, although based upon a small representative survey, showed that there was a great deal of duplication of e-mail information and no co-ordinated method for controlling this. I raised this in my e-mail survey and was asked by senior managers on Project Y if I could offer alternatives to assist them in dealing with this. After our meeting we concluded that a central process was required for this project. The project set up a central administrator to deal with sending out all briefing and Company information to those on the project and a set of names and appropriate requirements for each was established in order to solve the problem. After trialling this, the project decided it was working very well and were happy to keep it in place. I was pleased that the project responded to this single loop learning in a positive manner.

8.3.1.2 Knowledge Assets

Another example included the early analysis into the Private Venture process that raised the issue that supporting documentation was made available and visible to the whole business. After issuing my Speech Technology report to the management and presenting the results to a group of managers and engineers I was then involved in an initiative to create an up-to-date website of private venture work. This was established and was communicated to all employees so that they could see the type of work being undertaken and identify contacts for expertise in these areas. Once again this single loop learning reaction by the Company inspired me. I found it very rewarding when the research I was doing contributed to change within the Company, when the individuals learned more about any of the perspectives that were shared and when individuals gave me positive feedback on the work that I was doing. This was the reason I had chosen to adopt action research. I was very keen to create new knowledge for the Company, through the group, and to combine a balanced approach to theory and practice throughout. As the groups and I met and shared we went through a learning experience during each cycle of the research and this was then the basis of the way in which we all viewed the next cycle and so on.

There are several other examples in my diary that illustrate the Company's response to the findings in my research and this is pleasing to be a part of.

The next three sub-sections deal with the collaboration meetings throughout the research cycles and enable the similarities and differences to be identified.

8.3.2 Cycle one

During this cycle I was quite new to the Company and was only just finding my feet as a Senior Software Engineer on a team of around eight people, plus managers. I was learning-in to the domain and picking up new technical skills during this cycle. At the same time I was learning about my research areas and settling into the doctorate. I was reading the knowledge management literature and trying to determine issues such as definitions and terminology.

The diary was an aspect that I shared with the main collaboration group. I was happy to show my vulnerability in thinking that the diary would be a waste of my time and how I had learned to use this as a good method for capturing information and reflection of what I felt and saw in my environment. I also read several excerpts (with names removed) to the group to show how this had been a useful tool for acknowledging why I felt a certain way in a specific scenario. Some of the group responded well to the discussion on diaries and others were more sceptical. In the initial months of meeting one member of the group was extremely negative and sceptical and I did not give much credibility to his input, however after twelve months I actually found myself starting to feel the same way as he had done and on reflection came to the conclusion that because some things are difficult to change in the Company I became frustrated. This had turned my thoughts to be more negative and sceptical that things might never change. I came to realise that to change some things in the Company, such as processes that have been in place for a long time, it is necessary to create networks of individuals who can see the benefit of that change and influence those that have the authority to change the process. This takes time and applicable information to make it happen.

I remember that I felt that I could not really stop people in the group from expressing their views, opinions and thoughts in case I missed out on something important. Sometimes this approach led to long discussions, which did not really add much value to my research. On occasion one or other of the group went off into a discussion that had very little to do with the issues being debated. Another reason that these meetings were longer than the later ones was that I was also finding out how to deal with and best manage this group of people I had never met before, and did not know or understand how to deal with. I also found it difficult to understand how I could adequately facilitate the meetings without strongly influencing the meeting directions towards my own goals rather than the needs of the Company. These meetings were also longer because we were all trying to find our way in them.

I felt that this process allowed all of the group members to participate in the collaborative decision-making, discussions and agreements. I always took the opportunity at the end of each meeting to ask the group if they were happy with the outcome and if they felt they had said everything they would have liked to say. In fact at the end of it all these meetings there was little response to making any such additional comments.

One of the collaboration groups was formed to assist in defining the value and direction of the current Process Group. This second group had set and defined goals that had been requested by the Senior Manager involved. I was asked to contribute mechanisms and methods for dealing with obtaining a list of issues and to consider how to deal with each of these. My role was more as a facilitator and to transfer my knowledge of analysis and issues than to lead the group as some sort of process expert, which I felt I was not qualified or directed to do. The group began in its early stages by looking at the current situation in order to assess it. In so doing we gained momentum in looking at the way in which the Process Group influenced the projects it worked with and how the rest of the business influenced it. In so doing we developed an influence diagram, which illustrated some problems with the way in which the Process Group interacted within the business and it became clear that the group should consider a new way of working. I remember the group being surprised as the diagram was built up illustrating the lines of real influence, which actually contradicted with the Company's designated lines of authority. This aspect was discussed at length in the group because there was such a marked difference between the two. People in the group realised, for instance that one key player in the influencing role was not even in the decision-making hierarchy yet was able to influence decisions in favour of his own group. These discussions led to much debate and at the time it made me think about how I would try to deal with this aspect in my own research later on. During the periods where I was gathering information about the Company and its processes in cycle one I was always careful to try to understand the official appointed position of individuals (e.g. Project Manager or Senior Programme Manager) but also aware that they may not be the key players in any decision-making. I also saw that there was a possibility of some of those involved in the research to influence others in the Company and that might be positive or negative.

Unfortunately the Company decided that the group was not producing enough valuable information and so the spending was stopped and the group disbanded. There may be many reasons for this closure but the investigation of these is beyond the scope of this thesis. When I reflected on the meetings I felt that there were a few issues that should be fed back to the Senior Manager that had been learned from this experience:

1. The group needed a set of clear objectives.
2. I felt that the information collated should be presented to the main process manager.
3. The group managed to produce a good set of information on the Process Group and its influences, which could be used by the Company to continue to look at the way this group is managed and can produce value for the Company and local projects.
4. I felt that the support was not really there for it whilst it existed. I feel that groups like this need be given an opportunity to exist for a while with feedback being provided on the progress and that they need support from the senior people in order to be successful.

8.3.2 Cycle two

In cycle two the main collaboration group continued to progress by examining the NVivo results from cycle one in order to firstly examine the types of information sources identified and to discuss the issues each one raised. We did this over several meetings as a workshop format whereby we created a list of issues and sources. These were written on post-it notes and placed on the walls to distinguish the engineer and manager differences. In some cases issues were read out from the NVivo report in order to clarify the context for the group. However, all transcripts remained confidential. We worked together as a group going through each information source and its related issues in order to look at identifying commonality. After each meeting I updated my own NVivo modelling to incorporate the clusters discovered. All of this work really reflected and evaluated the cycle one output in order to consider what we should choose to do next. During these meetings there were many discussions concerning the different views expressed by individuals in order to try to understand the perspective of the interviewee. As the group developed our own relationships I felt we were becoming more reflective just by participating together and having this time to dedicate to explore the information and results obtained. I watched the individual members grow in strength and understanding and in the latter stages several members of the group were cross-questioning views that were expressed in trying to understand why these were stated in the way they were, instead of just accepting them on face value as they had cone at the beginning of the group meetings. The use of this kind of forum was propagated into the local level projects by some of the members of my group in order to resolve project level issues.

After evaluating and reflecting on the previous cycle we then focused upon deciding what to do with the issue clusters we had now identified. Within these sessions we decided as a group that the area of e-mail overload, resource management and private venture knowledge transfer should be considered as candidates for the next phase. E-mail was considered important as the group agreed with the overload and disruption comments raised by the interviewees. Private venture was considered on the basis of the interview comments raised not only in this area but other generic comments where the PV work could be used as the example to try out these generic statements. Finally, resource management was selected as the group considered that this process had issues for all the members of the group as well as many issues raised in the interview data.

Within these three areas our focus was upon what we felt we wanted to know about each one and what research methods I should use to capture this information. Some of the group did not know what Likert scales were and how they were used so I gave a presentation on them. A member of the group later introduced these scales into the Company Intranet surveys. As we discussed the different methods for capturing data I realised that some of the comments raised by members of the group were important, for example some of my questions were phrased in a way to encourage a particular type of answer. I saw the validity of making my questions open to both positive and negative and therefore adjusted the descriptions appropriately.

I already had a clear idea that I wanted to have a shorter second research cycle after the massive data collection in cycle one, but I felt that I did not influence the group decision with this view. On the other hand the group were keen to get more quantifiable data in this cycle and this led to a discussion of questionnaire and survey techniques that could be utilised. Although the group felt that quantifiable data would be best there was some discussion as to the use of qualitative information and its use in conjunction with the former (Walcott, 1990). Once again I found myself explaining and teaching the group about the value and differences in the collection and output of the two types of mechanisms. Some time later several members of the group used this teaching to produce questionnaires for their business areas and projects to collect data, for example one member of staff used a Likert scale to get feedback from his staff on the way their project was managed (I was asked to validate and to give feedback on the content for him).

8.3.3 Cycle three

By the end of the collaboration meetings in cycle two both groups had formed extremely good relationships for example, the both groups began meeting socially to play football, trivia quizzes and go swimming. The group also saw friendships and several people went to lunch together after the meeting was over. I also saw that there was a sharing before and after the meeting between individuals where they shared information about their business area or project.

Our first objective was to reflect once more upon the results of the outputs in cycle two. I went back over the minutes of the previous three meetings to refresh the group on what we had discussed before we moved on. We decided that the results I had taken to the senior management on the private venture work were satisfactory and that there was very little scope for much further research in this area. In the e-mail results we felt that there was more that could be recorded in further research but that overall we had no better idea on the overload issue because of the nature of what was recorded in the survey. There was a lot of debate on the results and although initially we felt that they proved that the managers were overloaded it was later conceded that they might actually be dealing with the type of e-mail that related to their job. Therefore if these managers were dealing with issues directly related to their job these e-mails were not necessarily preventing them or interrupting them from doing their job. So we ended up agreeing that more work would need to be done in this area in order to get a proper view of the content of these e-mails and how they related to the job that the manager was doing. Because this is a collaboration group everyone was making some sort of contribution to the outcome.

We reviewed the resource management survey, which raised lots of issues and the debate revolved around appointing the right people with the right skills for specific roles within the Company. Several of the team said that their own experiences had been bad ones and that this process could be greatly improved. Some members of the group felt that they had some specific examples of the failure of the system from their own perspective, for example that roles were not clearly defined; the process allowed for errors; the individual's preferences were not captured anywhere; the skills were not matched to roles; the data was often out-of-date and the process was cumbersome and slow. I had also experienced a poor service through the resource management process when I needed staff with particular skills and was offered many without these. As a group we discussed different perspectives on the reasons why this may be the case.

Taking the results of the earlier survey to the resource management collaboration group provided me with the chance to see the groups reaction to the issues raised. Part of the group reacted quite defensively of their resource management process and felt that the problems were with the project managers and leaders who failed to update records and keep the process maintained. There were views that the Company failed to support that resource management process and did not mandate that staff used it and used it properly as they should. There was also some reaction to the issue raised that there were errors in the system and this was defended as an issue that was out of the groups hands since they relied upon the correct data form other sources which were not within their control. Some onus of the slowness of the process was also identified by the group as belonging to the managers using the system who take a long time to complete their parts of the process, although the group did accept some degree of responsibility for being slow at times.

With regard to the issue of undefined roles the group agreed this was an essential element that had not been dealt with adequately and needed to be resolved but the group acknowledged that they needed assistance from the project managers in doing this properly. The group also accepted that no individual preferences were recorded for the individual and that should be considered in the future. There were also some comments suggesting that the individual may not get what they want if a project needs someone with the skill-set they have and they are available to assist that project at the time.

In addition to discussing these issues the group raised a couple of other issues:

(1) They felt that the skills database had been a good idea but was poorly implemented and not particularly very useful to them because it was not used by the whole population and did not cover the skills for all of the posts available in the Company;

(2) There is currently no link of the skills database, skills required for a position and the individuals career aspirations and preferences;

(3) The group believed that there was a lot more information relating to an individual since they had joined the Company which was not all brought together when a position

becomes available e.g. the training that person may have had, any Belbin or questionnaire results recorded from internal courses, part-time courses studied by that individual that may not be sponsored through the Company;

(4) Often interviewers are not trained properly and therefore appoint the wrong member of staff

(5) There are no guidelines on any probationary period of employment so that if someone is not good at the role they take up their contract can be terminated.

In listening to the issues that the Resource Managers and Human resource personnel raised I was far more aware of the fact that the problems were not all really down to them and that other areas within the Company were equally responsible for some of the issues raised. As a Project Manager myself I can see why my input to the internal process is vital to achieving a proper resource management profile for the business. I had not really realised the full potential of my not completing some of the tasks I had previously regarded as monotonous and a 'waste of my time'. I resolved to attempt to keep my project personnel process up-to-date and with the correct data wherever possible. At this collaboration meeting I was given the opportunity to say how I felt about the service I felt was provided for me by the Resource and Human Resources Groups. I said that I often felt that the staff I received to work on my project were wrongly selected and did not meet my project needs, which often meant large training bills and often waits until the training was available before that person could be useful to my project. I was glad when this and several other points I raised were heard and discussed with the group as I felt they needed to hear these views and understand my position, just as much as I was learning about theirs. I found it a very good set of meetings where a lot of the sharing and discussion helped us to understand each other's point of view. Sometimes just being able to communicate helps us to understand. I was keen not to be negative but to explain how I felt and what I had assumed and open myself up to the group for some kind of session where we could talk freely. Part of my approach was to offer myself as a Project Manager seeking understanding and looking for ways to improve my own input and to assist the Resource and Human Resources groups in whatever way I could.

8.4 Reflection on Outcomes

The main outcomes from the research emanate from the interview data in cycle one; the surveys carried out in cycle two and the experiment and associated survey carried out in cycle three. In examining the interview data this was clustered into generic groupings in order to identify what could be examined further and why. The detail contained in these clusters is recorded in chapter five. Not all of the identified problems are examined in cycle two because of time-constraints.

By applying the action research method (Coghlan & Brannick, 2001) to my organisation I feel that I have transferred knowledge about action research methods to the Company through my collaboration groups who did not know anything about this before the group was formed. Secondly the group learned about knowledge management and contributed to our joint understanding of it through our groups. Thirdly, the groups gained understanding and knowledge about software intelligent agents. The groups also gained a better understanding of how the Company manages its data, information and knowledge as well as the weaknesses of the systems and tools that are in place within the Company. In early collaborative groups I found myself sharing the knowledge I had gained from reading the knowledge management literature. It was very obvious to me at this early stage that the individuals in the group had little idea of the concept of knowledge. The group did however have a reasonable idea of both information and knowledge. I spent some time in between group meetings reviewing questions I had been asked in order to identify problems and terms and definitions to help with our understanding. I say 'our' because at the time I had read some material but was learning myself.

Other knowledge that evolved out of the research includes the views of individual employees on political and social issues including the views of the Company culture. The group were also enlightened about other areas of the business, project demands, local and other organisational issues raised within this research. The group learned to work together and understand and respect the views of the rest of the group through the way in which the group discussed issues and ideas. It was good for me to be involved in the research and I learned a lot through the process too – I learned about myself, and my own views and attitudes and discovered new ways of dealing with the research through the interaction with the group. It was very good to know that several members of the group took ideas and things that they learned from this interactive group and used them elsewhere in the Company.

I also found myself using the same methods within my own project in order to try to resolve issues at a local project level e.g. getting my software engineering team to isolate problems and discuss ways of dealing with these through the group. As a result of my experiences I would like to develop a small case study based around one or two aspects of the research and use this to write a more practically oriented paper for publication into the academic domain. I think the things the groups and I have learned could be used in any domain, not just a large defence business but across organisations large or small through using action research as a tool for creating new knowledge and bringing information, understanding and people together. The process of action research that I used for this research was in fact a mechanism for knowledge creation and organisational learning (See Figure 8-2).

I have tried to capture the way in which I have seen the knowledge transfer and learning take place through the use of action research. The main differences between this and the traditional way in which the Company manages meetings is that the individuals have the opportunity to decline attending in the first place; that the individuals are able to say as much or as little as they like without recrimination as their input can be kept completely confidential; the individuals feel that they are making a contribution that is changing the Company around them; that the work undertaken by any group is seen to have an effect in the bigger organisation in some shape of form; that the individuals feel as though they are a part of the group decision-making process and can contribute to it; the groups have specific aims at the outset and although they are on a road of discovery they do have proper aims throughout; that the theory surrounding the problem is a part of the process and that there is regular reflection on what is happening in order to learn from the process.

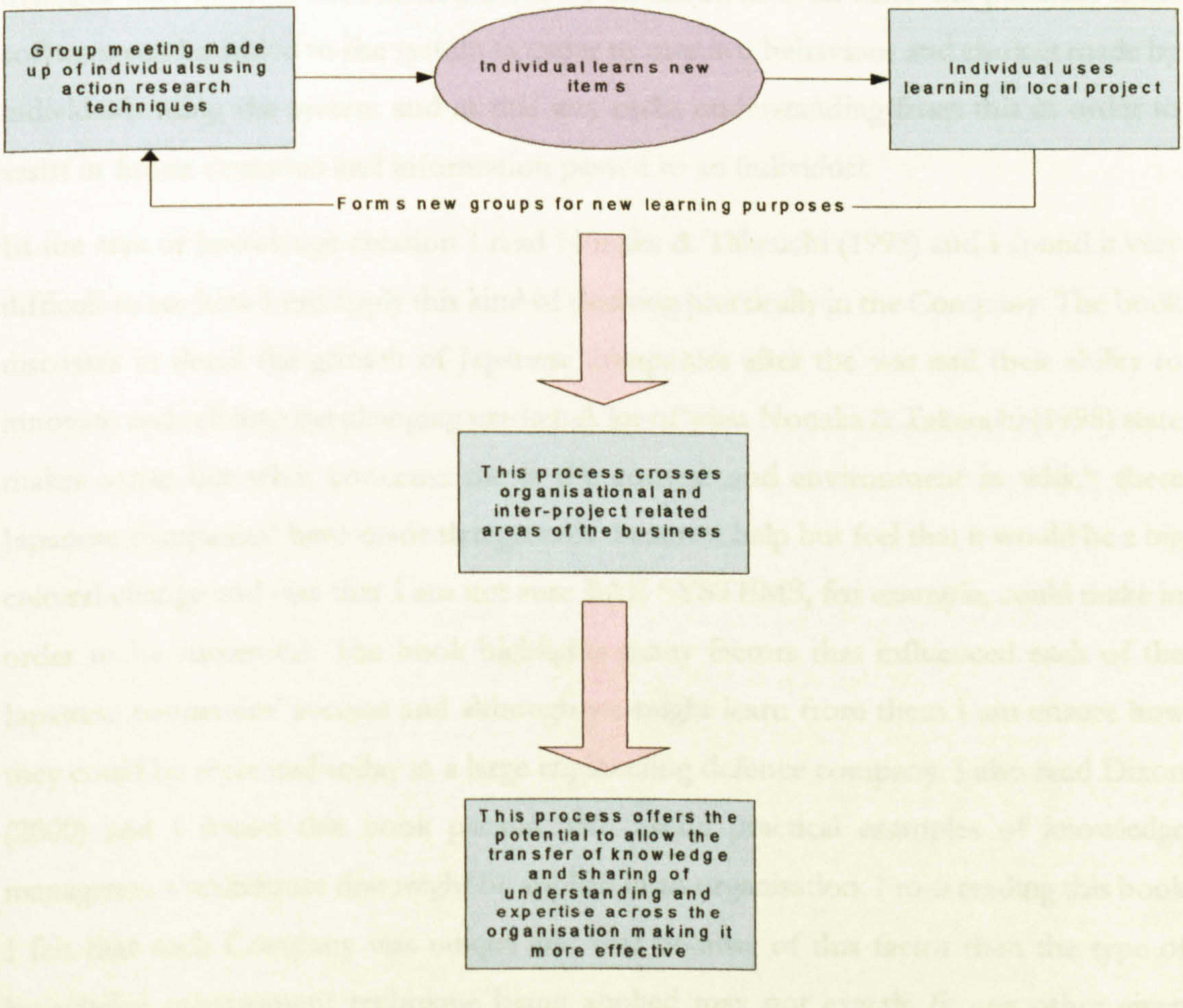


Figure 8-2: Action Research Learning Cycle

The knowledge management literature examined the specific area of tacit (Polanyi, 1973; 1966; 1969) and explicit (Dixon, 2000) knowledge in more detail and during the research I have decided to concentrate upon the latter. This was discussed with my main collaboration group who were in agreement. I felt that after reading the literature it would be better to deal with solving problems relating to explicit knowledge rather than the extremely difficult area of tacit knowledge which seems to be less well presented from a practical perspective in the literature I read. VacancyBot dealt with the gathering of information and in some cases pure data and interpreting this against a set of pre-determined criteria utilising software intelligent agents. In this way the knowledge is created through the inferences made based upon the criteria provided in the first place. Therefore if the weightings are set wrongly or the criteria are incorrect then the output from VacancyBot will be wrong. However, in the quasi-experiment I used both the main collaboration and the resource management groups to determine the calibration, quantification and criteria in order to have a reasonably good chance of providing an accurate response by the software agent system. But looking at this in a positive manner there is flexibility in the system and room for improvement of the software agent system in adding more learning ability based upon the selections made by a resource or project manager who receives the search results. As discussed in cycle three the personal agent software can be added to the system in order to monitor behaviour and choices made by individuals using the system and in this way make understanding from this in order to assist in future decisions and information passed to an individual.

In the area of knowledge creation I read Nonaka & Takeuchi (1995) and I found it very difficult to see how I can apply this kind of thinking practically in the Company. The book discusses in detail the growth of Japanese companies after the war and their ability to innovate and sell into the changing market. A lot of what Nonaka & Takeuchi (1995) state makes sense but what concerns me is the context and environment in which these Japanese companies' have made that growth. I cannot help but feel that it would be a big cultural change and one that I am not sure BAE SYSTEMS, for example, could make in order to be successful. The book highlights many factors that influenced each of the Japanese companies' success and although we might learn from them I am unsure how they could be recreated today in a large engineering defence company. I also read Dixon (2000) and I found this book packed with useful practical examples of knowledge management techniques that might be applied in an organisation. From reading this book I felt that each Company was unique and that because of this factor then the type of knowledge management technique being applied may not exactly fit any other given

Company. However, I did get a broad flavour of the kinds of mechanisms that may work in the Company.

I have already discussed how the use of action research has allowed the transfer of knowledge and some degree of organisational learning and the literature in this field (Argyris & Schon, 1996) helped me considerably in understanding the techniques and using them in practical ways within the Company (Coghlan & Brannick, 2001; Cope, 1998; Kemmis & McTaggart, 1988; Lewin, 1973; Dickens & Watkins, 1999)

8.5 Reflection on Personal Development

At the same time as the research work was going on I was developing my reflective diary, which included a lot of the detail of what I felt I was experiencing myself. As an internally focused actor within the Company I was not really in a neutral position because I was intervening in my environment. For example, when I reflected on my views I tried to test those views, I also tried to exchange ideas and interaction with others in the Company in order to see change taking place. In my diary I record my thoughts and feelings and some inferences I make about people, projects and issues within the Company. Some of these were tested where they related to themes within my research, others remain purely as inferences on my part and will not be discussed in this reflective chapter. Here I will illustrate a few pertinent examples where I tested my perceptions and views in the Company.

Some of my personal learning surrounded the following aspects of the research:

1. I found it difficult to decide what I could and could not say or do (e.g. I may have had authority as an employee to do something) from an ethical point of view when personnel discussed issues with me in connection with the research

2. It was also difficult (and sometimes important) to know whether individuals were speaking to me as a researcher or an employee and what their motivation for telling me some things actually were.

3. I was surprised by the reaction of the Company to some of the findings raised during the research e.g. to the spending return on investment of the Private Venture aspects of the Company or the failure to initiate a lessons learned process on the closure of Project X. Another key example was discovering the lines of influence in the process group, which was closed immediately on the grounds of failing to return value to the Company but was seen by the group, as being closed because we were discovering issues the Company did not want airing.

4. In raising the profile of issues raised from Project X to those in charge of Project Y I actually made it difficult to carry out my own role because I felt that senior managers were uncomfortable with my knowledge and experience. I had also raised so many issues relating to the control and problems within Project Y after a short analysis period, that there was negative feedback from senior management, as I believe they felt threatened.
5. I think I over-estimated my ability to be able to change a great deal through my research in the Company.
6. I found it hard to separate myself from my research in order to analyse the outcomes in an ordered and appropriate way. When the researcher is so close to the research then the aspects of what is real become the ones that are personally experienced by the researcher in that context.
7. It was also difficult for me to extract the pertinent data from such a very rich set collected throughout the research, for example, I found many areas where research could have been carried out to identify other important issues that may be looked at in far more detail e.g. the whole area of why the intranet system does not function so well, or why staff do not want to share their expertise.
8. My expectations for software agent technology usage in the Company were probably too high at the outset of the research after I had read the literature in this domain. In reality there is far more to creating a successful knowledge management system in the Company than purely software agents.

As the researcher in the research my initial thoughts surrounded what I experienced in the research. In this chapter I will concentrate on some example areas of my research where I felt that my own experiences were important to my research: the first looks at the area of roles and responsibilities and the second at getting information.

Example 1: Roles and Responsibilities

In the early period of my employment I found I was answerable to far too many managers (Figure 8-3) and this made me feel unsure and confused about who I should report to for which aspects of my role. This feeling of uneasiness made it difficult for me to be able to do the best job for the Company. This made it difficult when I was answerable to several bosses and they were all asking me to do different things and I was unclear as to exactly what was expected. I also found it difficult to get information e.g. what the project lines of responsibility were and this made it quite frustrating for me. In response to the situation I influenced the production of a project hierarchy chart and then communicated it to the other members of the team in case they were having the same issues as me. Later in the research I felt it was important to design role descriptions within the VacancyBot application so that the software agents would be able to match against a stable role and so that employees would be able to develop a career through the HR division based upon such roles.

On reflection I feel that I need structure and guidelines and clear responsibilities. These were lacking for me and others working on the site. I have realised that I prefer these types of guidelines and can see how the Company and the type of contracts it offers can be more effective and efficient with these boundaries. In my diary I record several examples where key personnel have not known their role and this has affected the outcome of the project concerned.

I have only been with the Company a short period of time and already I am finding it difficult to see the lines of authority in terms of managers involved in the project I am working on. I was given the initial task of writing a technical report under the Private Venture (PV) funding available within the Company. I have a team leader, a software development manager, a project manager, a resource manager and a PV manager. Depending upon what I am actually doing I report to different people. At the moment there is tension between two of these managers and the work I am trying to complete. I feel I need to rapidly discover who I report to for what, who I should be updating with my progress and who is supposed to be giving me the information and guidance I require to carry out my job. [5/10/98].

Figure 8-3: Diary Extract 05/10/98

In Figure 8-3 I record the tension that was taking place between two managers and based upon my own diary entries at the time and my recollections this was caused by the fact that they were fighting for their own areas of responsibility due to a lack of formal clarity of their roles. This was one example where I could see the real value of having a formal role and responsibility document to guide project members and to scope their authority over aspects of the project.

In Figure 8-4 I reflected on the lack of progress on the project and the failure of X to take responsibility for the work that I believe was his. Once again this may relate to the fact that X is unaware of his role and so has not taken up responsibility but delegated it. Alternatively he wrongly delegated it to the wrong members of staff. In this case I felt that by observing and also being a part of the research

I learned the importance of knowing the people within your project and understanding their strengths, weaknesses, expertise, skill and preferences. If managers understand their team members abilities they can delegate appropriate work to the right individuals and the project can successfully complete its deliveries. I used this knowledge in my role as a manager in the latter period of my time with the Company. I created an expertise group, which was made available to the whole project together with a mechanism for recording and measuring the successful use of that expertise.

It was quite clear that the team still has no project schedule and that X has spent months and months and months trying to create the Software Development Plan, which never seems to get finished. This has also made the team feel disillusioned. .....Whether they are right or wrong the team members feel this document should have taken far less time to create and they are very unhappy ....X is unaware of the team views and feelings and their lack of morale.... Yet the reality is he (X) has not noticed this at all for himself [28.10.99].

Figure 8-4: Diary Extract 28/10/99

I learned that there were several knock-on effects of X's action to delegate the creation of the software development plan: -

1. Many people trying to write one document gives varied views and styles which need to be managed and this was not done in Project X.

2. The engineers were aware of the procedure and that the document was a management document which caused resentment that the engineers should be writing it at all.

3. The engineers wanted to get on with their own tasks, which were more technical in nature and the reason that they were in the Company in the first place.

4. Whilst the engineers wrote the document they were unable to dedicate their time to their own role and tasks within the project.

Although I had some sympathy with the engineers views I also appreciated that if managers are short of time then they can quite easily ask for input from engineers especially where they have weaknesses in their knowledge. I do not feel that I have a problem with this point.

I feel the Company needs to know which individual employees are doing, what I perceive as the real work, and contribute using their skills and understanding, and encourage and nurture these people. I also feel that the Company will continue to have inefficiency and ineffectiveness of its staff and new projects are more likely to be just as unsuccessful. When I joined Project Y as a manager I did not follow the example I had encountered in

Project X as I felt that it would cause the same types of problems to my individual team members and I felt that the project would suffer, as did Project X.

I did try to help the Company to recognise this through my research and through my actions in following up the work on Project X with a lessons learned activity, which did reveal some issues for resolution from within the Company. No Lessons Learned activity had taken place at the closure of Project X and I felt it was my duty to ensure that this did happen so that the other projects on site could learn through our mistakes and successes. The lessons learned activity did eventually take place and at this point my engineering team raised their concerns over the project.. During my time on Project X I learned much about myself, my Project and the Company mostly through the use of the reflective diary. I do not think I would have learned as much without this approach because my records allowed me to review my feelings and thoughts at the time and reconsider my next actions as I learned.

In response to my experiences on Project X I made it my job in my next role in the Company to isolate the knowledge I felt was valuable within the project in order to utilise this. I set up a skills network across the project as a major initiative on joining the project. This was placed on the local Intranet project site and made available to the whole project.

Example 2: Obtaining information

In the early collaboration group meetings several of the group had suggested that the information within the Company was inaccessible and scattered across the various sites, such that it was difficult to know what existed and in what format. Others interviewed also identified areas such as poor information management, out-of-date information and problems associated with particular toolsets they used on a day-to-day basis. These issues were recorded as part of the minutes and I then held a brainstorming session to identify areas of potential interest. As we worked through the session we isolated the issue that employees of the Company could be more effective in their roles if they had the information that they needed, at the right time in order to do their jobs. This issue was the first one to be considered.

One of the key learning processes I adopted involved the sharing and communication of information and knowledge through my interaction with others within the Company. Sharing this information and knowledge is a key element of this research but often I came across individuals unwilling to share. According to Davenport et. al. (1998) knowledge hoarding is a human tendency and it is a symptom of the traditional engineering way of working and is unworkable in the new knowledge management economy as it can affect a company's effectiveness. But to prevent hoarding there has to be an irresistible incentive to share knowledge.

I also recorded a failure by the Company to provide me with the information I needed to carry out my new role with efficiency and professionalism. In most cases I felt I was left to get on with the job which in my case was not too bad because I feel that I personally manage to do the job required as I tend to go and find out information for myself quite adequately. However, I feel that this kind of management was an inefficient use of my time and resources and I could have been far more effective for the Company had all the issues raised been dealt with early on in the Project X program. If this had happened to less-determined individuals then it could have been far more detrimental to the Project X and ultimately to the Company's effectiveness and profitability.

As my initial role was to be tasked and to achieve deadlines for Project X I struggled with the lack of information regarding even the more simple issues such as finding document template materials for my task of creating a Speech Technology Report. One of the problems I encountered as a new member of staff was particularly: where to find information for carrying out my day to day work, for example, locating the time sheet entry system when I had eventually been told that I should have been filling one out weekly. The majority of the problems I had were in locating and understanding the work I was tasked to do. I was also surrounded by a lack of information relating to the organisational structure, where to find information on the Company Wide Web (CWW), and what procedures I should be adopting to do the task I was given to some degree of quality. In particular I felt inadequately informed (See Figure 8-5 and Figure 8-6). I soon got into the frame of mind of proactively seeking the information and doing the tasks needed.. However, I felt that I had a professional responsibility to raise these issues with someone and to try and help prevent this from happening to other new members of staff. I felt annoyed and frustrated with the attitude of staff that continually failed to share the information they had available. For example, in Project X my belief was that this was for purely selfish reasons on the behalf of the people involved based upon the set of facts I had at the time. My diary records my thoughts on why I believe this was done and the advantage that individuals gained for themselves in not sharing. It also made me think about the way the culture and social aspects of sharing highly influence the transfer of that information in the Company. My feelings were that I should share this kind of information with others and that I should not feel disappointed when others do not contribute as much as I do. In practice I found this harder to achieve and harder to control the way I felt about it personally. I made quite good attempts to identify the information needed in my projects and I feel that I did contribute to the sharing process, for example, I recall setting up a web site for technical expertise on Project Y thereby making my staff available to each other when they needed assistance with that technology.

LP on the other hand had had extra tuition from DERA on the AX product and on his return failed to disseminate that information to me. Secondly, LP had been developing the BTD software with the help of N and if he made notes or found problems with the implementation he failed to disclose any of this information to me although he had been asked to. [14/10/99]

Figure 8-5: Diary Extract 14/10/99

Having requested requirements from all five of my immediate bosses and getting no response I wrote my own requirements based on common sense, the original explanation and a few experienced guesses. I sent out the requirements I made to the five bosses requesting feedback if this was not what they required. Two bosses responded favourably and the rest did not bother. [18/10/99]

Figure 8-6: Diary Extract 18/10/99

In Figure 8-6 I recall that I wanted to establish what was required from the task I had been given. At the time I had no idea of why the mangers involved did not answer my requests. I think some were genuinely busy and my request may not have been at the top of their agenda. On reflection other managers were unlikely to know what was really required because they were managers without the technical knowledge in this particular case to scope the requirements. In any case my own feelings were those of frustration and anger because I wanted to know what was expected of me and no one seemed to be listening. I also felt that I wanted to prove that I could do a good job for my employees and it did not help that I felt I was blocked from progressing as quickly as I would have liked. I looked to resolve the situation through writing down what I thought was an appropriate set of requirements and then sought the backing or alteration from my managers. By doing this I had done the hard work for them and they could then see the scope of what I planned to achieve. From this I got two reasonable responses and that did encourage me to some degree and I had given the rest the opportunity to comment. I learned that it is sometimes easier to create this solution and then get feedback rather than ask the managers what they want. I think it enables them to focus on it and see what is missing and I think it enables them to go on and do other management tasks rather than come up with the ideas and technical aspects themselves. I did not mind operating this way and felt it gave me better responses (positive and negative) to my proposed solutions rather than be frustrated that the managers were not giving me any ideas. I used this method in other situations e.g. in setting up the new software technology group resource website on the Intranet.

A similar experience took place when I tried to get information for putting together a HCI process that could operate with a prime contractor, the Company and the MoD (including end-users and other representatives) in good relationships, there was nothing to be found. In one incident I tried to get information relating to official standards (Figure 8-7). I was disappointed at the lack of information, knowledge and even the ability to identify proper expertise within the Company. The resources in this area were scarce. I felt disappointment and general apathy as I had faced this problem in several other areas I had been working in the Company already. I felt that the Company really did not know where the information and expertise was and I found it time-consuming and tiring trying to locate it myself when I had imminent deadlines to meet. I used my learning from this time to develop expertise groups and technical Intranet pages as well as formulating mechanisms to understand my own staff expertise, ability and knowledge and this helped my teams considerably in finding the help, support and information they needed. The process I created was monitored for usage and people were given recognition for their efforts. This process was then used in other projects across the Company.

I could not believe the lack of information available from the Human Factors (HF) dept. in the Company. Although they work to MoD standards I thought that they might know about the commercial HCI standards since I understand the Company is looking to get further into the commercial as well as the military markets. Also from my own personal view I think it would be good to say to a military customer 'by the way we are providing this application to recognised commercial/international standards too'. This would give the customer extra satisfaction in what we are providing them. Also perhaps our competitors do not do this either and so we might have an extra string to our bow when bidding in the future. The HF Department had little information on the commercial HCI standards and most of the resources they did have were out-of-date. They did not even seem to have a decent selection of books or magazines on the latest HCI issues. [03/04/99]

Figure 8-7: Diary Extract Issue 03/04/99

Another thing I did was rectify the problem I had found in locating sources of material - Figure 8-8. I remember that I felt it was wrong to criticise the HF group but illustrate to them a solution that they might use themselves in the future. Although I was aware that they may not take me up on that.

I made a concerted effort to put together a HCI Report with appendices containing references to useful material I located myself. I then made this available to my own project and the HF group in order to transfer that information. I also made a list of suggested future enhancements, which could be undertaken if the Company thought it was of value to them. The details of the report were also advertised on the Company Intranet. [03/04/99].

Figure 8-8: Diary Extract Response 03/04/99

My final views include the fact that I learned a lot about the company and about the individuals I met on the project. I now feel better able to deal with these same issues should I encounter them in the future. I also feel that I still want to aim to avoid demonstrating some of the behaviour I encountered myself. I also want to recreate the team environment and openness that proved so successful on my own team. I felt that I learned a lot in my role and I tried very hard to encourage and help other new members of the team. I made all the information I gained available to anyone within the project and in other projects and groups outside of it in a proactive approach to sharing and collaborating. I also tried to encourage others to do the same.

From a project point of view the fact that the business always seems to promote the competitive edge and the performance value (Johannessen, et. al. 1999) rather than a balance between those values, means that the Company culture fails to take much account of the capabilities of individuals and teams of individuals working together, which in itself can produce high returns. In the case of the Project Y my teams were split into a 'them and us' culture of those based in Cowes and those based in Christchurch. The cultural views, the methods of working and even the processes used for producing software for the two distinct groups were very different. However, within a few weeks of joining the project I recognised the divide and made the decision to get involved and to try and create a culture which allowed an understanding of both groups and a view of the capabilities of individuals rather than the perceived view of that individual. I realised through interaction with my staff that they had misguided views of their colleagues on the opposite site. By my recognition of this and a second key discrepancy within the project I was able to create a new group meeting involving both sites' team leaders in resolving that problem. I also discovered a second problem that involved discrepancies in the team level plans, which had been developed in a certain amount of isolation. These plans had expected in-feed deliveries into them from colleagues' teams, however these had not been agreed and, because the teams were not co-ordinated, these deliveries were not viable in most cases.

Therefore I brought the teams within project together to deal with this. In so doing I wanted to promote an awareness of the capabilities and technical abilities of the team leaders across the divide instead of the pre-conceived views, which they had when I first joined the project. This meeting of co-ordination rapidly moved from a monthly to a fortnightly event and I incorporated a social time after the meeting during which the team leaders got to know each other better. Building on this process I found the group cohesive and united in the belief in getting the Project Y delivered effectively. This also had a knock-on effect into other areas within the project as people within the co-ordination meeting spread the positive feedback to colleagues on both sites.

Another issue I raised early on in the co-ordination meeting was the fact that all the teams were not working towards one goal or a delivery into the other milestones at the next level up. The whole area of software deliveries and integration were re-addressed and the holes in the plans sorted out through a general cohesion within the group. I then reflected in the higher-level milestones and their inter-relationship because I recognised that the same issues affected these as it did at the lower team leader planning level. It took over seven months for me to build stronger relationships between the sites around this inter-team co-ordination issue. However, the results were positive in that my teams were all very positive at a Capability Maturity Model review about how they wanted the project to succeed and how they wanted to work together in achieving that.

My time with Project Y revealed that the same types of problems exist on several projects in the Company. When reflecting on the project and my experience on Project Y I raised several points that needed to be addressed, including some I tried to address whilst on the project.

In my role as a Development Manager I tried to reflect on my views as an engineer in order to guide me on what my engineering teams expected from me. From this point of view I feel quite confident that I achieved a reasonably good result. I also found that exactly the same issues I discovered on my previous projects existed on this one too e.g. poor communication, lack of strong leadership control, appointing the wrong members of staff into inappropriate positions within the project, failure to co-ordinate and organise the essential elements of the project and an over-emphasis on process (sometimes for process sake). In response to these issues I believe I did the best I could with the issues within my immediate control and those that were out of my control were communicated to the appropriate members of staff to deal with. I do not believe I would have done as good a job in my role as a development manager if I had not learned through all my previous experiences within the Company even though some of the lessons were hard at the time.

I gained a significant amount of learning about through my research environment. I now see how I can make connections between what I saw happening and my perception of myself through the process of reflective learning. The learning and insights I have gained have also been passed on to other employees within the Company. These members of staff have taken the diary as a mechanism for trying to capture their own decision-making and the impact and insight in to those decisions.

I learned a great deal through my diary writing and this chapter has only captured a small element of insights. I think this is a good learning technique and I think other students could gain more from it if the DBA allowed the sharing of student diaries to improve the ways of writing or recording in them and provide them with examples. In my experience I would recommend the use of reflective diaries because of the integrated reflection during the research and the valuable historical resource they provide when re-visiting issues and experiences for later reflection, debriefing, evaluation and research. Some of the greatest and most influential works in history were based upon written diaries or journals, for example, where would we be without the valuable journals of people such as Charles Darwin, Anne Frank, etc?

8.6 Summary

In looking at this reflection I believe that I have contributed to changes within the Company, through my individual contributions, through my research and through the collaboration forums over the last three years. The research itself and the methods and mechanisms used have shared knowledge which has been used more widely than purely within the scope of the research. The research outcome has in my view been a success and has produced a software agent demonstrator that has been evaluated and shown to add value to the Company within the resource management process and beyond that into other areas of the business. There has been a regular incorporation of the theory into the practice from the domains of action research, methodological approaches, usability and interface design, knowledge management and software agent technology.

WORKING TOGETHER FOR EFFECTIVENESS

9.1 Introduction

The purpose of this chapter is to summarise the research conclusions. This research assesses the appropriateness of software agents for knowledge management tasks in the defence engineering industry and was carried out over an extensive period within BAE SYSTEMS, Christchurch (UK). This entailed evaluating the information acquired through the data capture process and identifying the area of the Company's resource management as a suitable problem domain.

9.2 Contribution to knowledge

There is no one universal theory of knowledge management that applies to all organisations. Every organisation is so unique and individualistic, as well as complex, that the successful application of key knowledge management principles can only act as an aid to implementation. For example, the successful application of the theories of knowledge management is influenced by the organisational environment, culture and management stances of the company. Equally the right cultural climate and the receptiveness of the organisation to adopt these knowledge management principles are required. Additions to new knowledge in this research in the field of knowledge management are extremely specific to the specific case organisation and the environment where the research has been carried out and as such are not of themselves generically applicable. Section 7.1 deals with the findings made during this thesis and then continues by discussing in-depth the literature in relationship to those findings.

9.2.1 A Company that does not know what it knows?

It was determined early in this research that BAE SYSTEMS Ltd was situated in what the knowledge management literature describes as the cognitivist organisation model (Von Krogh et. al. 2000). As such, the literature suggests that the Company would not only have an infrastructure of technology, but that data and information collected by the organisation would be useful and applicable to the projects and human resources within the Company. The cognitivist approach also suggests that the organisation would have the ability to share the right knowledge (in the form of information and data) openly across the organisation. However, this research has revealed that the common, and anecdotal, statement that 'the Company does not know what it knows' (Davenport & Prusak, 2000[4])

[4] See also: http://thestrategyworks.com/articles/knowledge1.htm
and http://xephon.com/freepdfs/ii.iss.0.980500.p.l.pdf

is true for BAE SYSTEMS Ltd, Christchurch. This research shows that, far from storing relevant and applicable information or data, in many cases this has not occurred and in other cases the information is out-of-date, not openly available, and often incorrect.

9.2.2 Technology can be counter-productive

Although technology has been put in place to collect, retrieve or distribute information the majority of it is either unused or fails to give the user community the information it seeks. The technology used is counter-productive to managing the Company knowledge as revealed through the interviews in cycle one of this thesis. The Company fails to use its expertise. The full list of issues is revealed in detail at the end of cycle one (chapter four). Further research of the issues highlighted in this domain may prove useful to the Company in the future when looking at any redevelopment of knowledge management systems.

9.2.3 Context does not imply performance

A reasonable expectation at the outset of this research was that BAE SYSTEMS Ltd. would be effective in its knowledge management because of its need to track the defence sector; the need to develop reliable highly important defence equipment and services for the military as well as the desire to retain staff through extensively long projects that may deliver over a 20-30 year period. I think I expected that this defence Company would value the importance of knowledge due to the serious nature of its business. But throughout this research I realised that this was not the case and that far from being an effective and dynamic knowledge-based Company it appears to be a Company that needs to be made aware of the consequences of its decisions and its future if it does not change. There is little identifiable literature in the domain of knowledge management in the defence domain and this is an area where the specific attributes of this industry could be investigated further or compared with that available in a commercial domain in order to assist defence companies with knowledge management techniques.

9.2.4 Intelligent agents are very useful in knowledge management

Another aspect that adds to knowledge is the demonstration of the applicability of software intelligent agent systems in this domain for management purposes, e.g. the functional provision and management of personnel. The theories together with the people, techniques and tools combine to make the organisation successful in knowledge management. This research illustrates the ability of software agents to be utilised to enable the organisation to access and deliver more of its knowledge but it is also dependent upon the complexity of the organisation. All knowledge management theories have elements of the social, process and technology arenas that influence the practical success this is why one theory does not fit all. BAE SYSTEMS is no exception since the entirety of the complex organisation needs to be considered in the design of a bespoke knowledge management solution using both theory and practice.

There are numerous sources of literature concerning the development of software agents (Belgrave, 1996; Franklin & Graesser, 1966; Genesereth & Ketchpel, 1994) and some which examine their usefulness for information management. None of the literature read during this thesis address the issue of the practical application and testing of such an application in a defence organisation seeking to implement agents for knowledge management (Bigus & Bigus, 1998; Bradshaw, 1997). Neither are there any extensive guidelines or rules for developing a knowledge management system using agents, which has proven to produce a successful system that could be reused in a Company such as BAE SYSTEMS Ltd (Coen, 1994b; Haddidi, 1994). In the majority of the literature there is a great deal of theorising and potential future usage of software agent technology but very little that has been developed and tested with outcomes (Belgrave, 1996; Ferguson, 1992; Bradshaw, 1997; Chang & Lange, 1996; Brustoloni, 1991; Brenner et al., 1998; Finin et al., 1994; Jennings & Wooldridge, 1997). This practical application of software agents has therefore advanced the starting point for any future research in this domain and has provided detailed information concerning the application, development and the measuring of the successfulness to this particular example in context. The future potential of these agents and the furtherance of research areas for the applicability of them was covered in detail in chapter six (See section 6.11)

9.2.5. There are key characteristics for usability for interface development of KM solutions

A key aspect addressed by this research is the usability of any such software agent package in order to ensure that there is validation of the underlying agents, which are utilised via an interface (Nielsen, 1993; Galitz, 1997; Microsoft, 1995). This thesis has provided new theoretical guidance for developing and measuring the successfulness of interface development (see chapter six (See section 6.10), for example

- The use of usability factors to measure end-user opinions of the applicability and suitability for an interface design
- The combination of human factors and international standards with a set of pre-defined usability factors to achieve adequate measurements of the interface
- The use of continuous end-user feedback and involvement in the process from analysis to development and testing.

- The development of a process for the interface development that has been repeated and proven successful elsewhere in BAE SYSTEMS Ltd after the thesis was completed.

The research has also provided a practical example that will assist other researchers and other organisations examining this technology as well as contributing to the managerial professional practice

9.3 Contribution to Practice

As a professional manager in the defence domain I have learned a great deal myself in the research I have undertaken (discussed in chapter eight) however, there is much that can be passed on to other professional managers. In the aspects of utilising and developing software intelligent agents, for example, other managers can learn by the successes and the failures recorded in this thesis. There are also guidelines for the development of interfaces, interface development techniques and usability criteria to measure the success of the development of any application with a user front-end. This research also provides and insight into the types of commercially available software agent products. This research offers strategic insight in the realm of resource management for other managers wanting to automate or improve their process as well as factors for consideration when developing a process from scratch.

9.4 The issues

The initial difficulties arose in assisting the Company in understanding the research methods and the potential added value. In the early part of the research this was achieved by illustrating the progress being made in the collaboration groups and the changes being effected by these within the Company. This was followed by research reports indicating issues and raising potential solutions, which were disseminated to the relevant groups or individuals within the Company.

The main areas providing input from the Company include cycle one that provided interview data from thirty representative employees in the Company. These were never passed over to the Company in order to retain the confidentiality since it may have been possible to identify the individual through the information they provided. Instead a set of clusters of information issues were collated through the collaboration groups which were passed to the senior manager backing this research. Cycle two provided three sets of research data containing both qualitative and quantitative information and conclusions of this research. The details were passed on to appropriate members of the senior management in a position to decide what could be done about the results for the future.

Some of the results produced a change in the processes or procedures in the Company at the time. Cycle three examined the implementation of a software agent application called VacancyBot that was used to improve the resource management process in operation within the Company. The results were used to draw conclusions about the improvements made and include the successful deployment of software agents; more effective selections of candidates based upon skills and competencies; more efficient conduct of several elements of the resource management process; an evaluation of the software agents; and an evaluation of the interface usability. Other conclusions relate to the appropriateness of VacancyBot and software agents to the Company in general, as well as the application of software agents to the rest of the business.

There were many issues raised by the analysis of the resource management process (in cycle two) including

(1) A need for a system that helps in time critical, accurate, and consistent decision-making in relation to resourcing projects

(2) Resource managers must deal with far more skill diversity than ever before

(3) Access to the right data, knowledge, and expertise at the right time is necessary to effectively carry out project tasks

(4) Tools are required which aid in the integration and interpretation of data hence making it more useful

(5) Significant savings could be realised through reduction in time-consuming tasks, replicated information

(6) There is a need to facilitate appointing the most appropriate member of staff to their appropriate position within the Company in an effective manner.

A key outcome from this research illustrates the fact that the Company has a significantly large amount of widely distributed, multi-formatted information and data. Employees noted that in many cases they were often hindered in accessing the information they needed because it was symptomatically out-of-date, difficult to locate, unavailable, used complex communication protocols, involved challenging procedures or multiple IDs and security passwords, was dependent upon others, with high levels of inconvenience. Turning this information into usable knowledge and appropriate formats is part of the work that software agents can do for the users. The term "knowledge" implies acquiring information, transforming it for its intended audience, and delivering it in some appropriate manner.

Another key element identified by this research is the fact that the majority of the information is accessed through an application interface. Most of the interfaces discussed by the employees (in the cycle one interviews) identified significant issues in the lack of usability of these interviews. As such this aspect of the research was given a high priority since if the usability of the interface gave the end users a problem then the agent technology might not be accurately investigated. In response to this challenge this research relies upon the International and commercial standards for interface development in order to produce a more appropriate interface for the VacancyBot application. The usability of the interface is measured and tested against the standards in the form of a questionnaire in cycle three. VacancyBot through this quasi-experiment has shown that many of these issues have been addressed in order to make the resource management process and the resource managers themselves more effective and efficient.

However, there is one issue that must remain clear at the end of this experiment and that is that agent software can only provide an accurate view of the data and information it has access to. If the data is not originally entered into the system then the agent cannot invent it, however it may make inferences based on an historical view. I have always maintained throughout this thesis that software agents are enablers of knowledge management and that they are not a silver bullet for incorporating knowledge management into the Company. Software agents cannot deal with the social factors that influence the decision-making, which is one reason that I do not believe agents will take away all roles within the Company in the future. Agents cannot deal with the political and cultural issues that exist in organisations either. But these and similar social aspects allow personnel to interact with agents in order to provide a solution and this also encourages users to see the value of their own input into such an application.

One of the main goals in this research has been to improve the effectiveness of the Company through the application of a software agent application. This effectiveness resides in the issue of task competency, in that VacancyBot was able to carry out assigned tasks on behalf of the user and the results show that this is fulfilled. This allocation of part of the recruitment process thus enables staff to devote time and energy to achieving other tasks without being required to divert their attention to administrative, decision-making and skills-matching tasks for the recruitment process. The agents have also allowed for role clarity and skills based on matching individual skills to the assigned tasks and the opportunity to build new competencies. VacancyBot will also allow the resource manager the freedom to pursue his job as he sees fit knowing that the application is dealing with particular aspects of his role. Agents provide the resource manager with the tools to do the job effectively too. VacancyBot also gives access to information and knowledge that is relevant to the job or specialisation being provisioned. There is a knowledge exchange between the agent and the user of the system and a genuine transmission of information up, down and sideways in the organisation.

Software agent technology has recently reached the stage of development whereby natural language is an input to the application so those individuals can receive meaningful replies to a wide range of factual questions. This means that for applications like VacancyBot a speech interface could be developed to enable searches to be made via mobile telephone, for example, in order to locate information, contact experts or get copies of the Company's latest slide show presentation sent out by e-mail to them (Devlin & Scott, 2001).

The speed of development of technology for collecting and disseminating information and making it available electronically is currently increasing through the latest wireless devices. Together with an upward increase in the power of computers and the ability to store vastly greater amounts of information this means that companies today are in need of new generation information systems which filter, monitor as well as collate and categorise that information. Software agents provide mechanisms to do this work and to add meaningful interpretation and understanding to that information on behalf of an individual, group or organisation. Software agents provide mechanisms for knowledge storing and systems that will allow the sharing of particular elements of that knowledge with partners, suppliers and customers or any other stakeholder.

The use of an agent system could also be built into an expert system. Since the VacancyBot application deals with assigning the right individuals to the right job successfully, enhancements could be made to add the agents to an expert system. I would envisage that the expert system be created in order to retain knowledge within the Company boundaries and secondly to enable this expertise to aid the selection, career movement and promotion of an individual. By allowing the agents to trawl the expert system as well as their other sources they can assimilate this information and infer whether an individual has the expertise for specific tasks within the business when expertise is required. The expert system would have a different function in that it would be the basis for retaining knowledge that can be shared across the business rather than lose it when the employees leave the Company. The Company would use the knowledge more effectively if shared in this manner. Those sharing their expertise would gain recognition and should be rewarded for their contribution.

Software agents have the potential to assist users in solving problems where information is incomplete or unclear or in searching large amounts of data. They can significantly increase performance and productivity of many repetitive tasks and help in handling information overload (e.g. they can summarise and interpret information) providing employees with the right information at the right time.

In today's world companies often need to make real-time decisions on many aspects of their business world, since information is very fluid and can move in and out of the Company very quickly. Organisations may also have difficulty in retaining their key personnel - the people capital – who can easily look at alternative jobs on the Internet and have interviews by telephone. It is also difficult for companies to know what type of expertise they need in the future and how to acquire these resources.

Another issue related to knowledge or information management is the fact that if companies begin to make it easier to transfer knowledge internally and if the personnel become accustomed to sharing that knowledge because of the change in the company environment or culture, then does this mean that transfer of that knowledge externally will then result? If this is the case then companies need to look at protecting their knowledge more proactively. This would present a particular problem with the secure defence projects with which BAE SYSTEMS deals.

In order to create a knowledge management application like VacancyBot I learned that it is extremely important to design and analyse thoroughly before implementation. I felt I needed to understand the end-user community and stakeholder views for example, how they think and work, what is important to them and what they expect from the system.

9.5 Summary

Software agent technology can offer the Company a great deal of potential improvements in both the resource management domain and on an organisational level. Software agents are pervasive, pro-active and if programmed properly can be simple and unobtrusive for employees with minimal human interaction if preferred. Using techniques from the artificial intelligence domain these software agents can learn from the past history and using rule-based algorithms can assist employees with their work. However, it is also important to note that these agents can only work with the information they have and the correct rule-based design and they cannot deal with the social, political, psychological and cultural aspects of the information they work with.

GLOSSARY AND ACRONYMS

AI	Artificial Intelligence
AMS	Alenia Marconi Systems
CARS	Combat and Radar Systems division of the Company
CDI	Communications and Defence Infrastructure division of the Company
CV	Curriculum vitae
CWW	Company Wide Web
DERA	Defence environmental research agency
EPF	Electronic Project File
HF	Human factors, the element of the Company dealing with interface design and ergono
HR	Human Resources
HTML	Hyper Text Markup Language
IPR	Intellectual Property Rights
JAD	Joint Application Development
PDR	Personal Development Review
PDP	Personal Development Plan
PV	Private venture – funding used for future innovation
QUEST	Application to validate and verify potential orders for the Company
RAD	Rapid Application Development
RDD-100	A requirements management tool used by the Company
RPM	Resource Planning Module
SAP	This is one of the Company database tool

SQL	Structured Query Language
SPSS	This is a statistical analysis tool
TES	Timesheet Entry System
VU	Virtual University
WWW	World Wide Web

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APPENDICES

Appendix A: History of BAE SYSTEMS Tables

Date	Events/Changes taking Place which affect BAE SYSTEMS
Pre-1990	(1970's) British Aerospace (BAe) formed as a nationalised corporation by the merger of British Aircraft Corporation, Hawker Siddeley Aviation, Hawker Siddeley Dynamics and Scottish Aviation. (1980's) British Aerospace formed as a public limited company (PLC), acquiring the assets and business of the nationalised corporation. UK Government sold 51.57% of its shares to public. Foreign shareholding initially limited to 15%. (Later rose to 29.5%). Sperry Gyroscope acquired (£42 million). 1982 - Sowerby Research Centre established at Filton, Bristol as BAe's scientific research organisation. 1987 - Royal Ordnance plc acquired (£190 million), Steinheil Optronik GmbH acquired (£17 million), Ballast Nedam Group acquired (£47 million). British Aerospace plc became HQ management organisation controlling wholly-owned subsidiaries, each marketing its own specialised products under its own name British Aerospace diversification – buying into all sorts of businesses most of which are unrelated to the defence industry – through a wave of strategic change emanating from the USA – particularly Harvard Business School and names like McKinsey and Professor Tom Peters.
1990	Bishopsgate Systems Ltd acquired for £6 million, Microtel Communications Ltd formed. Honda acquired 20% interest in Rover Group Ltd in exchange for a 20% reciprocal holding by Rover in Honda of the UK Manufacturing Limited. Ballast Nedam Construction formed and acquired major parts of the business of Rush and Tompkins. British Aerospace (Liverpool Airport) Ltd formed and acquired 76% shareholding in Liverpool Airport plc. 49% interest acquired in Kelsey Instruments Ltd. 51% shareholding acquired in Satellite Management International Ltd.
1991	Heckler & Koch GmbH, the German small arms, machine tool and general engineering company, acquired. London Business Aviation Limited formed. Euroflag formed in Rome as a European joint venture company to design, develop and build a new medium lift military transport aircraft. BAeSEMA Ltd formed as a joint venture company with the Sema Group. Sales of Rover fell by 20%. Government defence spending came under scrutiny BAe losses in commercial aerospace division increased BAe went to the City to borrow £430 million from a rights issue BAe share prices fall on the stock market
1992	British Aerospace Defence Limited began trading as a wholly owned subsidiary of BAe on 1st January 1992. The three previously separate defence companies: British Aerospace (Military Aircraft) Ltd, British Aerospace (Dynamics) Ltd and Royal Ordnance plc, plus Systems and Services Division now operate as divisions of British Aerospace Defence Ltd. BAe biggest asset write-off in UK corporate industry – £1 billion, mostly through restructuring Regional Aircraft

Date	Events/Changes taking Place which affect BAE SYSTEMS
	BAe share prices at an all time low £0.97 BAe takeover seemed likely from GEC and gained a lot of press. Major cut backs in BAe through downsizing take place across most sites (reducing the work force by 60,000) Recession hit BAe and the Cold War implied long-term pain for the business in all sectors
1993	British Aerospace (Dynamics) and GEC-Marconi form a joint venture company, UKAMS Limited, to manage and develop their involvement in the naval Principal Anti-Air Missile System (PAAMS) guided weapons project. Sale agreed of Ballast Nedam BV to a consortium of Hochtief AG, Internationale Nederlanden Group and the Ballast Nedam Pension Fund; Rover Group to BMW AG. British Aerospace signs agreement with CSC for the provision of IT services. Sale agreed of 80% of Spectrum Technologies Limited. British Aerospace plc retains 20%. BAe long term strategy in aerospace and defence industry alone BAe removal of past diversification company acquisitions such as corporate jets, construction, property and strategy business. BAe arms contract with Saudi Arabia (multi-billion sale)
1994	BAe final sale of Rover Group Mergers of US based Defence industry (e.g. general Dynamics, Rockwell, Lockheed, McDonnell Douglas, Martin Marrietta, Northrop, Grumman and Loral) creating more powerful rivals. BAe first profit in 3 years and the share price is on its way up.
1995	Portfolio of retail, commercial and leisure properties sold for £107m British Aerospace announces the sale of its 50% shareholding in The Burwood House Group plc to ASDA Group plc. BAe internal opinion survey – revealed four fifths of the workforce perceived leadership, quality, communication, opportunity and satisfying our shareholders in a negative light. Proof that something needed to change BAe shares continue to rise. BAe order book continues to grow
1996	British Aerospace plc announces the acquisition of AWADI, an Australian defence company, for A$50 million BAe win £3 billion Nimrod maritime patrol aircraft contract (creating job opportunities etc.) Boeing takeover McDonnell Douglas and establish it as a co-leader alongside Lockheed
1997	British Aerospace acquires 49% of STN Atlas Elektronik GmbH, the German based systems integration business for approximately £90 million. Matra BAe Dynamics agrees acquisition of a 30% interest in German guided weapons business LFK, a subsidiary of Daimler Benz Aerospace. British Aerospace signs agreement to acquire Siemens Plessey Systems (UK) and Siemens Plessey Electronics

Date	Events/Changes taking Place which affect BAE SYSTEMS
	Systems (Australia) for approximately £319 million subsequent to regulatory approval. British Aerospace forms new business unit British Aerospace Defence Systems from 50% shareholding in BAeSEMA, 49% shareholding in STN Atlas and other company defence systems activities, including Siemens Plessey Systems subject to completion.
1998	British Aerospace disposes of its 26.1% interest in Orion Network Systems Inc for $143 million in cash. British Aerospace reduces its shareholding in Orange plc with the disposal of shares representing 16.11% in Orange plc for £763.8 million. British Aerospace retains a 5% interest in Orange. BAe reproduce 1995 opinion survey and the results show improvements in 75% of the questions answered negatively in the earlier survey. BAe turnover just under £9 billion BAe order book£28 billion BAe Acquisition of 100% of Siemens Plessey British Aerospace announces sale of Arlington Securities, its property development subsidiary British Aerospace agrees the acquisition of a 35% interest in Saab AB, the Swedish aerospace and defence company, for £269 million subject to regulatory approvals. British Aerospace founds its Virtual University. The Virtual University will link education, training and development for the British Aerospace workforce with the acquisition of new technologies and strategic research.
1999	BAe becomes BAE SYSTEMS once merged with Marconi Defence Systems BAe Acquisition of 49% of STN Atlas (Germany) BAe Acquisition of 100% of AWADI (Australia) BAe Acquisition of 20% of Advanced Technologies and Engineering (South Africa) BAe Acquisition of 35% of SAAB AB (Sweden) BAe Acquisition of 100% of Reflectione (US) BAe Acquisition of 100% of Australia Aviation College (Australia)

Date	Events/Changes taking Place which affect BAE SYSTEMS
2000	Thompson CSF Merge with Racal (competitors) Defence Research Agency moving into commercial development for defence industry (compete with BAE SYSTEMS). Finmeccanica joins forces with EADS (competitor partnering) BAE SYSTEMS buys 100% of Lockheed Sanders. BAE SYSTEMS partnering with Boeing on some major contracts Pressure from Boeing to get BAE SYSTEMS to join them in the 747X development rather than the Airbus A3XX. But UK Government pressure for European alliance – outcome is still to be had. Boeing believe there will be no market demand for A3XX size aircraft but smaller point to point. Boeing also feel Airbus will run at a massive loss and that Boeings 747X would be cheaper to make than Airbus's A3XX. Possibility of BAE SYSTEMS and Boeing making a joint bid for the UK air traffic control system. BAE SYSTEMS Ltd discussing and developing a merger with Alenia Marconi Systems and the Combat and Radar Systems element of BAE SYSTEMS Ltd. BAE SYSTEMS valued at around £12 billion (Boeing valued at around £23 billion).
2001	Merger of part of BAE SYSTEMS with Alenia Marconi Systems forming Combat and Radar Systems division within BAE SYSTEMS

Table A-1: Historical Business Events Affecting BAE SYSTEMS

Appendix B: Recruitment Survey

1. Introduction

This web-based research survey has been developed in order to investigate the issues raised in response to the interviews carried out as part of my Doctoral studies at BAE SYSTEMS Ltd. The interview data in specific cases gave strong indications that the BAE SYSTEMS Ltd recruitment process was inefficient in places. The interviews also suggested that resource managers and staff mangers often had difficulty in identifying the right employee for the right position within the Company. This survey sets out to examine the whole recruitment process and what factors, for example, are used to determine the suitability of applicants to specific roles. This survey sets out to explore these views in more detail and particularly concentrates on the quantitative measurement of data using a Likert scale.

This report describes the method used to collect data. It also analyses the results of the survey. Conclusions are then recorded. Finally, an evaluation and future enhancement of the survey are considered to complete this research.

1.1 Method

This survey consisted of two sections. The first section recorded data such as the name, job title, grade and specific site as well as the candidate's involvement in the recruitment process. This is illustrated in Figure 1.1. The rest of this section contain Likert scaled responses to various criteria identified prior to the survey as being a part of the process in some form. The scaled questions were divided into the following categories: -

Technical Factors – These factors consist of applicants' experience, academic ability and past record e.g. personal development Plans and Staff Dialogue records if they are an internal candidate or curriculum vitae, educational qualifications for external and internal candidates. There are 10 areas identified within this group – see Figure 1.2.

Company Factors – These factors consist of the applicants' Company experience or project and domain experience within the Company. They also examine the Company values; the applicants' knowledge of the internal workings of the Company. The majority of these factors will only apply to an internal candidate seeking to move within the Company. There are 10 areas identified within this group – see Figure 1.3.

Skill Factors – These factors examine the applicants desire for a new position, their determination and enthusiasm. They also look at issues like personality and how they present themselves. There are 7 factors identified in this category – see Figure 1.4.

Social Factors – These factors consist of the more extra curricular or less common aspects of the categories e.g. personal circumstances or personal recommendation. There are 11 factors identified within this group – see Figure 1.5.

Each of the categories listed above were judged by the candidates on a Likert scale that allows the user to select a choice from a range of options. This range is then used to apply a number weighting in order to calculate the statistical analysis of the results. The scaling is made up of a range as follows:

Not Important	This scale rating means that the factor being marked is of no importance to the marker in their opinion.
Mildly Significant	This scale rating means that the factor being marked is of some significance but certainly not a major factor.
Significant	This scale rating means that the factor being judged is of significant value to the marker but not very significant or essential.
Very Significant	This scale rating means that the factor being judged is of very significant value to the marker but not essential.
Essential	This scale rating means that the factor being judged is essential value to the marker, Implying that the marker feels he could not work without knowing that piece of information.

The second section of the questionnaire aimed to collect opinions and provided open-ended questions for candidates to respond with as much or as little as they chose to declare. The questions posed are illustrated in Figure 1.6.

The survey was placed on the Company's internal Intranet site. The results were then submitted to an Access database where they were available for analysis.

All Christchurch Staff Managers and Resource Managers were identified and sent e-mail instructions of why the survey was available and the purpose of it. This first group are users of the recruitment process as part of their day-to-day role within the Company. The e-mail included a hyperlink to the survey. A second group of individuals was also identified – this group included Development Managers and Project Managers. This second group was identified as the key personnel requesting the service of the first group to meet their project resourcing needs. The e-mails were sent out to equal numbers of staff in the first and second group. Thirty-two candidates in the two groups were asked to complete a questionnaire and give their opinion on the importance of various aspects of the recruitment process. A total of 14 out of 16 candidates responded from group one (Resource and Staff Managers) and 15 out of 16 other managers responded to the request.

In the following analysis the group of managers are divided into two sections. The first section contains results relating to Staff Managers and Resource Managers with the second section containing the results of all the other managers. This second group receive the services provided by the first group and their views were considered relevant to get a holistic view of the recruitment process.

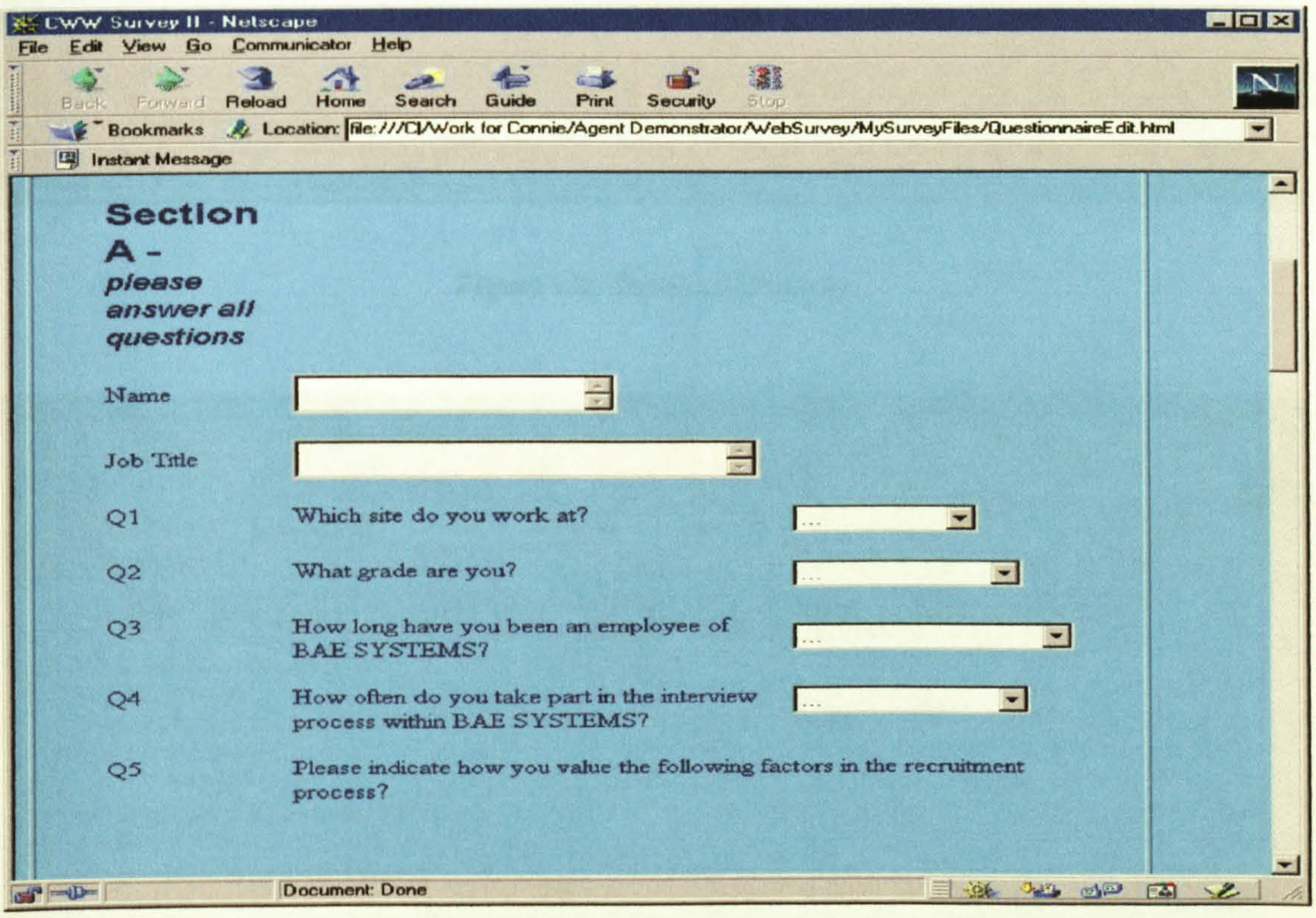


Figure 1.1: Section A: Opening Questions

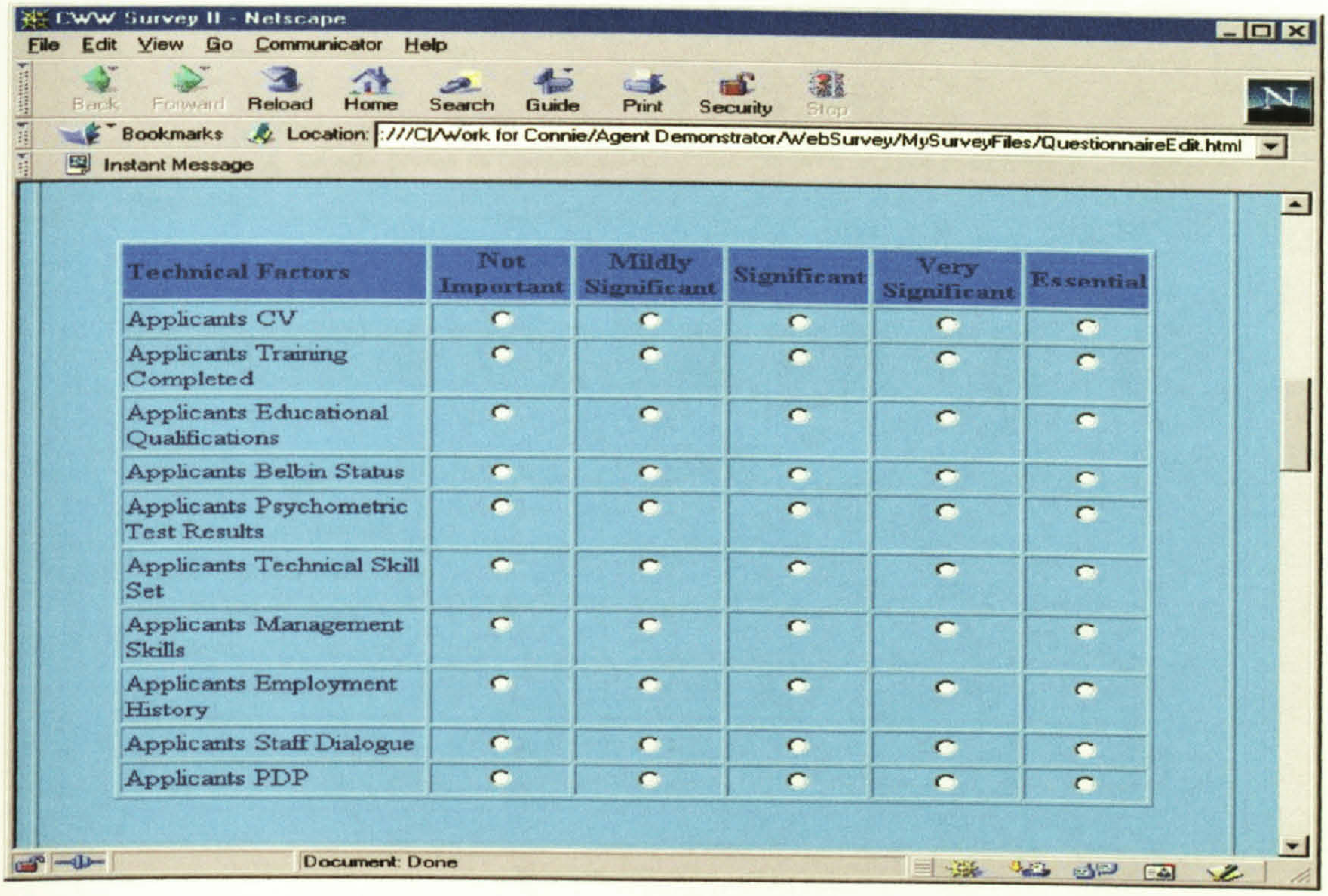


Figure 1.2: Technical Factors

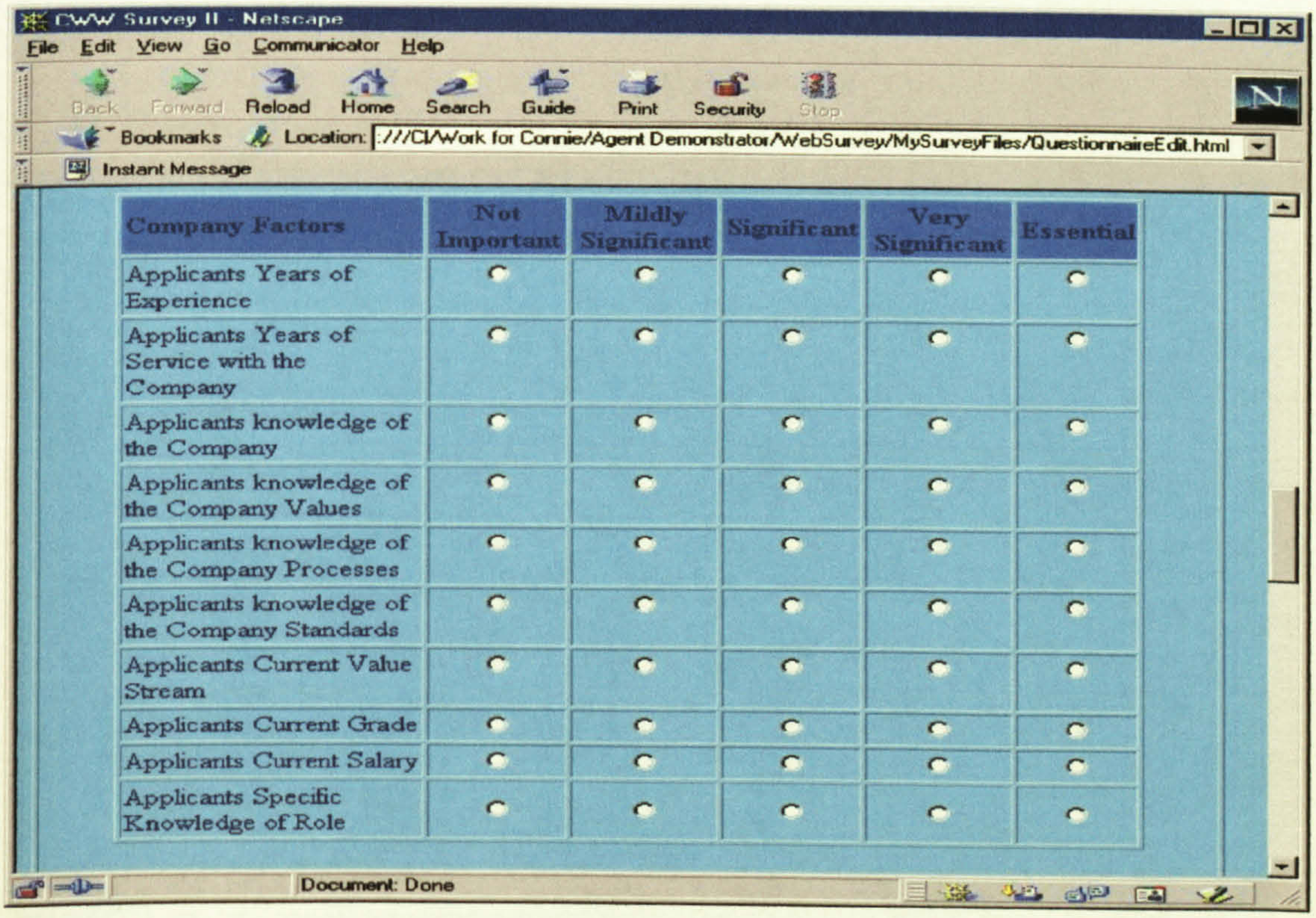


Figure 1.3: Company Factors

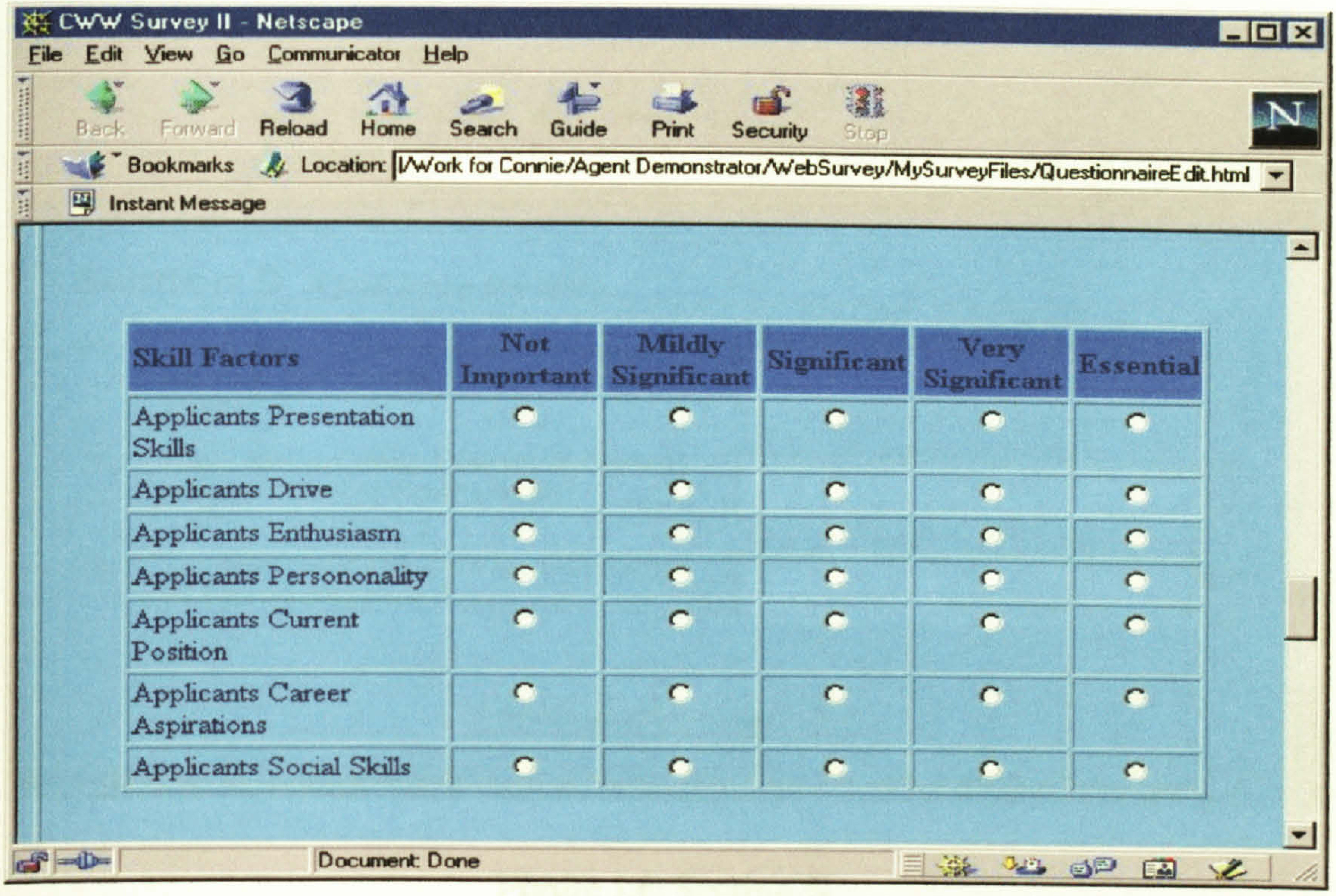


Figure 1.4: Skill Factors

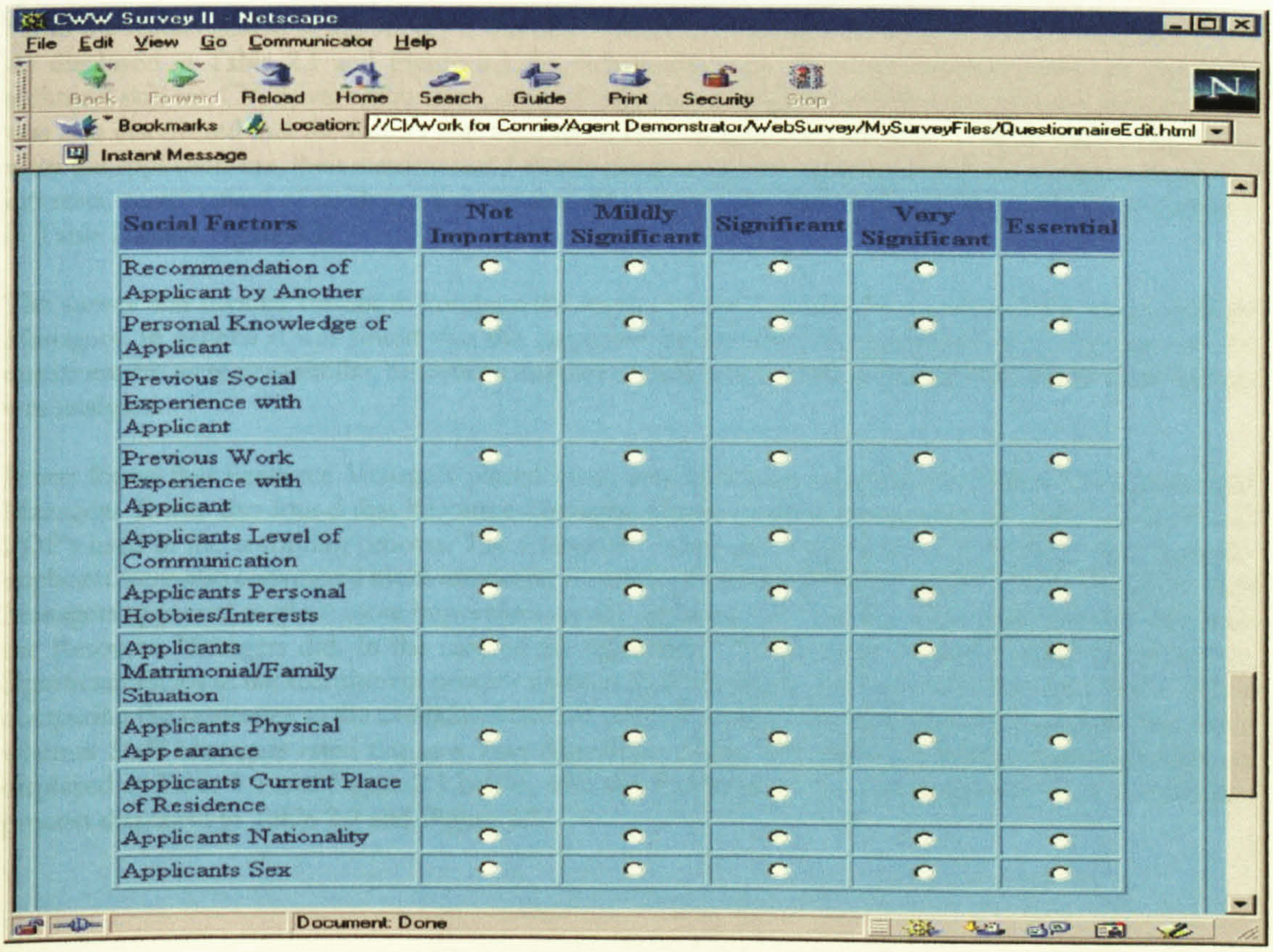


Figure 1.5: Social Factors

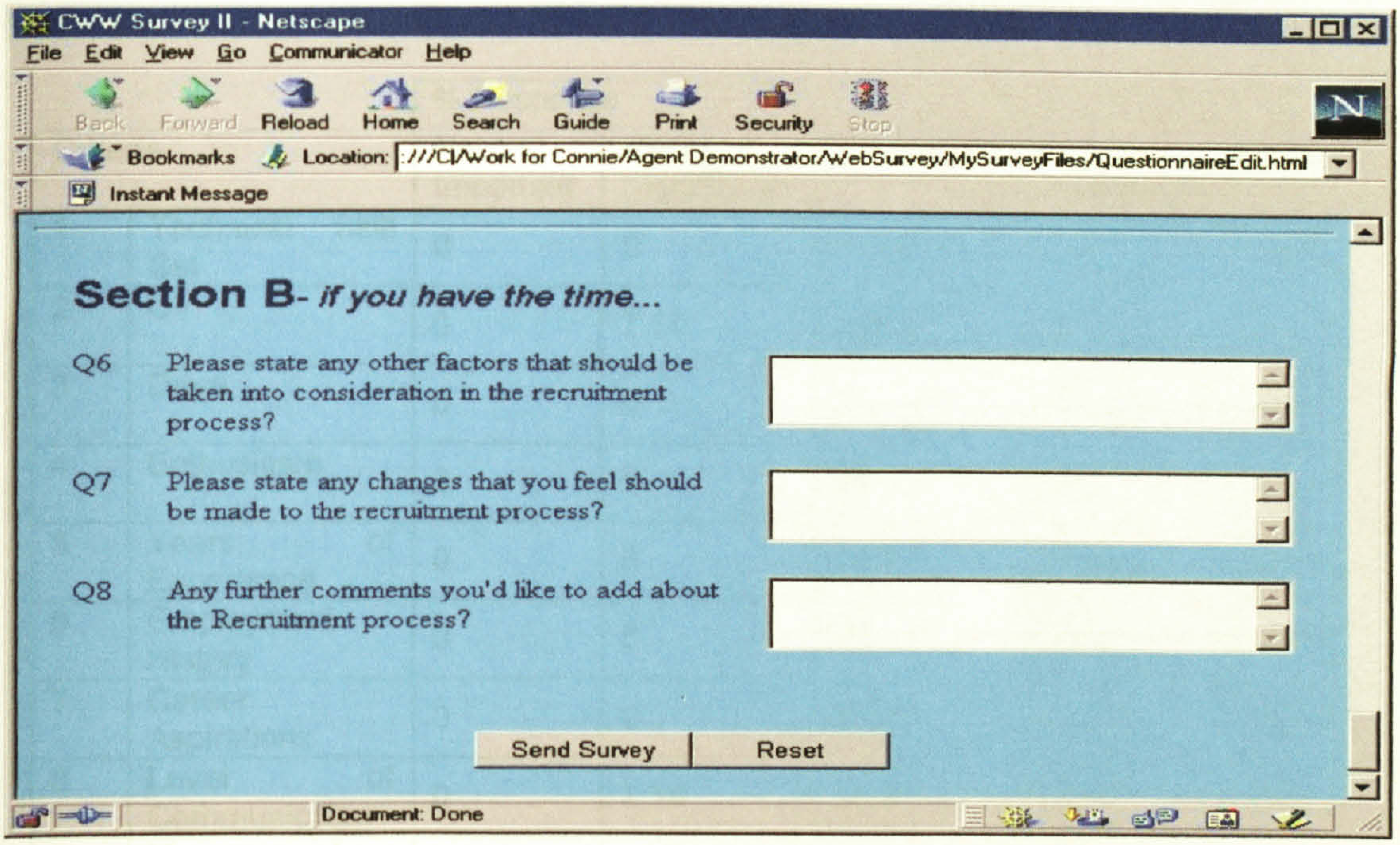


Figure 1.6: Section B

2. Analysis of the Results

2.1 Resource and Staff Manager Results

From the results gained in this survey it was discovered that some factors were more essential than others. As displayed in Table 2.1 and Figure 2.1 the factors that were the most important were an applicants technical skill set, CV, drive, enthusiasm, years of experience, employment history and career aspirations. It was also discovered that the factors that were taken into consideration the least in the recruitment process were the applicants sex, their matrimonial / family situation, social experience with the applicant, hobbies / interests, current place of residence and physical appearance. The data relating to these factors are displayed in Table 2.2 and Figure 2.2.

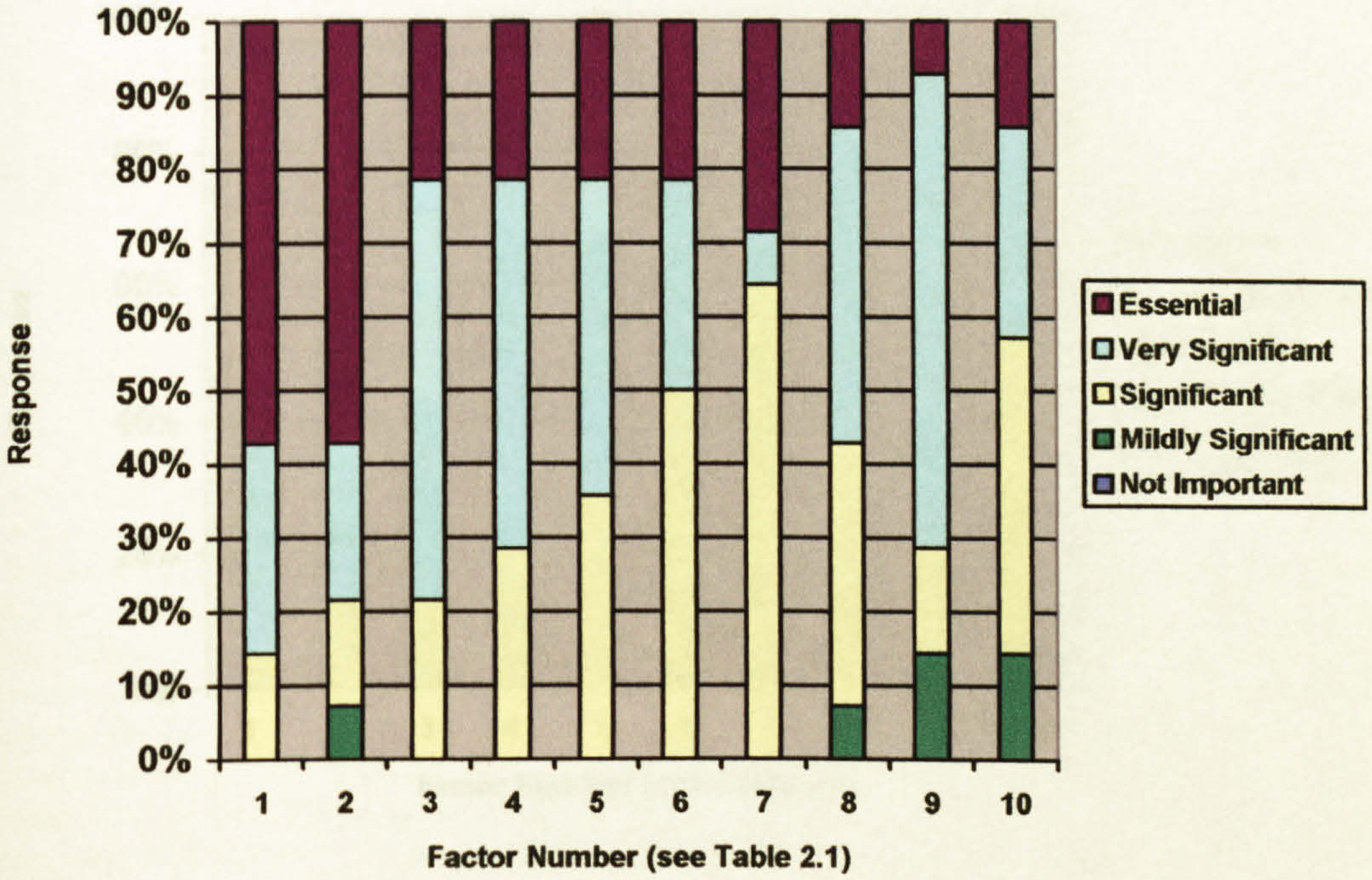
The survey was divided further to compare the results of the Resource Managers and the results of Staff Managers. In general it was found that the responses by Resource Managers and Staff Managers to the questionnaire were very similar, however a number of differences in the responses were found when the data was analysed.

It was found that Resource Managers placed more importance on an applicants Belbin Status than Staff Managers. It was also found that Resource Managers placed a higher importance on Staff Dialogues and PDP's used in the recruiting process. The Company Values and a previous working experience with the applicant were also considered more important factors by Resource Managers than by Staff Managers. Staff Managers appeared to place more importance on the applicants CV and the applicant's current salary than the Resource Managers did. In the case of the applicants CV, Resource Managers rated this as a Very Significant factor in the recruitment process whereas Staff Managers rates this as an Essential factor. When comparing the responses to the candidates current salary Resource Managers rated this as a Significant factor whereas Staff Managers rated this as a Very Significant factor. The factors rated the most important are displayed in Table 2.1 and Figure 2.1 below, with the factors rated the least important in the recruitment process displayed in Table 2.2 and Figure 2.2.

Criteria		% Response				
		Not Important	Mildly Significant	Significant	Very Significant	Essential
1	Technical Skill Set	0	0	14.29	28.57	57.14
2	CV	0	7.14	14.29	21.43	57.14
3	Drive	0	0	21.43	57.14	21.43
4	Enthusiasm	0	0	28.57	50	21.43
5	Years of Experience	0	0	35.71	42.86	21.43
6	Employment History	0	0	50	28.57	21.43
7	Career Aspirations	0	0	64.29	7.14	28.57
8	Level of Communication	0	7.14	35.71	42.86	14.29
9	Management Skills	0	14.29	14.29	64.28	7.14
10	Specific Knowledge of Role	0	14.29	42.86	28.56	14.29

Table 2.1: Ten Highest Rated Factors in the

Figure 2.1 : Ten Factors Rated the Highest in the Recruitment Process by Resource and Staff Managers

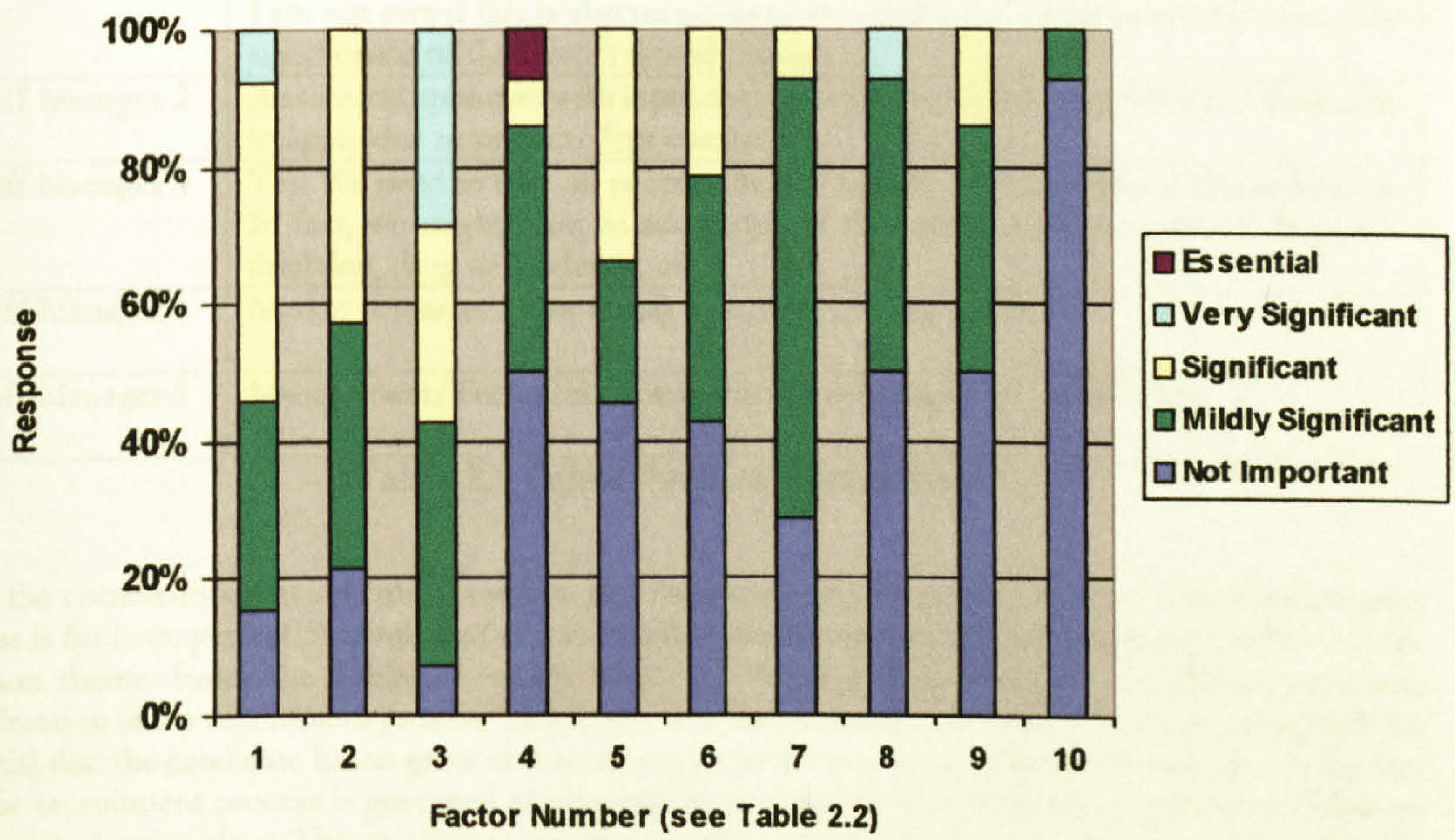


Recruitment Process

Criteria		% Response				
		Not Important	Mildly Significant	Significant	Very Significant	Essential
1	Current Value Stream	15.38	30.77	46.15	7.69	0
2	Years of Service with Company	21.43	35.71	42.86	0	0
3	Psychometric Tests	7.14	35.71	28.57	28.57	0
4	Nationality	50	35.71	7.14	0	7.14
5	Physical Appearance	42.86	21.43	35.71	0	0
6	Current Place of Residence	42.86	35.71	21.43	0	0
7	Personal Hobbies / Interests	28.57	64.29	7.14	0	0
8	Social Experience with Applicant	50	42.86	0	7.14	0
9	Matrimonial / Family Situation	50	35.71	14.29	0	0
10	Sex	92.86	7.14	0	0	0

Table 2.2: Ten Lowest Rated Factors in the

Figure 2.2 : Ten Factors Rated the Lowest in the Recruitment Process by Resource and Staff Managers



Recruitment Process

Question 6: Please state any other factors that should be taken into consideration in the recruitment process?

Role	Comments
Resource Planning Manager	Are they willing to work away from Christchurch
Resource Manager 1	None
Resource Manager 2	Covered fairly comprehensively above
Resource Manager 3	I have to say that answering the questions is difficult. Usually, the factors depend upon the role/job, whether it is technical or managerial, etc, whether the applicant is internal or external, security clearance required etc.
Resource Manager, BCC	*Relationship with other possible team members (i.e. do they have a good/bad relationship with others being recruited onto the project?) *Reputation is a BIG factor *Visibility is also important; Project Mgrs often prefer to recruit people they know to perform well, rather than take "a risk" on those they don't know *Availability; when the engineer will come available
Resource Group Manager 1	'Nationality' is mildly significant because it is difficult to recruit people who are not British or British Citizens.
Resource Group Manager 2	For an internal candidate, we should consider whether the new role would be a development opportunity for a high potential individual.
Previously Resource Group Manager	i. Availability for the type of work required (travel, etc.) ii. note a match of e.g. skill factors to job needs is required - not to any absolute standard.
Staff Manager 1	The significance of the above factors will be very much influenced by the role that the applicant is being considered for. So my responses are generic and will change according to the position being recruited for. I am not sure if this is also meant to cover candidates' external to BAE. Again the significance of the factors would change.
Staff Manager 2	An internal applicant with aspirations compatible with a new post is not always able to apply due to project/dept constraints.
Staff Manager 3	Yes. We need to take on people who are healthy. No mention of this as a factor. In fact, we might want to ask people if they were smokers, suffered from any disability, drug dependency, etc.
Staff Manager 4	Market forces and how it may affect the starting salaries.
Staff Manager 5	Management/Technical experience will depend on job applied for.

Table 2.1 Other Factors Considered

From the comments collected from Resource and Staff managers it appears that the current recruitment process is far from perfect. A number of very interesting points were raised, some appearing to have a very common theme. From the Table 2.1 which relates to, "what additional factors should be taken into consideration in the recruitment process", it appears that the candidates availability is an issue along with the potential that the candidate has to grow in their new role. In the case of an internal vacancy, due to the fact that the recruitment process is governed at a project level it is extremely difficult to grant a candidate an appropriate leaving date. The candidates current project wishes to hold on to their resource while the candidate may wish to move to a new project which requires the candidate to start before they can be released from their current project. In this case there must be some top-level discussion taking into account the employees needs and the opposing projects needs to come to an amicable agreement. A candidate's potential is highlighted by a resource manager who stated, "for an internal candidate, we should consider whether the new role would be a development opportunity for a high potential individual". There also needs to be a mapping of the candidate's skills with the skills required for the vacancy. A process of implementing this would greatly increase the efficiency of the recruitment process both in terms of speed and, more importantly, in terms of getting the right candidate for the job.

Question 7 : Please state any changes that you feel should be made to the recruitment process?

Table 2.2 Changes to the Recruitment Process

Role	Comments
Resource Planning Manager	Essential that the Applicant knows within 4 working days if we are going to offer.
Resource Manager 1	Would like more domain-based competency testing as part of the process.
Resource Manager 2	Speed - apart from specific recruitment fairs or days, the process can be delayed by the necessary HR approval, sifting of CV's, advertising the post, etc. the fastest part is actually making the offer.
Resource Manager, BCC	More emphasis needs to be made on the importance of this. Often it is a last minute panic or is a matter of who is free at the time
Resource Group Manager 1	The Psychometric tests we do are on graduates and s/w trainees only. The results usually confirm the interviewers scores. Maybe these tests should be considered for other recruitment groups.
Staff Manager 1	Current recruitment process is too much driven by short-term demands of projects. Consequently we do not consider a person's longer term potential in the selection process. I personally believe we need a more continuous recruitment process which is more driven by business needs rather than the projects.
Staff Manager 2	Speed the whole thing up - the bureaucracy can sometimes mean it takes so long to generate an offer letter that a good candidate goes elsewhere.
Resource Group Manager 2	For an internal appointment to a project too much hangs on a single RGM's opinion. The net should be cast as widely as possible, to pick up those who may be interested (or need a challenge).
Staff Manager 3	The problem with many of the factors is that their importance/relevance can change depending upon the type of job being applied for. For this reason I found myself answering many of the questions with "depends...". As a result, I cannot see how the relative importance of the factors can be assessed in isolation from the job. Conclusion: this questionnaire is flawed.
Staff Manager 4	Improve training for interviewers. Having a common interview process which is followed by everyone, so 'like with like' can be compared.
Previously Resource Group Manager	None
Resource Manager 3	None
Staff Manager 5	None

From the comments made by Resource and Staff Managers in Table 2.2 it can be seen that the main changes required to be made to the recruitment process relate to the speed of the process and formulating a common mechanism to aid recruitment. With relation to the issue of the speed of the recruitment process it is the mechanism of finding the correct candidate that requires speeding up and not necessarily the actual offering of the post. This is highlighted by one resource manager who stated, "apart from specific recruitment fairs or days, the process can be delayed by the necessary HR approval, sifting of CV's, advertising the post, etc. the fastest part is actually making the offer". This point relates to the second issue of formulating a common, generic recruitment process. If a common process existed then this would subsequently speed up recruitment and iron out a lot of difficulties currently experienced in this area.

Question 8 : Any further comments you'd like to add about the Recruitment process?

Table 2.3 Further Comments

Role	Comments
Resource Planning Manager	Some real difficulties encountered when having to go through Corporate driven assessment centres, particularly for Graduates
Resource Manager 1	For the more senior posts, would like to challenge the candidates with an appropriate problem, give them thirty minutes to prepare, then get them to present their solution to a few practitioners in the field
Resource Manager 2	Occasionally corporate edicts on headcount, recruitment, contractor numbers, preferred agencies etc. can get in the way of resourcing projects and meeting our milestones.
Resource Manager, BCC	There is a difference between recruitment of personnel into the company, and re-allocation of staff onto a different project. I have based my responses on the latter of these
Resource Group Manager 1	None
Staff Manager 1	None
Staff Manager 2	None
Resource Group Manager 2	Internal CVs for all employees kept up to date annually (maybe during a Staff Dialogue) available to search by all RGMs and HR.
Staff Manager 3	None
Staff Manager 4	The current methods of recruitment seem to work for the Portsmouth office, but it could be improved.
Previously Resource Group Manager	None
Resource Manager 3	None
Staff Manager 5	None

Table 2.3 highlights the argument that a more structured approach should be applied to the recruitment process. One Resource Manager commented that for a more senior post a candidate's problem solving and innovation skills should be tested. This is highlighted in the comment, "For the more senior posts, would like to challenge the candidates with an appropriate problem, give them thirty minutes to prepare, then get them to present their solution to a few practitioners in the field". This approach could not only be applied to senior management but to other levels of the company. An approach similar to this is undertaken at Graduate Assessment Centres where a number of tests are performed to assess the candidate's suitability. In the Assessment Centres candidates are given a business problem and asked to present a solution in the form of a written report. A group exercise is also undertaken to assess individuals team working and group work activities, and in the case of a Software role a generic software test is also undertaken to assess the candidates technical abilities. These assessments are in addition to a thorough interview, which, in the case of more senior personnel, is sometimes the only form of assessment. However, in stating this, the Assessment Centres are drive from a corporate level and often do not feed directly to a project's specific needs. This point is highlighted by a resource manager who commented, "Some real difficulties encountered when having to go through Corporate driven assessment centres, particularly for Graduates". In these cases there needs to be a higher level of communication between the corporate level of the company and the project level to ensure the needs of all parties are met. The comments above also highlight the differences between recruiting personnel from an outside source and managing an internal transfer of an employee.

2.1 Conclusions

The results obtained from Resource Managers and Staff Managers provide an interesting insight into the importance of different factors in the recruitment process. It was found that the employees CV and their technical skills were the most important factors. The technical skills are an extremely important factor for obvious reasons, namely, this is what the employee will use to perform their day-to-day job and is the single largest reason for employing someone. At the other end of the scale it was found that the employees sex, matrimonial / family situation, social experience with the applicant, hobbies and current place of residence had no real bearing on the recruitment of a candidate. These factors do not necessarily affect the employee doing their job therefore do not matter to a manager when recruiting.

There were also some interesting results when comparing responses by Resource Managers and Staff Managers.

Due to the differences in the nature of their roles, Resource Managers have slightly differing opinions from Staff Managers. The criteria with the largest differences are displayed in Table 2.4. This table provides some interesting results. It appears that Staff Managers rate the candidates CV more critical than resource managers do. It is also clear that Resource Managers rate Staff Dialogues and PDP's higher that Staff Managers do. This may be due to the fact that Resource Managers are actively involved in Staff Dialogues and PDP's and therefore see them as having more value. A large difference of opinion is also seen when the responses to current salary are analysed. Here is can be seen that Staff Managers believe that current salary is a very significant factor whereas Resource Managers believe that salary is somewhere between a mildly significant factor and a significant factor. This difference may be due to the fact that Staff Managers have more contact with employees, with employees feeling more comfortable confiding in their Staff Manager rather than in the more organised environment of a Staff Dialogue or PDP which is conducted by Resource Managers.

Table 2.4 : Differing Opinions of Resource Managers and Staff Managers

Criteria	Resource Manager Average	Staff Manager Average
Candidates CV	3.88	4.83
Belbin Status	2.38	1.60
Staff Dialogue	3.38	2.60
PDP	3.00	2.20
Knowledge of Company Values	3.00	2.33
Current Salary	2.63	4.00
Previous Work Experience with Applicant	3.00	2.33

Key
1. Not Important
2. Mildly Significant
3. Significant
4. Very Significant
5. Essential

Tables 2.1, 2.2 and 2.3 highlight the differences of the recruiting mechanism across the company. There appears to be a different mechanism for recruiting graduates than for recruiting more experienced employees. Although these are two separate groups with different criteria applied to each case, there are some common areas where criteria can be applied to both groups.
There appears to be no common, structured approach to recruiting employees within the company. At present there is no mechanism for finding the best candidate suited to a particular job with recruitment often performed using word of mouth. Another general comment made by Resource Managers and Staff managers related to the speed of the recruitment process. These comments related to the speed of finding suitable candidates, which highlights previous comments regarding the need for a common recruitment mechanism.

1. **Other Manager Results**

The questionnaire was completed by a range of other managers with the most popular factors shown in Table 3.1 and Figure 3.1 and the least popular factors shown in Table 3.2 and Figure 3.2. From these tables and figures it can be seen that the criteria which are rated most important in the recruitment process are the applicants CV, technical skill set, level of communication, enthusiasm, specific knowledge of the role, personality, drive, employment history, career aspirations and management skills. The factors which were rated the least important in the recruitment process include the applicant's sex, physical appearance, current value stream, matrimonial / family situation, personal hobbies / interests, years of service with the company, current place of residence, psychometric tests, knowledge of the company values and the applicant's nationality.
Although a number of different managers in different roles were surveyed it is not possible to draw comparisons with different sets of managers as only a small cross-section of the management population was examined. The ten factors rates the highest in the recruitment process are displayed in Table 3.1 and Figure

3.1, with the factors rated the least important in the recruitment process displayed in Table 3.2 and Figure 3.2.

Table 3.1 : Ten Highest Rated Factors in the Recruitment Process

Criteria		% Response				
		Not Important	Mildly Significant	Significant	Very Significant	Essential
1	CV	0	6.67	20	40	33.33
2	Technical Skill Set	0	0	13.33	73.33	13.34
3	Level of Communication	0	6.67	26.67	60	6.66
4	Enthusiasm	0	0	26.67	73.33	0
5	Specific Knowledge of Role	0	0	40	53.33	6.67
6	Personality	0	0	40	53.33	6.67
7	Drive	0	6.67	20	73.33	0
8	Employment History	0	6.67	53.33	26.67	13.33
9	Career Aspirations	0	0	53.33	40	6.67
10	Management Skills	0	13.33	33.33	53.34	0

Table 3.2 : Ten Lowest Rated Factors in the Recruitment Process

Criteria		% Response				
		Not Important	Mildly Significant	Significant	Very Significant	Essential
1	Nationality	53.33	13.33	26.67	0	6.67
2	Knowledge of Company Values	13.33	60.00	26.67	0	0
3	Psychometric Tests	15.38	46.16	38.46	0	0
4	Current Place of Residence	20.00	53.33	26.67	0	0
5	Years of Service with Company	20.00	66.67	13.33	0	0
6	Personal Hobbies / Interests	26.67	60.00	13.33	0	0
7	Matrimonial / Family Situation	33.33	53.34	13.33	0	0
8	Current Value Stream	46.67	46.67	6.66	0	0
9	Physical Appearance	66.67	26.67	6.66	0	0
10	Applicants Sex	93.33	6.67	0	0	0

Figure 3.2 : Ten Lowest Rated Factors in the Recruitment Process

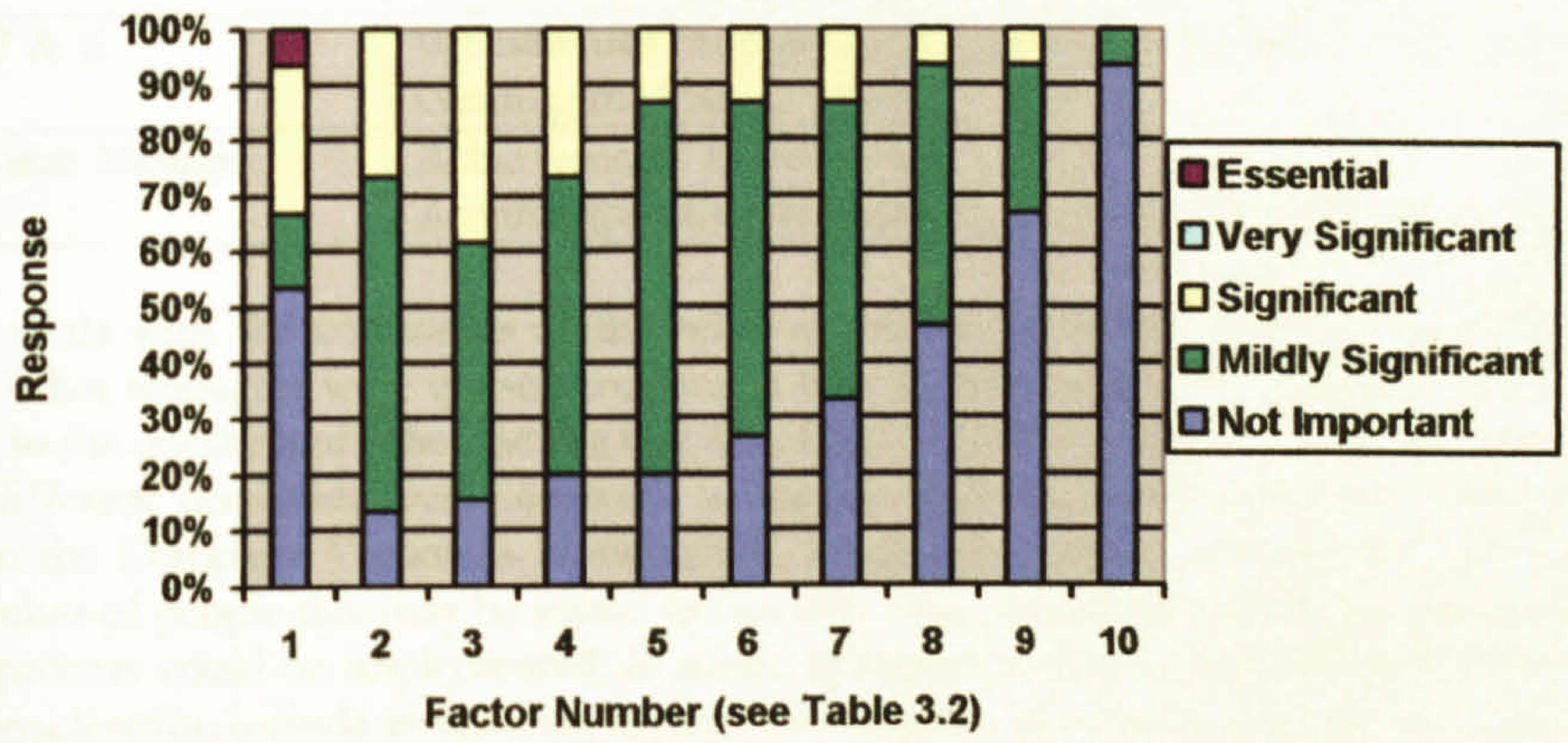
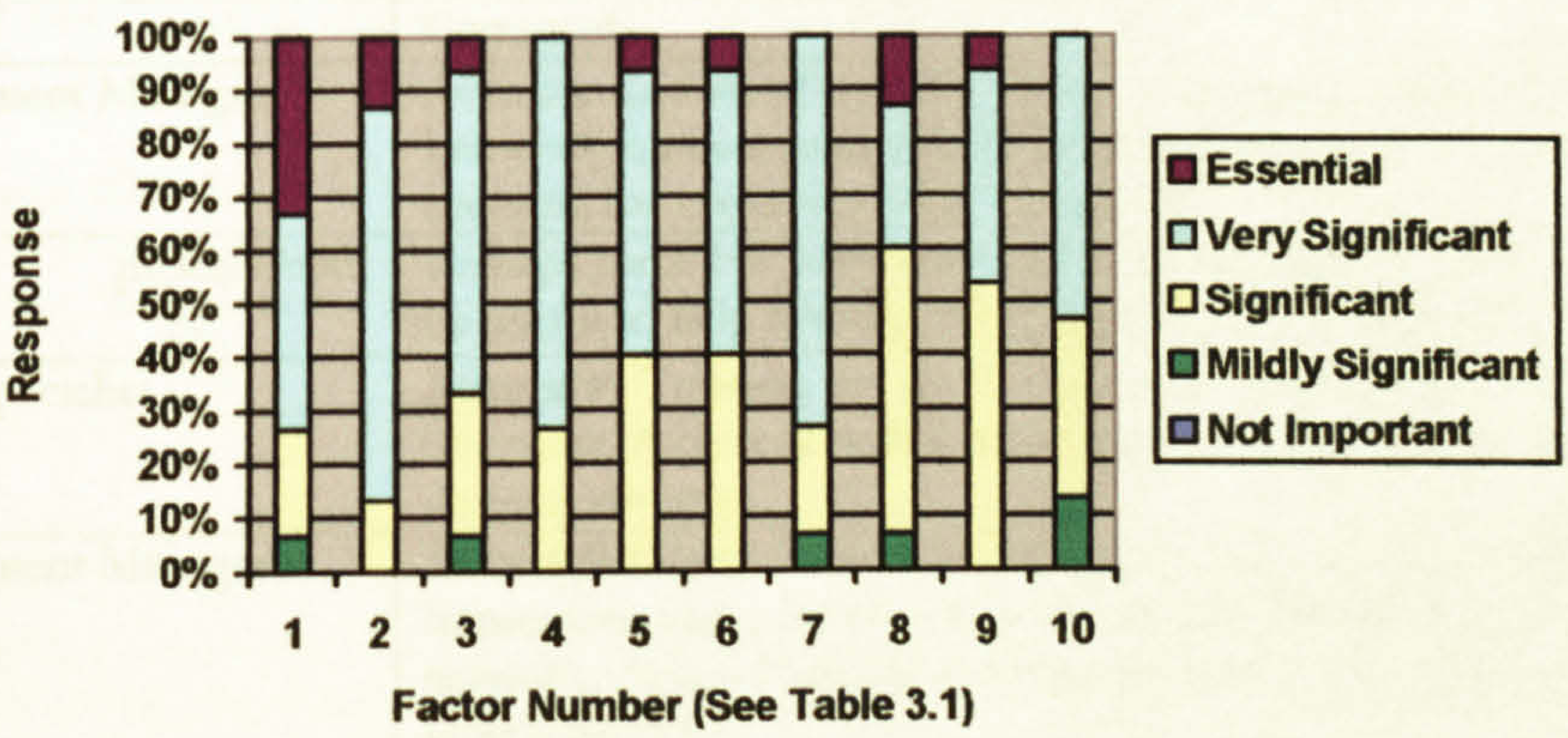


Figure 3.1 : Ten Factors Rated the Highest in the Recuitment Process by Other Managers



Question 6 : Please state any other factors that should be taken into consideration in the recruitment process?

Role	Comments
Development Manager	All of the Company Vacancies should be advertised at a central point on the Intranet and on Notice Boards for fair selection procedures to be available. I have seen jobs created and filled without a vacancy advertisement - this is unfair. People should not get a job based on who they know in the business - it needs to be fairer than that.
project procurement manager	None
System Specialist	None
Development Manager	Although it does not relate directly to the recruitment process, it seems that recruitment is becoming more of a problem. One significant factor is that we are not using new technologies and tools enough - no one

	wants to program in Ada for example. More consideration should be given to the commercial realities when defining the toolsets to be used on projects.
Director, BCC	Availability, loyalty
Engineering Development Mgr	Willingness to relocate Wife's occupation Regularity of job changes in the past Views on Defence industry
Head of P & E	We now use "competency based" interviews for some posts, and Hay Grading for Exec 3 posts.
Development Manager	Achievements in past roles Attitude (positive/negative and to acceptance of responsibilities)

This section deals with the comments of the other managers, excluding Resource and Staff managers. Although 15 other managers were questioned, only a few returned responses to questions 6, 7 and 8. With regards to the question of other factors that should be taken into account in the recruitment process, a number of different responses were received. It appears that some vacancies are filled without being advertised on the Company Vacancies Noticeboard. Using this method, clearly, does not maximise the potential number of people that may be suited to this job. This represents another area where a centralised recruitment process could be implemented, in order to improve this process. Other factors that may be taken into consideration include availability, loyalty, a willingness to relocate, regularity of job changes in the past and views on the Defence industry. If achievements in past roles and competencies were available to managers, this would streamline the recruitment process and allow for a more objective recruiting approach.

Question 7 : Please state any changes that you feel should be made to the recruitment process?

Role	Comments
Development Manager	Accurate records of peoples service, experience, qualifications, training, knowledge, know-how should be recorded and be available for those applying for vacancies in the Company.
project procurement manager	Perhaps some HR involvement for internal transfer assessment would be useful to help avoid putting square pegs into round holes!
System Specialist	Interview Training as an essential prerequisite to performing an interview. A clear & well-defined interview/recruitment process. Well defined job roles.
Development Manager	Although I don't know in detail where posts are advertised, I get the impression that a lot of vacancies are filled through local recruitment agencies. What about advertising nationally in specialist journals, e.g. UNIX Review? I don't believe current location is an important factor when recruiting - the cost of a decent relocation package is small if it results in getting the right people.
Director, BCC	Should be made much faster
Engineering Development Mgr	I believe we are inconsistent in our approach to recruitment. The vast majority of the information that we use to make a decision usually comes from an interview. We do not train the appropriate people but rely on their natural ability, or not, to be able to interview effectively. There are, to my knowledge, no guidelines on what to look for and what to watch out for. We do not make consistent use of standard tests such as Belbin.
Head of P & E	None
Development Manager	None

Table 3.4 highlights the changes that managers feel could be made to the recruitment process. One of the main points made in this table relates to the training of interviewers. At present no formal training is available for interviewers and, as pointed out by an Engineering Development Manager, "the vast majority of the information that we use to make a decision usually comes from an interview. We do not train the appropriate people but rely on their natural ability, or not, to be able to interview effectively. There are, to my knowledge, no guidelines on what to look for and what to watch out for". This is an extremely valid point with a great deal of responsibility resting on the interviewer's shoulders to find the correct candidate for the job. The Director of BCC makes a point, which is in line with a number of comments made by Resource and Staff managers, that the recruitment process needs to be speeded up. This seems to be the

most common point raised and probably relates to the length of time taken to find the appropriate candidate and not to the speed of offering the suitable candidate a position.

Question 8 : Any further comments you'd like to add about the Recruitment process?

Role	Comments
Development Manager	The skills required to do the job in question should also reflect the desired capability and competencies of the role.
project procurement manager	None
System Specialist	In my experience, it has been a very adhoc process, no training, no clear idea of where the individuals are intended to work & what role they would fulfil.
Development Manager	It clearly isn't working effectively at the moment and needs urgent review.
Director, BCC	None
Engineering Development Mgr	None
Head of P & E	Nationality essential for security clearance only
Development Manager	None

Table 3.5 contains any further comments that are made by managers. These comments seem to be consistent with many issues that have been raised in previous sections. Examples of these are matching the skills that are required to perform the role to the candidate's skills and competencies and the requirement for a formal, structured recruitment process which can be applied across the business.

Analysis

Table 4.1 shows the ratings of the criteria in the recruitment process by Resource/Staff Managers and Other Managers. The ratings were calculated based on giving 7 points for every Essential rating, 4 points for every Very Significant rating, 2 points for every Significant rating, 1 point for every Mildly Significant rating and 0 points for every Not Important rating. The points were then totalled and a percentage calculated. The results were then compared and placed in the table below.

From Table 4.1 it can be seen that many of the results are very similar between the 2 populations questioned. However, there are a number of differences between the two sets of responses. It appears that the group of Other Managers seem to rate Personality as more important than Resource/Staff Managers. Other Managers also rate a Working Experience with the Applicant, Personal Knowledge of the Applicant and Social Experience with the Applicant as more important factors than Resource/Staff Managers do. On the other hand, the group of Resource/Staff Managers seem to rate Years of Experience, Current Grade and Current Salary as more important factors than Other Managers do. Taking these differences alone it seems that the Other Managers seem to rate factors not directly affecting the candidates job, more highly than Resource/Staff Managers do. Resource/Staff Managers are involved in recruiting on a more regular basis than the group of Other Managers, which may explain these specific differences. The frequency of interviewing can be seen in Appendix B of this document.

Table 4.1: Comparison between Resource/Staff Managers and Other Managers

Rank	Resource / Staff Managers	Other Managers
1	Technical Skill Set	Applicants CV
2	Applicants CV	Technical Skill Set
3	Drive	Level of Communication
4	Enthusiasm	Enthusiasm
5	Years of Experience	Specific Knowledge of Role
6	Employment History	Personality
7	Career Aspirations	Drive
8	Level of Communication	Employment History
9	Management Skills	Career Aspirations
10	Specific Knowledge of Role	Management Skills
11	Educational Qualifications	Work Experience with Applicant
12	Current Grade	Social Skills
13	Personality	Years of Experience

14	Current Salary	Personal Knowledge of Applicant
15	Knowledge of Company Processes	Educational Qualifications
16	Recommendation by Another	Training Completed
17	Current Position	Presentation Skills
18	Training Completed	Recommendation by Another
19	Social Skills	Current Position
20	Staff Dialogue	Knowledge of Company Processes
21	Belbin Status	Current Grade
22	Knowledge of Company Values	Staff Dialogue
23	Work Experience with Applicant	Current Salary
24	Presentation Skills	Social Experience with Applicant
25	PDP	PDP
26	Personal Knowledge of Applicant	Belbin Status
27	Knowledge of Company Standards	Knowledge of Company Standards
28	Knowledge of Company	Knowledge of Company
29	Current Value Stream	Nationality
30	Years of Service with Company	Knowledge of Company Values
31	Psychometric Tests	Psychometric Tests
32	Nationality	Current Place of Residence
33	Physical Appearance	Years of Service with Company
34	Current Place of Residence	Personal hobbies / interests
35	Personal hobbies / interests	Matrimonial/ Family Situation
36	Social Experience with Applicant	Current Value Stream
37	Matrimonial/ Family Situation	Physical Appearance
38	Sex	Sex

From the results obtained from this survey it appears that the recruitment process within the company requires a more structured approach. The recruitment of graduates, which occurs at a corporate level, takes into account various competency tests and other key skills. This approach does not seem to be mirrored when interviewing for an internal vacancy. Interviewing for an interval vacancy seems to be the area that requires the most work. Candidates are often recruited in an ineffectual manner and not on the basis of recruiting the most suitable candidate for the position. The speed of the recruitment process also requires increasing with far too much time being spent on finding a suitable employee. A manager's time is extremely valuable and is often used up unnecessarily by searching CV's.

From the comments received by the managers it appears that a central vacancy list should be held in addition to a central reservoir of potential candidates. This will allow the skills of the candidates to be matched with those required for the role and enable the most suited candidate to be allocated to the vacant position. This area is seen as a potential for HR involvement and may also call for a number of the current databases to be linked in some manner or for the information contained in these databases to be pooled into one central database.

In an interview situation it also appears that some formal training is required to enable interviewers to conduct interviews effectively and to know what points to look for in a potential candidate. This would be a valuable asset to the interview process, which is currently done in an ad-hoc manner and relies on the interviewers natural ability, or lack of. This skill would be able to be applied both to recruitment on an internal basis and on an external basis.

In summary, a common structured approach to the internal recruitment process is what is required. The involvement of HR will be necessary to deal with CV's and other personal details. This will free up manager's time to advertise for the post and to perform interviews for the position. In addition, interview training will also be necessary in order to maximise the potential for hiring the most suitable candidate for the advertised role.

Future Developments

The study of the recruitment process proved to be fascinating with some interesting results produced. However, as with all research there is always room for improvement and modifications that can be made to provide a more robust study. In this case I feel that more accurate results would be obtained by taking a larger cross-section of the manager population to provide more data from which to base the findings.

To further this research a new recruiting mechanism needs to be put in place. This mechanism will require the input of managers and engineers across the business in order to cover all aspects of the recruitment process and to make this a standard, streamlined and quicker mechanism for recruiting candidates both internally and externally to the company.

Appendix A

RawData1.xls

Appendix B

RawData2.xls

Appendix C: E-mail Survey

1. Introduction

This research survey has been developed in order to investigate the issues raised in response to the interviews carried out as part of my Doctorate. The interview data gave strong indications that employees at BAE SYSTEMS Ltd were overloaded with e-mail information. The interviews also suggested that employees spent a large amount of their time dealing with these e-mails. This survey sets out to explore these views in more detail and particularly concentrates on the quantitative measurement of e-mail data.

This report analyses the individual categories of Manager results and Engineer results before comparing these two groups. Conclusions are then recorded. Finally, an evaluation and future enhancement of the survey are considered to complete this research.

1.1 Method

This study focuses on the number of e-mails received by employees (into their In Box in MS Outlook) within the company and the time spent dealing with each of the e-mails.

This survey identifies particular criteria by which measurements are made. Firstly, there is a distinction between **Personal E-mail** and **Work-related E-mail**. Secondly, there is a distinction between the time spent dealing with each incoming e-mail, which are categorised: -

Read Only: This category is received and read and requires no further action on the part of the receiver. They are usually the communication of information of some description e.g. in the personal category this could be a joke or in the work-related category it could be some kind of Company notice.

Immediate Response: This category is received but interrupts the employees' workflow in order to respond to a request which is required more expediently e.g. a superior requires information urgently for a specific purpose which cannot wait. Action by the employee is necessary to complete the request.

Slower Response: This category requires a response from the receiver in order to complete them but this is not required immediately. There may still be a deadline to respond later in the week, or month, or no deadline given but a response expected. These e-mails may trigger other action in order to completely close down the e-mail e.g. a superior asks for a check on the number of reviews a software team has carried out in the last 12 months – this would trigger the receiver to spend time talking to individual team leaders and identifying information from the project directory in order to respond to the request.

Each e-mail was recorded on a spreadsheet for ease of use and included an e-mail identity number and description used by the candidate for personal tracking only. The subject matter or content was not specifically identified for the purposes of this research.

The time factor used was explained to the candidates prior to them beginning the recording. The time factor was the time to completely close down an e-mail – in this case if one incoming e-mail triggered further e-mails this was included as part of the original e-mail time spent closing the original e-mail down. This time factor includes all the work or actions taken in responding to the original e-mail e.g. talking to others, drafting a proposal etc.

The survey was sent at random to three managers and three engineers within the Company. This division is based on the same prior categorisation used in the Doctorate to keep it consistent with this view. These candidates were selected using the Christchurch Outlook address book.

The candidates were told verbally by telephone what was being requested and asked if they were content to take part in this survey over a one working week period and return the results to me. They were also told that their identities would be confidential. The request was to open the e-mail In Box on Monday morning and categorise and complete the day one part of the spreadsheet. They were to track the progress and completion of each of these e-mails. For the rest of that working week they were to maintain the survey spreadsheet in order to track the total number of incoming e-mails in one week and record the details requested. Realising that some e-mail would be incomplete within a working week a request was made to estimate the remaining time required to close down the outstanding e-mails.

2. Engineers E-mail Activity

This section describes the patterns seen upon gathering data relating to engineers' e-mails.

2.1 Read Only, Immediate Response and Slower Response E-mails

Table 2.1 shows the number of e-mails received by engineers over a 5-day period and the time spent dealing with these e-mails. A total of 140 e-mails were received with 1125.3 minutes spent dealing with these e-mails. Table 2.1 and Figure 2.1 below display information relating to those e-mails requiring a read-only response, those requiring an immediate response and those requiring a slower response.

			Immediate		*Slower*		*Total*	
	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)
Day 1	30	39.1	8	19.5	3	210	41	268.6
Day 2	12	13.1	6	13	2	300	20	326.1
Day 3	16	14.1	13	27.5	2	240	31	281.6
Day 4	19	29	6	12	2	182	27	223
Day 5	16	17.5	5	8.5	0	0	21	26

Table 2.1: Number of e-mails received by engineers and time spent dealing with these e-mails.

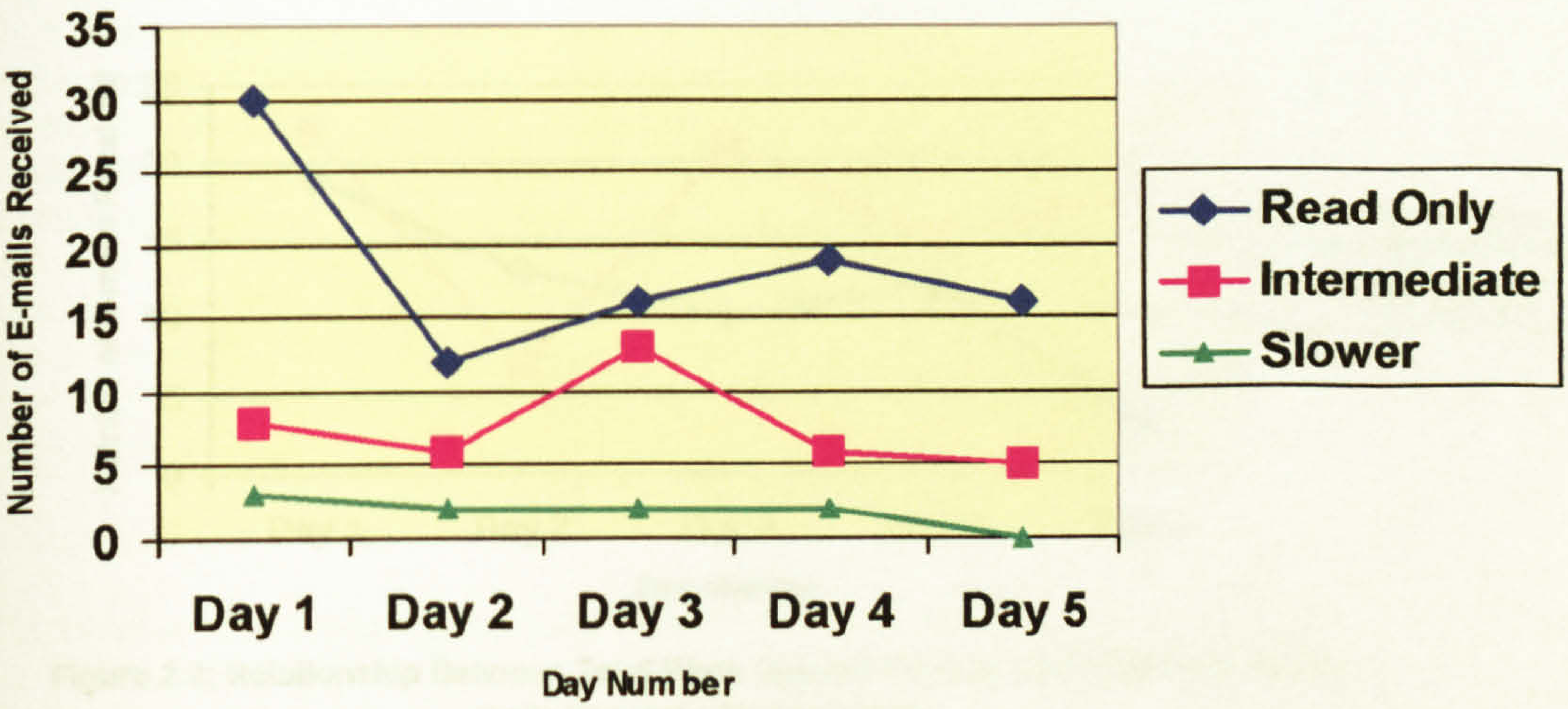


Figure 2.1: Total Number of E-mails Received by Engineers per Day

2.2 Work Related and Personal E-mails

The received e-mails were also labelled as work-related e-mails or personal e-mails. Table 2.2 and Figure 2.2 show the number of work-related e-mails and the number of personal e-mails received by engineers over a 5-day period. The time taken to deal with each e-mail was also recorded in Table 2.2.

	Work Related E-mails		*Personal E-mails*	
	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)
Day 1	19	240.6	22	28
Day 2	13	320	7	6.1
Day 3	10	252.6	21	29
Day 4	12	197	15	26
Day 5	3	6.2	18	19.8

Table 2.2: Total work-related and personal e-mails received by engineers and time spent dealing with these e-mails

The data relating to work and personal e-mails and the relationship between whether the e-mail required reading only, an immediate response or a slower response has also been analysed. Table 2.3 shows how many work-related e-mails were read only, how many required an immediate response and how many required a slower response. The time spent dealing with these e-mails was also calculated in the table below.

Category	Number / Time Spent	Work-Related	Personal
Read Only	Number of E-mails	32	61
Read Only	Time Spent (mins)	38.9	73.9
Immediate Response	Number of E-mails	16	22
Immediate Response	Time Spent (mins)	45.5	35
Slower Response	Number of E-mails	9	0
Slower Response	Time Spent (mins)	932	0

Table 2.3: Comparison between total work and total personal e-mails received and the response time.

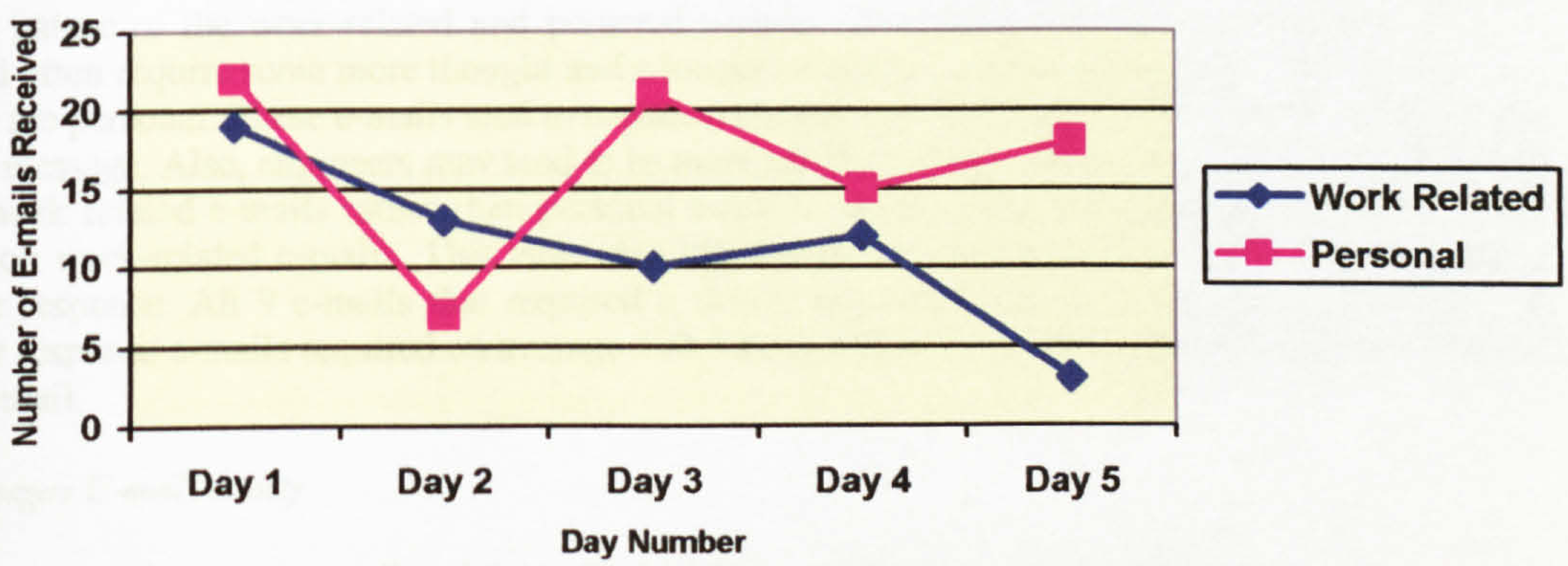


Figure 2.2: Relationship Between Total Work Related E-mails and Total Personal E-mails Received by Engineers

2.3 Conclusions

From the data collected in this study a number of trends become apparent. It indicates that engineers receive considerably more read-only e-mails than any other category. On a daily basis more read-only e-mails are received than immediate and slower response e-mails combined. However, although more read-only e-mails were received, engineers spent on average 1.21 minutes on each read-only e-mail and spent on average 2.12 minutes on each immediate response e-mail. These two values can be compared with the slower response e-mails where an engineer spent on average 103.56 minutes dealing with each slower response e-mail. This is highlighted by the data shown in Table 2.1 and Figure 2.1.

The data collected from each engineer was taken over a 5-day period. In each case the 5-day period spanned one whole working week with data for Monday relating to Day 1 and data for Friday relating to Day 5. With this in mind, no visible trend appears to be present for the read-only e-mails received and the immediate response e-mails received. However, there appears to be a decrease in slower response e-mails throughout the week. From the information presented in Table 2.1 and Figure 2.1 the number of slower response e-mails peaks at 3 on Monday and drops to 0 slow response e-mails received on Friday. One reason for this may be that tasks may build up over the weekend or early on Monday morning and are received by the engineer on Monday. Since these tasks require a greater length of time to complete, a task is normally set early in the week to allow the engineer to complete the task and send results before the end of that current week.

In the comparison between work-related e-mails and personal e-mails received by engineers an interesting pattern emerged. From the data presented in Table 2.2 and Figure 2.2 it can be seen that in 4 out of 5 days engineers received more personal e-mails than work-related e-mails. Although engineers received more personal e-mails, most of the engineers time was spent dealing with work related e-mails. From a total of 140 e-mails received 41% were work related with 59% personal e-mails. It was found that from the total time spent dealing with all e-mails, 90% of an engineers time was spend on work-related e-mails with 10% spent on personal e-mails. This suggests that Engineers value the work-related e-mails and deal with them as they are meant to. Whereas the personal e-mails are likely to be of social origin (e.g. jokes and similar material) from others in the engineering community and require less work to deal with them but there are more of them.

Engineers' standard working hours are 37 hours per week. It is possible to calculate the amount of time spent dealing with e-mails during a working week. It was discovered that 18% of an employee's weekly time was spent dealing with e-mails. This can be broken down further to show that 15% of an employee's time is spent dealing with work-related e-mails and 3% spent dealing with personal e-mails.

Table 2.3 shows that of the e-mails received that are read only, two thirds are personal e-mails and the remaining third are work related. The e-mails received requiring an immediate response have slightly more personal e-mails than work-related e-mails. However, in general the numbers are fairly similar.

The numbers are dissimilar in the time taken to deal with the immediate response e-mails; with the work-related immediate response e-mails requiring more time than personal e-mails. This may be due to the nature of the work-related and personal e-mails. Immediate response e-mails that are work related often require some more thought and a longer response than those immediate response e-mails which are personal. These e-mails tend to require a shorter response and little thought as to the content of the message. Also, engineers may tend to be more careful with grammar and spelling when dealing with work related e-mails rather than personal e-mails, which could subsequently increase the time spent on work-related e-mails. This table also highlights that no personal e-mails which required a slower response. All 9 e-mails that required a slower response were work related. In addition, the slower response e-mails required on average 103.5 minutes per e-mail to complete the work related to this e-mail.

3. Managers E-mail Activity

The next section analyses the data collected from a Managers perspective.

3.1 Read Only, Immediate Response and Slower Response E-mails

Table 3.1 shows the number of e-mails received by managers over a 5-day period and the time spent dealing with these e-mails. A total of 325 e-mails were received with 49 hours spent dealing with these e-mails. Table 3.1 and figure 3.1 display information relating to those e-mails requiring a read-only response, those requiring an immediate response and those requiring a slower response.

			Immediate		Slower		Total	
	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)
Day 1	51	140.5	23	297	23	414	97	851.5
Day 2	32	70	25	138	8	116	65	324
Day 3	23	44.5	12	218	8	165	43	427.5
Day 4	41	69.5	19	306	4	331	64	706.5
Day 5	40	113	7	128	9	390	56	631

Table 3.1: Number of e-mails received by managers and time spent dealing with these e-mails.

From Table 3.1 and Figure 3.1 it can be seen that managers receive most e-mail on Monday. This may be due to a number of e-mails sent over the weekend. It can be seen that managers tend to receive far more read-only e-mail than those requiring an immediate or slower response.

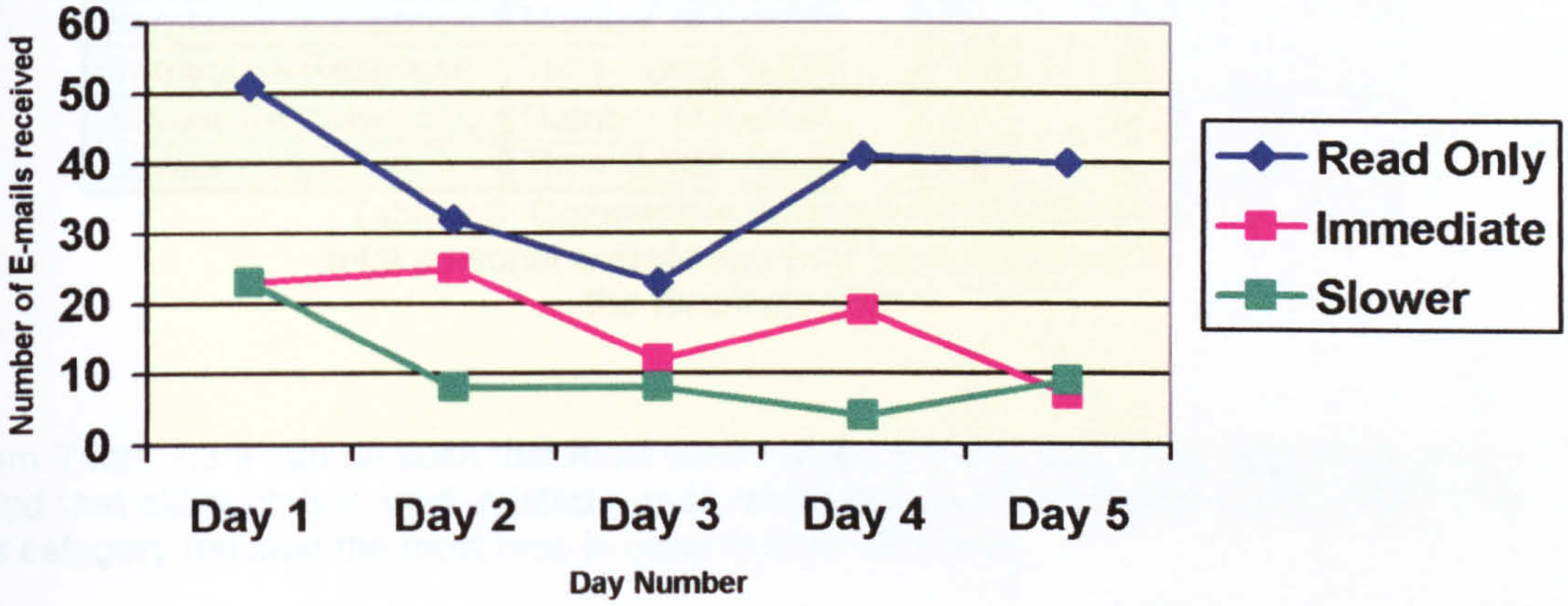


Figure 3.1: Total Number of E-mails received by Managers per day

3.2 Work Related and Personal E-mails

Data relating to whether a received e-mail was work-related or whether it was personal was collected and is presented in Table 3.2 and Figure 3.2 below. The number of personal and work-related e-mails received is presented along with the total time taken to deal with each category of e-mail per day.

	Work Related E-mails		Personal E-mails	
	No of E-mails	Time Spent (mins)	No of E-mails	Time Spent (mins)
Day 1	94	828.5	3	23
Day 2	63	314	2	10
Day 3	42	426.5	1	1
Day 4	63	703.5	1	3
Day 5	56	631	0	0

Table 3.2: Total work-related and personal e-mails received by managers and time spent dealing with these e-mails

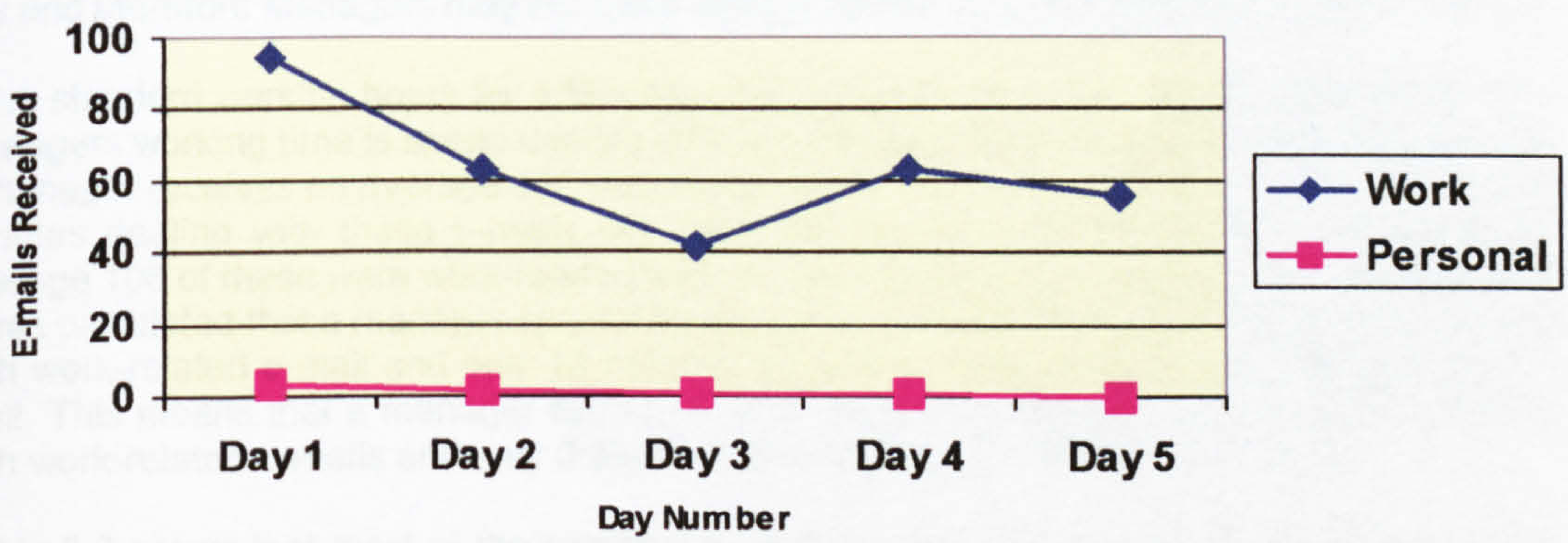


Figure 3.2: Relationship Between Total Work Related E-mails and Total Personal E-mails Received by Managers

E-mails falling into different categories were analysed further to produce Table 3.3. This table displays the number of read-only, immediate response and slower response e-mails that were work-related or personal.

Category	Number / Time Spent	Work-Related	Personal
Read Only	Number of E-mails	182	5
Read Only	Time Spent (mins)	413.5	24
Immediate Response	Number of E-mails	85	1
Immediate Response	Time Spent (mins)	1084	3
Slower Response	Number of E-mails	51	1
Slower Response	Time Spent (mins)	1406	10

Table 3.3: Comparison between total work and total personal e-mails received by managers and the response time.

From Table 3.3 it can be seen that most work-related e-mails were read-only. It can also be noted that although less work-related e-mail required a slower response, e-mails falling into this category required the most time in order to deal with them.

3.3 Conclusions

This survey data indicates that managers receive more read-only e-mail than any other category of e-mail. In nearly all cases, more read-only e-mails were received than immediate response or slower response e-mails combined. However, although a large amount of read-only e-mails were received, each manager spent on average 2.34 minutes dealing with each of the read-only e-mails. This figure can be compared with those requiring an immediate response and a slower response where a manager spends on average 12.64 minutes dealing with immediate response e-mail and spends on average 27.23 minutes dealing with slower response e-mails. Most of this read only material probably relates to communication from higher up the organisation which needs to be disseminated down the chain of command.

From the information presented in the tables and graphs above it can be seen that managers tend to receive far more work-related e-mails than personal e-mails. In fact, from a total of 325 e-mails received by 3 managers only 7 personal e-mails were received. It should be noted that the same manager received the 7 personal e-mails; the remaining two managers received no personal e-mails whatsoever.

There does not appear to be a general trend corresponding to total e-mails received over the 5 day period. However it is noticeable that more e-mails appear to be received on day 1 than on any other day. In this study day one corresponds to Monday and day 5 corresponds to Friday. The fact that more e-mails are received on day 1 may be due to the fact that a number of e-mails are received over the weekend and accumulated on Monday. Also Friday is a shorter day and therefore Managers may not have cleared their in-box on Friday afternoon efficiently.

If the standard working hours for a Manager are 37 hours per week then the percentage of a managers working time is spend dealing with e-mails can be calculated. It was calculated that a manager receives on average 108 e-mails per week and spent on average 16 hours and 20 minutes dealing with these e-mails per week. Of the 108 e-mails received per week, on average 106 of these were work-related with, on average, only 2 personal. From these results it was calculated that a manager spends on average 16 hours and 8 minutes per week dealing with work-related e-mail and only 12 minutes 20 seconds per week dealing with personal e-mail. This means that a manager spends 44% of his weekly standard working hours dealing with work-related e-mails and only 0.5% of their time dealing with personal e-mail.

Table 3.3 shows that most of the personal e-mails received by managers are read-only with only one personal e-mail requiring an immediate response and only one personal e-mail requiring a slower response. Since there are only 7 personal e-mails received by managers not a great deal of extra information can be gained from Table 3.3.

4. Comparison between Employees and Managers E-mail Activity

Table 4.1 displays information relating to the total e-mails received in different categories and the time spent dealing with these e-mails.

	Engineer	Manager
Total e-mails received	140 e-mails	325 e-mails
Total time spend dealing with e-mails	18 hours 46 minutes	49 hours
Total work-related e-mails received	57 e-mails	318 e-mails
Total time spent dealing with work-related e-mails	16 hours 56 minutes	38 hours 23 minutes
Total personal e-mails received	83 e-mails	7 e-mails
Total time spent dealing with personal e-mails	1 hour 50 minutes	37 minutes
Total read only e-mails received	93 e-mails	187 e-mails
Total time spent dealing with read-only e-mails	1 hour 53 minutes	7 hours 17 minutes
Total immediate response e-mails received	38 e-mails	86 e-mails
Total time spent dealing with immediate response e-mails	1 hours 20 minutes	18 hours 7 minutes
Total slower response e-mails received	9 e-mails	52 e-mails
Total time spent dealing with slower response e-mails	15 hours 32 minutes	23 hours 36 minutes

Table 4.1: Comparison of total e-mails received by managers and engineers over 5-day period.

Table 4.2 contains information relating to the average number of e-mails received and the average time spent dealing with these e-mails on a per-employee basis. Also included in this table is data comparing the time spent dealing with e-mails with the standard number of hours worked per week.

	Engineer	Manager
Per Employee Basis		
On average how many e-mails does an employee receive per week?	47 e-mails	108 e-mails
What is the average time spent by an employee dealing with e-mails per week?	6 hours 15 minutes	16 hours 20 minutes
On average how many work-related e-mails does an employee receive per week?	19 e-mails	106 e-mails
On average how many personal e-mails does an employee receive per week?	28 e-mails	2 e-mails
What is the total time that an employee spends on work-related e-mails per week?	5 hours 39 minutes	16 hours 8 minutes
What is the total time that an employee spends on personal e-mails per week?	1 hour 3 minutes	12 minutes 20 seconds
Assuming a 37 hour week, how much time does an employee spend dealing with work-related e-mails per week?	15%	44%
Assuming a 37 hour week, how much time does an employee spend dealing with personal e-mails per week?	3%	0.5%

Table 4.3: Comparison of e-mails received by managers and engineers over a 5-day period

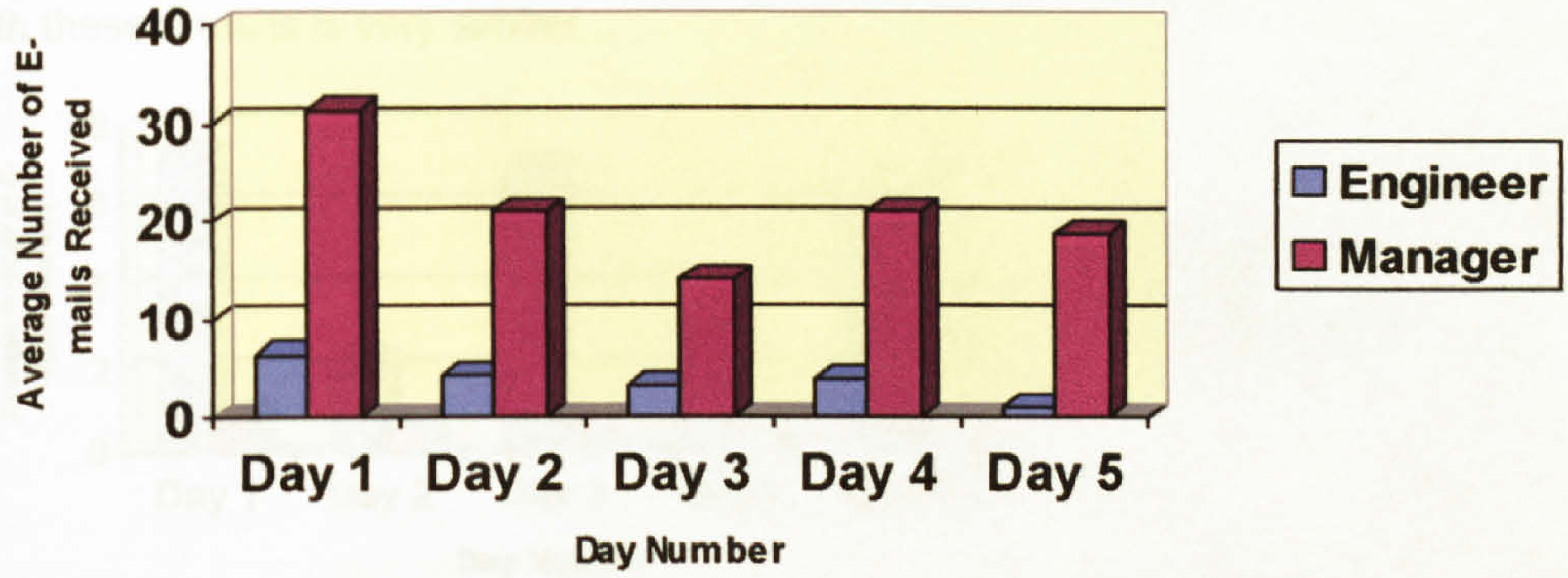


Figure 4.1: Average Number of Work-Related E-mails received per Day

	Engineer	Manager
What is the average time taken to deal with a work-related e-mail?	17.83 minutes	9.13 minutes
What is the average time taken to deal with a personal e-mail?	1.3 minutes	5.29 minutes
What is the average time taken to deal with a read-only e-mail?	1.21 minutes	2.34 minutes
What is the average time taken to deal with an immediate response e-mail?	2.12 minutes	12.64 minutes
What is the average time taken to deal with a slower response e-mail?	1 hour 44 minutes	27.23 minutes
What percentage of read only e-mails are work-related?	34%	97%
What percentage of read only e-mails are personal?	66%	3%
What percentage of immediate response e-mails are work-related?	42%	99%
What percentage of immediate response e-mails are personal?	58%	1%
What percentage of slower response e-mails are work-related?	100%	98%
What percentage of slower response e-mails are personal?	0%	2%

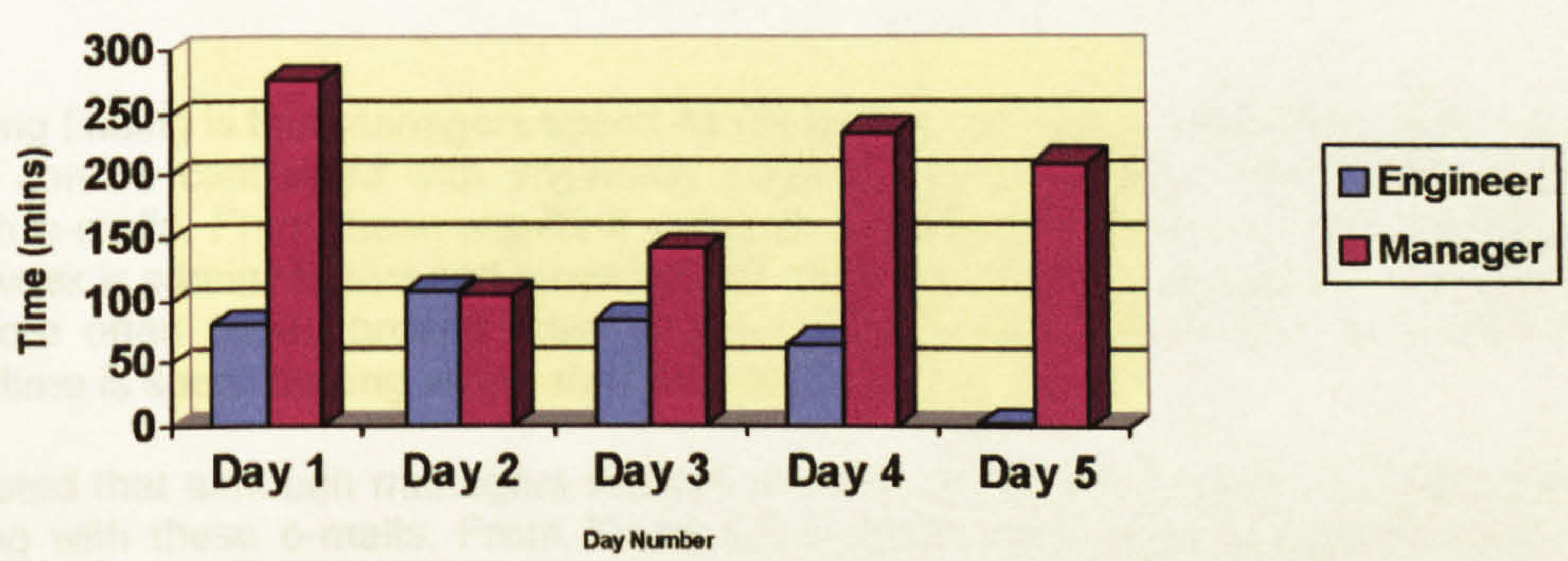


Figure 4.2: Average Time Spent on Work-Related E-mail

Table 4.2: Comparison of e-mails received by managers and engineers over a 5-day period

Figure 4.1 highlights the vastly different pattern of work-related e-mails received by managers and those received by engineers. It can be seen that managers receive vastly more work-related e-mails than engineers. Figure 4.2 shows that on the whole managers spend more time dealing with work-related e-mails than engineers. However, on days 2 and 3 it can be seen that although managers receive far more work-related e-mails on these days, the time spent dealing with these e-mails is very similar.

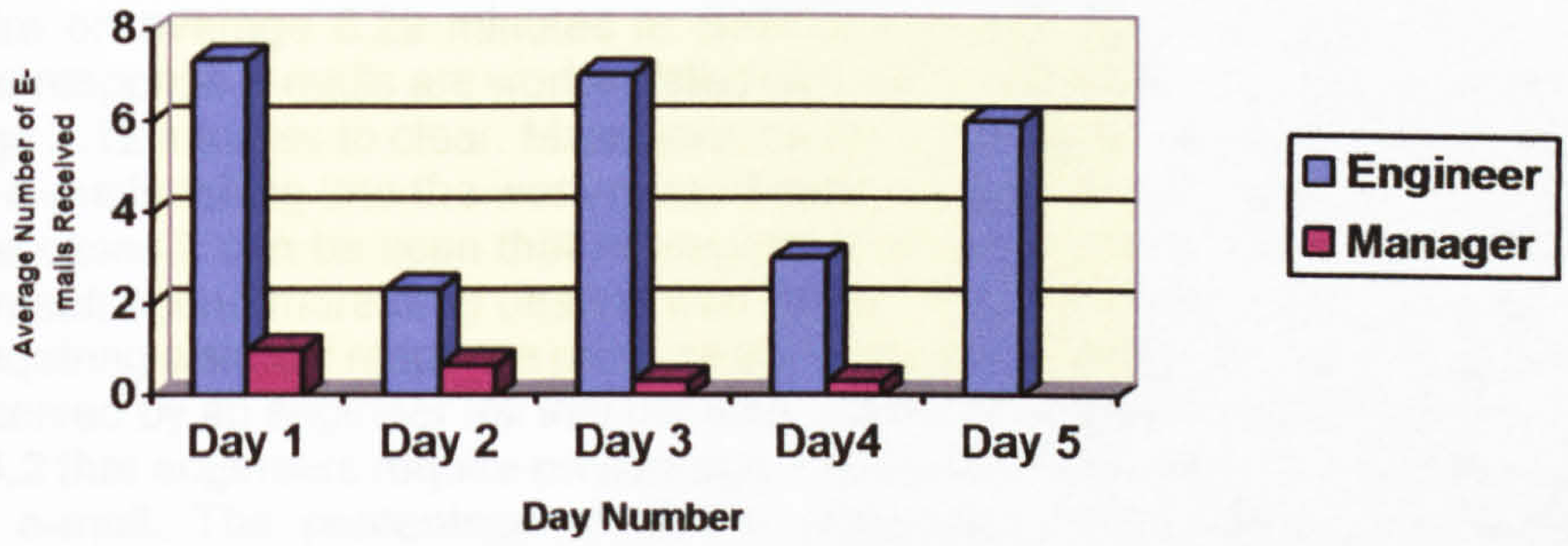


Figure 4.3: Average number of Personal E-mails Received per Day

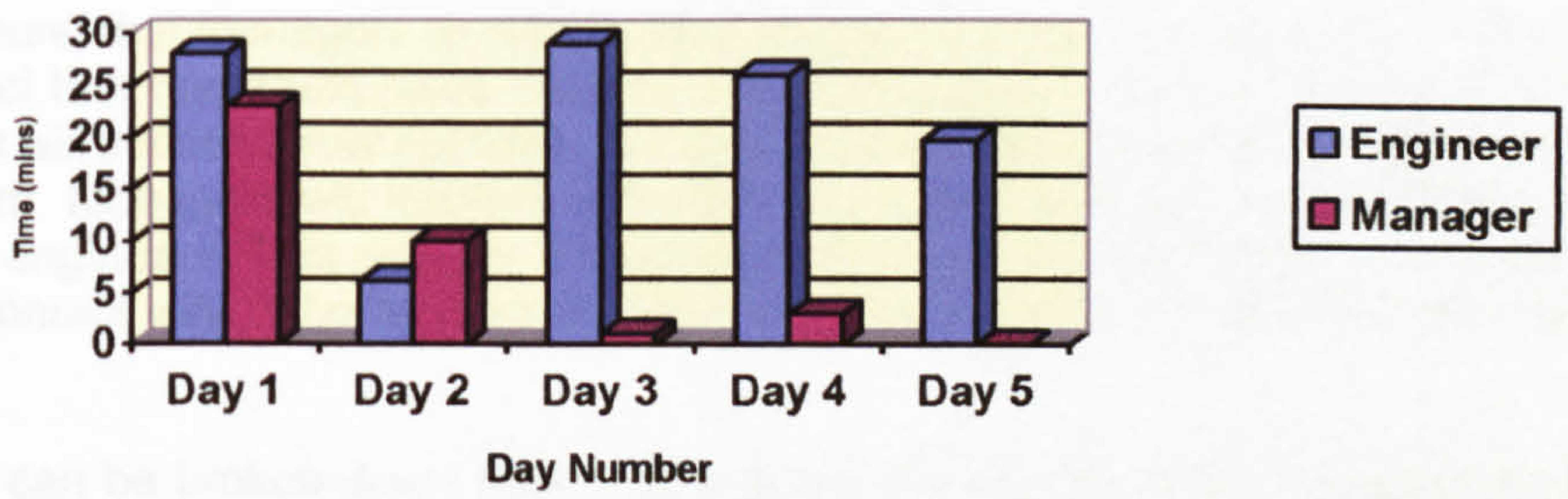


Figure 4.4: Average Time Spent on Personal E-mails per Day

Figure 4.3 shows that engineers receive far more personal e-mails than managers. It can be seen that managers receive very little personal e-mails with engineers receiving on average more than 5 personal e-mails on 3 out of the 5 days. On day one managers received an average of 1 personal e-mail which is the highest average value achieved by managers throughout the entire 5-day period.

Figure 4.4 shows that although engineers receive more personal e-mails, in 2 out of the 5 days the time spent by managers and engineers dealing with personal e-mail are very similar. This is an interesting result considering that the highest average number of e-mails that a manager received per week is 1 whereas an engineer often averaged over 5 personal e-mails per day.

4.1 Analysis

An interesting finding is that managers spend 44.5% of their working week dealing with e-mail. This figure can be contrasted with engineers who only spend 18% of their working week dealing with e-mails. From these results it could be implied that most of a managers work during the week is administrative and e-mail based. Whereas the work for engineers during the week is more often based around other sources. This would explain why so much of a manager's time is spent dealing with e-mail related tasks.

It is also noted that although managers receive more work-related e-mails, they spend less time dealing with these e-mails. From Table 4.2 it can be seen that managers spent on average 9.13 minutes dealing with a work-related e-mail. This can be compared to engineers who spend 17.83 minutes dealing with work-related e-mails. This trend also applies to personal e-mails where engineers receive more personal e-mails and spent on average 1.3 minutes dealing with each personal e-mail; whereas managers receive less personal e-mails but spend on average 2.34 minutes dealing with one. In general, it appears that managers receive more e-mail but spend less time dealing with these e-mails. This may be due to the fact that when an engineer receives a work-related task via e-mail it tends to require more effort than a work-related task that is received by a manager.

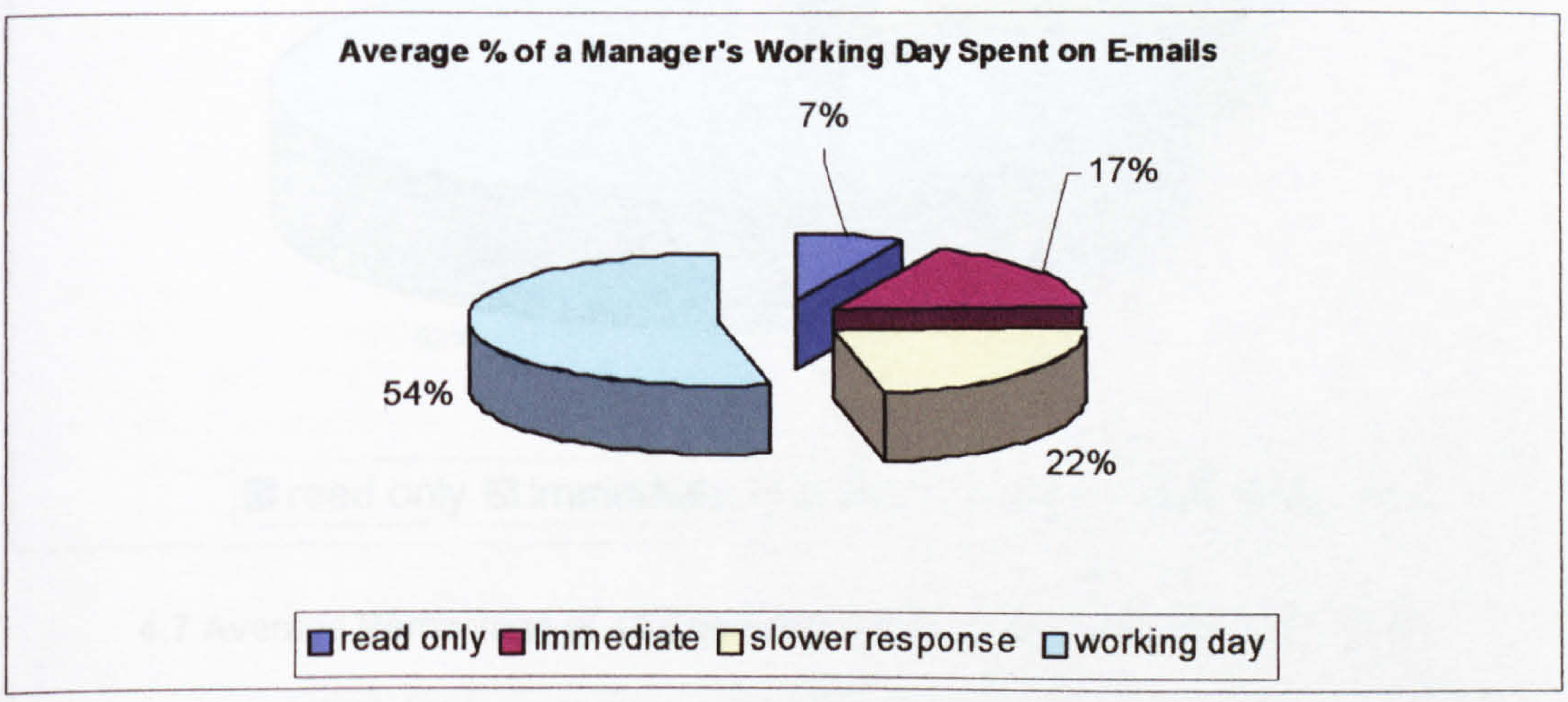
The results displayed in Table 4.2 show that 34% of read-only e-mails received by engineers are work-related with an engineer requiring on average 1.3 minutes to clear each read-only e-mail. Compare this with managers where 97% of read-only e-mails received are work-related and require on average 5.29 minutes to clear. It can also be noted that 42% of engineers immediate response e-mails are work-related with each immediate response e-mails requiring on average 2.12 minutes to clear. Managers, on the other hand, have 99% of their immediate response e-mails falling into the work-related category and require 12.64 minutes to clear. In both these cases it can be seen that managers receive by far the most work-related e-mails and as a result spend more time dealing with these. The remaining figures dealing with those e-mails requiring a slower response produce the most intriguing results. Every slower response e-mail received by an engineer fell into the work-related category. In addition to this it is shown in Table 4.2 that engineers require on average 1 hour and 44 minutes to deal with each slower response e-mail. The percentage of slower response, work-related e-mails received by managers is 98%. This is very similar to the figure of 100% produced for engineers. However, it only takes a manager on average 27.23 minutes to deal with each slower response e-mail. This highlights the thought that engineers work-related tasks tend to be more of a time-consuming nature than managers.

4.2 Discussion

This study has found that managers tend to receive far more e-mails than engineers. This may be due to the fact that managers have contact with a far greater volume of employees than engineers, which will subsequently put them in a position where more people are likely to make contact with them. Managers will interact with other managers and will be responsible for a large number of engineers. This number will outweigh the number of people that an engineer will come into contact with, who tend to be other engineers they work with and their direct manager.

These numbers can be broken down further to analyse the number of work-related e-mails received by managers and employees. From the e-mails collected it appears that managers received far more work-related e-mails than engineers. On the other hand it was discovered that engineers received far more personal e-mails than managers. The reason for engineers receiving more personal e-mails than managers is a cultural issue. Engineers engage in more social e-mails than managers whether it be organising football games or organising a social event. It is far easier to send one e-mail addressed to a number of people rather than phone each person individually.

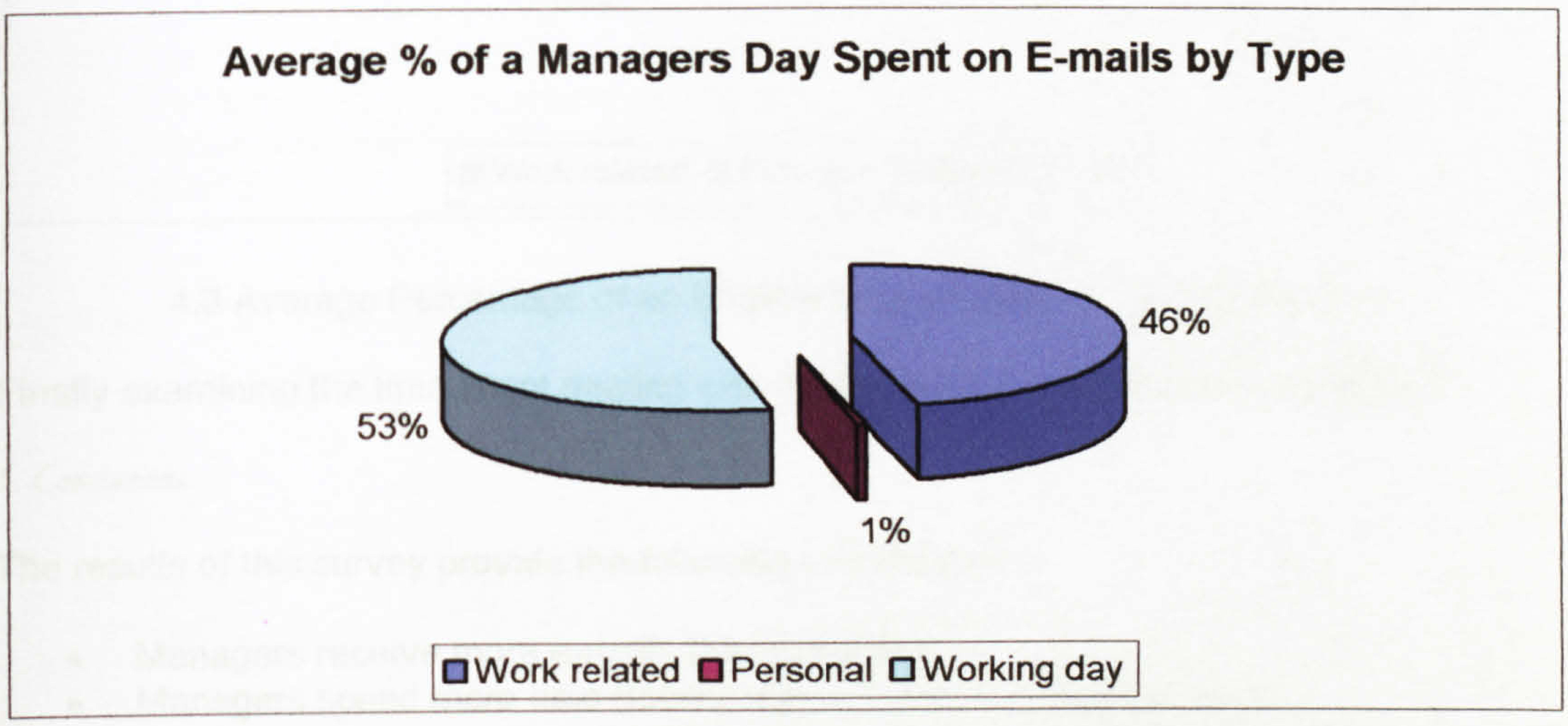
Looking at Appendix 2 there are calculations for the total time per engineer or manager divided by three to get the average time. This is represented as a percentage of a standard working day (i.e. seven hours or 2100 minutes). This is represented in the following pie charts: -



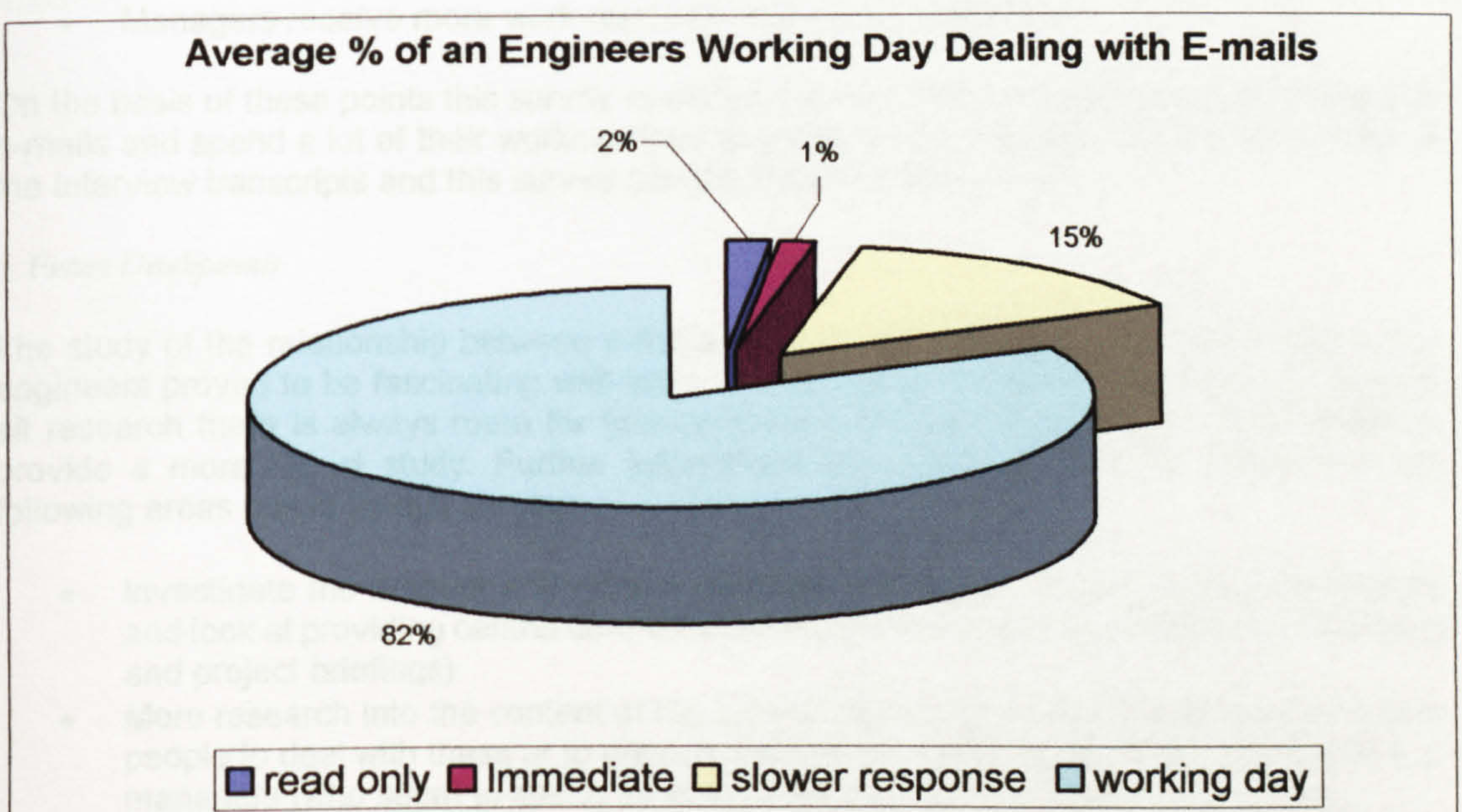
4.5 Average Percentage of a Managers Day Spent on E-mails

This gives quite a clear indication of how dealing with e-mail eats up the manager's time. The figures are indicators of the amount of time managers spend on dealing with e-mails that is a concern here.

Managers seem to have a lot of immediate e-mails (See Figure 4.5) whereas engineers get hardly any (See Figure 4.7). There is less difference in the amount of slow e-mails. Therefore it is the immediate e-mails that are taking up most time. Followed by the read only category then the slower ones. The read only are probably there to ensure good communication within the business and you thus it may not be possible or desirable to reduce these. But where it is possible to improve the situation for the manager is to reduce the amount of those e-mails in the immediate response category. The first question that comes to mind is: are these immediate responses only able to be dealt with by the manager? Also are any of these duplicates?

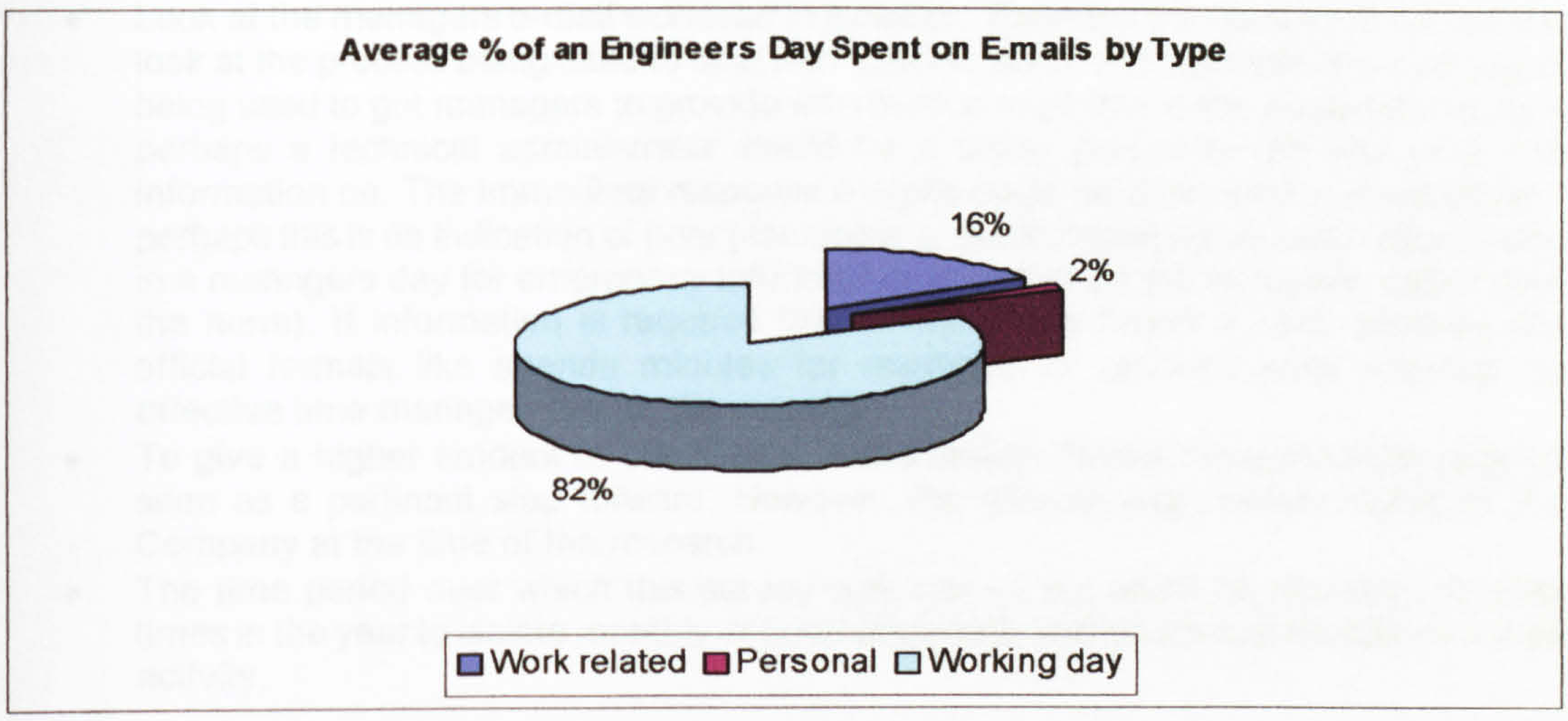


4.6 Average Percentage of a Managers Day Spent on E-mails by Type



4.7 Average Percentage of an Engineers Working Day Dealing with E-mails

Engineers are weighed down mostly by e-mails in the slow category. In a further investigation it may be worthwhile considering the content of these slow e-mails e.g. are these helping the engineering team or are they answering questions; or passing information; or problem solving etc. Or are they issues that should be more effectively dealt with by someone who is more appropriate to deal with them e.g. a team secretary or technical administrator.



4.8 Average Percentage of an Engineers Day Spent on E-mails by Type

Finally examining the time spent dealing with the personal e-mails is pretty negligible

5. Conclusions

The results of this survey provide the following conclusions: -

- Managers receive more e-mails than Engineers
- Managers spend more time dealing with e-mails than Engineers do
- Managers spend on average 47% of their working day dealing with e-mails
- Engineers spend on average 18% of their working day dealing with e-mails
- The immediate category of e-mails is the one that takes up the most time resolving for Managers.
- Managers receive more work-related e-mails than Engineers

On the basis of these points this survey identifies the fact that Managers are overloaded with e-mails and spend a lot of their working time resolving them. This was suggested in some of the interview transcripts and this survey sample supports these views.

6. Future Developments

The study of the relationship between e-mails received by managers and those received by engineers proved to be fascinating with some interesting results produced. However, as with all research there is always room for improvement and modifications that can be made to provide a more robust study. Further information and research could be directed at the following areas raised by this survey: -

- Investigate the amount and type of repeated information sent from several sources and look at providing central co-ordination of communications material (e.g. Company and project briefings)
- More research into the content of the e-mails sent out. In order to identify alternative people to deal with these or to prevent these from reaching particular employees e.g. managers (who seem to spend so much time dealing with those they receive)
- Social e-mails could be dealt with through the Social Newsgroups only – thus reducing the e-mail traffic on the network and the fact that engineers can go there to see them rather than deal with them in their In Box (e.g. jokes).
- Re-run the survey on different areas of the business to test the findings elsewhere.
- Place Company notices and team briefs on the Intranet rather than send e-mails relating to this information to so many individuals. Individuals' responsibility to get the information if they want it.
- Increase the scope of this survey to include all time spent receiving e-mails, dealing with responses to e-mails and using the e-mail to send out messages. This would provide a more holistic view of the usage and efficiency of e-mail.

- Look at the managers e-mail workload in isolation. Examine the content of e-mail and look at the process being used to deal with specific tasks. For example, if e-mail is just being used to get managers to provide information available in the project directory – perhaps a technical administrator would be a better person to get and pass that information on. The immediate response e-mails could be examined in more detail – perhaps this is an indication of poor planning e.g. there should rarely be an interruption in a managers day for emergency information (it should be the exception rather than the norm). If information is required like this then why hasn't it been planned into official formats like agenda minutes for resolution or planned early allowing for effective time management for the manager.
- To give a higher amount of confidence in the results further repeated trials may be seen as a pertinent step forward. However, the sample was representative of the Company at the time of the research.
- The time period over which this survey was carried out could be repeated at other times in the year to isolate monthly or quarterly trends and peaks and troughs of e-mail activity.

Appendix 1

The following document contains the collated data that is used in this study.

"e-mail time spend totals.xls"

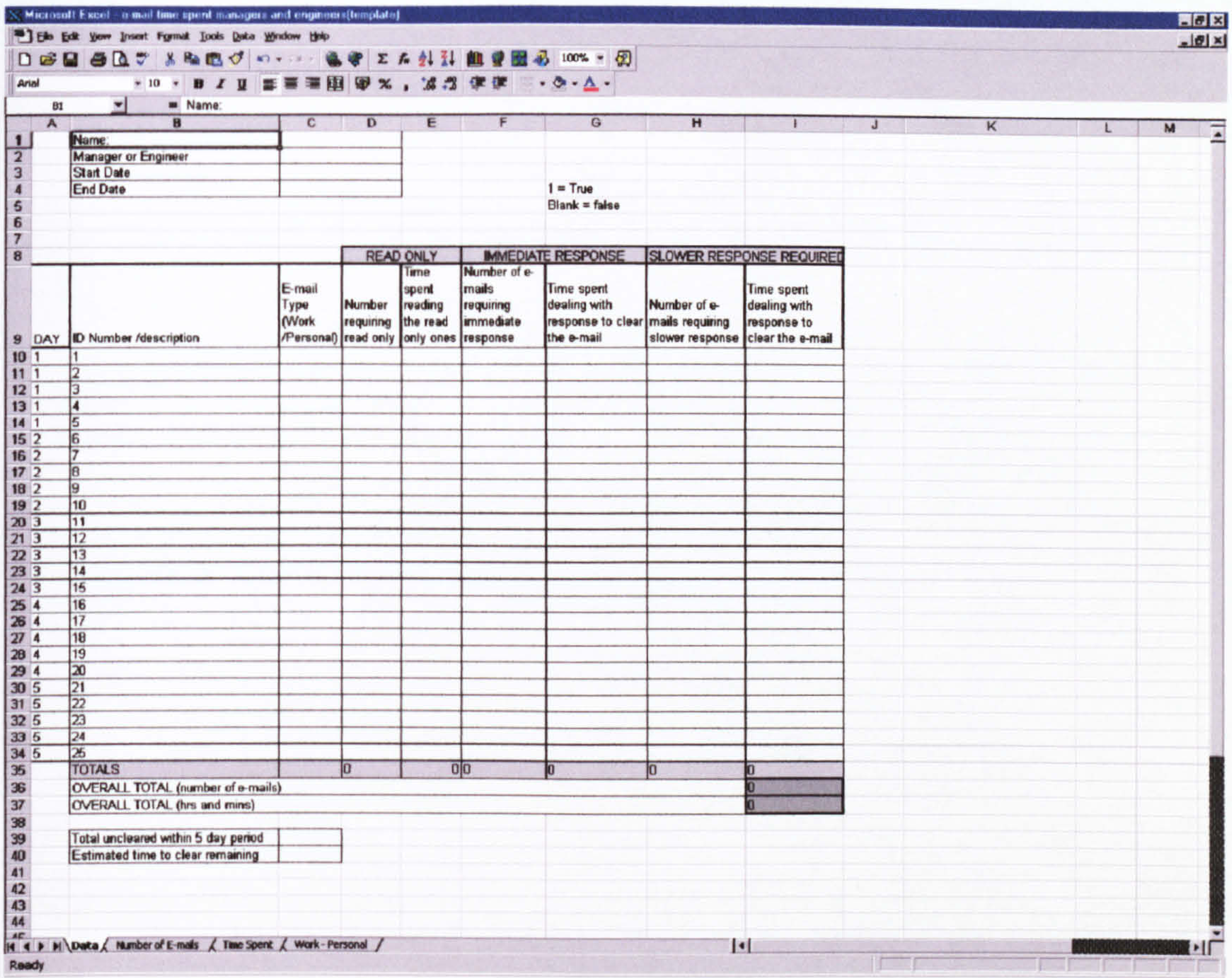
Appendix 2

The following document contains the extra statistical analysis of the collated data that is used in this study.

"E-mail additional stats Version 3.xls"

Appendix 3

The figure below shows the template used to capture the number of e-mails and times of e-mails received by an employee and manager.



Appendix D: Speech Technology Survey

1.0 Introduction

In order to analyse the results of the speech questionnaire, which looks at evaluating the responses of those individuals given the chance to read the Speech Technology Report I have divided the data as follows:

1. The questionnaire was split into two sections, one dealing with the Report as a medium for communicating information
2. The group of individuals in the sample are divided into two groups; group 1 being mainly managers of above a G9 and engineering staff of grade G9 and below (since my doctorate thesis is in exactly the same divisions)
3. Out of twenty-five questionnaires sent out five were not filled in. One of these was due to a serious illness and absence from work the other four gave reasons of being too busy – all five were from Managers Group (Group 1).
4. The response rate for the answered questionnaires was calculated to be 80%
5. The sample consisted of all the Domain Experts on the Christchurch site plus some named individuals who were recommended by the sponsor. The sample included a total of 25 candidates of which ten are engineers and fifteen are managers. Since five managers failed to fill in the questionnaire the graphs illustrate a 1:1 ratio of candidates in Managers (Group 1) and Engineers Group (Group 2).

The questions asked fall into two categories: those concerned with the Report itself and the contents etc. and the Technology involved. These questions were then divided into quantitative responses to which check boxes were ticked using the following options:

SA	Strongly Agree
A	Agree
SLA	Slightly Agree
DK	Don't Know
SLD	Slightly Disagree
D	Disagree
SD	Strongly Disagree

The alternative style of questions relate to the qualitative answers given to open-ended questions which allow comment to be made on the reasons for some of the quantitative answers. Also provided were questions that relate to the usefulness of the technology to the Company and the obstacles to using such technology.

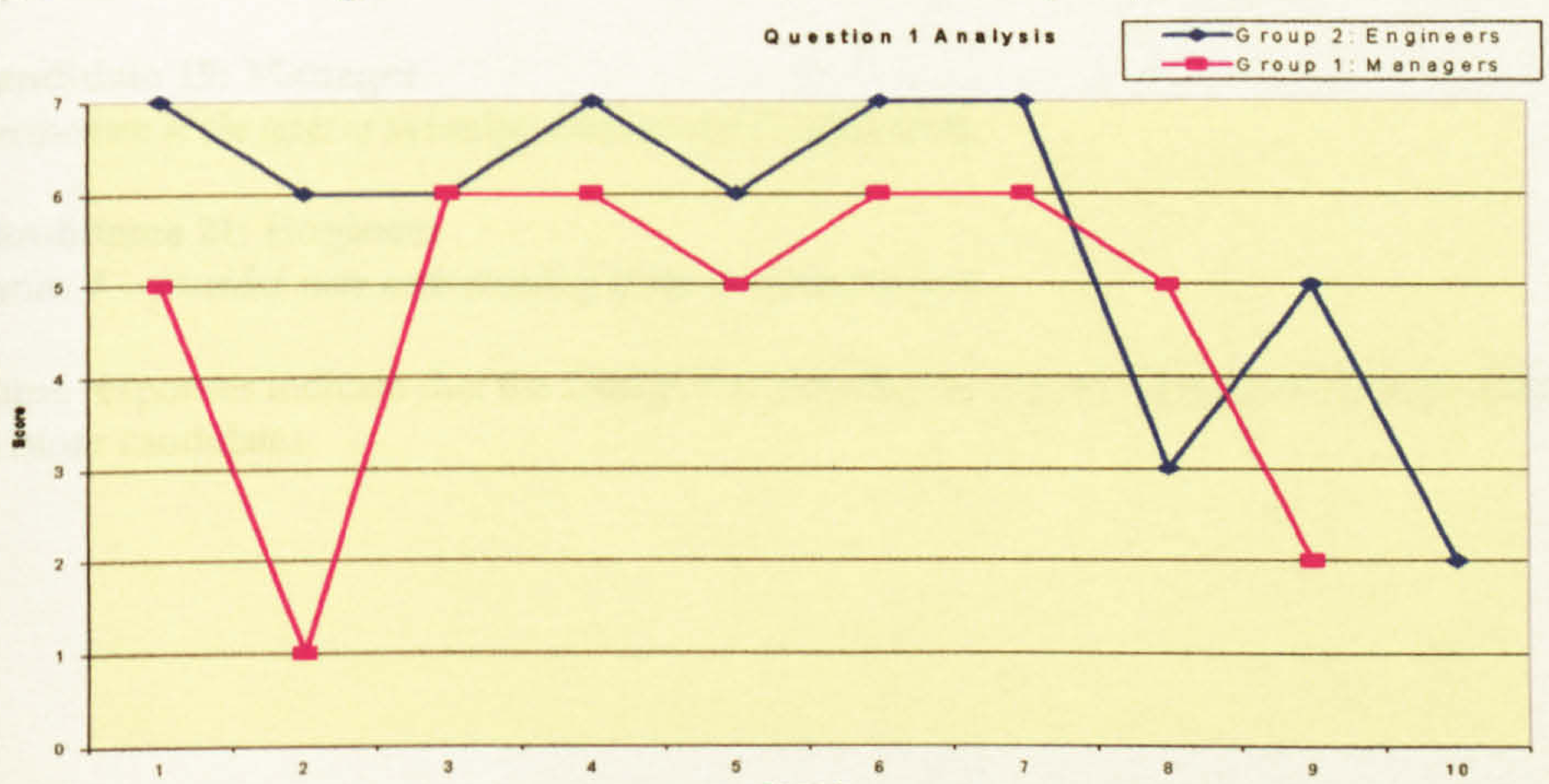
Since the report was written for those in the Domain Experts Group the contents were aimed at this level of understanding.

2.0 The Analysis

In looking at the scores from each group identified the following deductions have been made:

Q1.I have read all of this report

More engineers read the report in the first place. Four out of the five managers who did not respond stated that they had not filled out the questionnaire because they had not had the time to read the report in the first place. Also one manager indicated that he had not read the report yet answered the rest of the questionnaire.



Q2.I have enjoyed reading specific sections of this report

The majority of answers to this question are positive with ten agree or strongly agree replies across both managers and engineers but the stronger responses are from the engineers. Most people enjoyed reading specific sections of the report and the candidates as referenced made the following comments: -

Which ones and why

Candidate 1: Engineer
I thought the Design Factors section was very well done and it allowed me to rapidly gain an understanding of the subject so that I could assess the benefits and problems involved with this technology.

Candidate 2: Engineer
Design factors section provided useful insight into different aspects of speech technology and current state of the art.

Candidate 3: Engineer
No one specific section. Mainly the areas that describe the technical problems, how they are resolved at present and how they may be resolved in the future. Section 3 mainly covers these issues.

Candidate 4: Manager

Section 3: because I am a masochist! – no, because I had some vague knowledge of speech technology but needed an update. I am coming at it from two angles – (1) use with communications systems (would be interested to know if the techniques are applied to coder / decoders for error-tolerant low bit rate digitisation and (2) as an input device for communications management systems.

Candidate 7: Manager
Speaker dependency and noise (3.2 and 3.5) – confirmed some prejudices and corrected others.

Candidate 8: Manager
Section 4 – implementation – interesting comparisons to guide my ability to assess the suitability for future applications
Section 3 – design factors – gained better understanding of the technology.

Candidate 9: Manager
I have browsed through the document and will use it to support any needs in this area

Candidate 15: Manager
Particularly in the areas relating to microphone performance, the performance of speech in noisy conditions and the type of speech recognition algorithms available.

Candidate 16: Engineer
Summary of products available – useful for future products
Summary of technology – interest

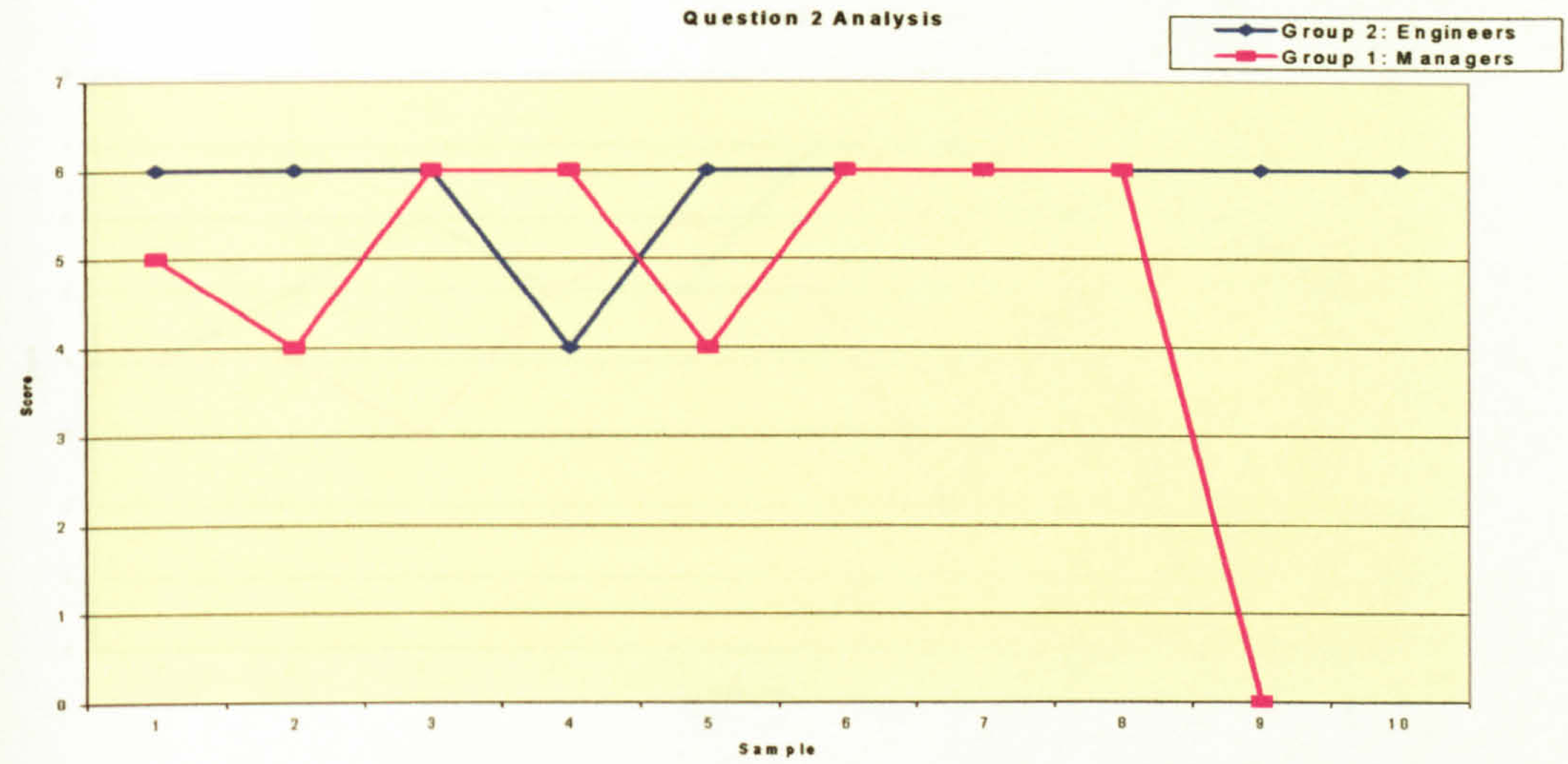
Candidate 17: Manager
Introduction and design factors.

Candidate 18: Engineer
Hard to single out, I suppose it isn't specific sections I've enjoyed reading, more a general introduction to the technology, the sort of problems faces and the analysis of the currently available solutions.

Candidate 19: Manager
Comparison of the types of technology involved and its applicability

Candidates 21: Engineer
Section 4 – provided some understanding of the available products

These responses indicate that the Design Factors chapter was recognised as being probably the most useful to more candidates.

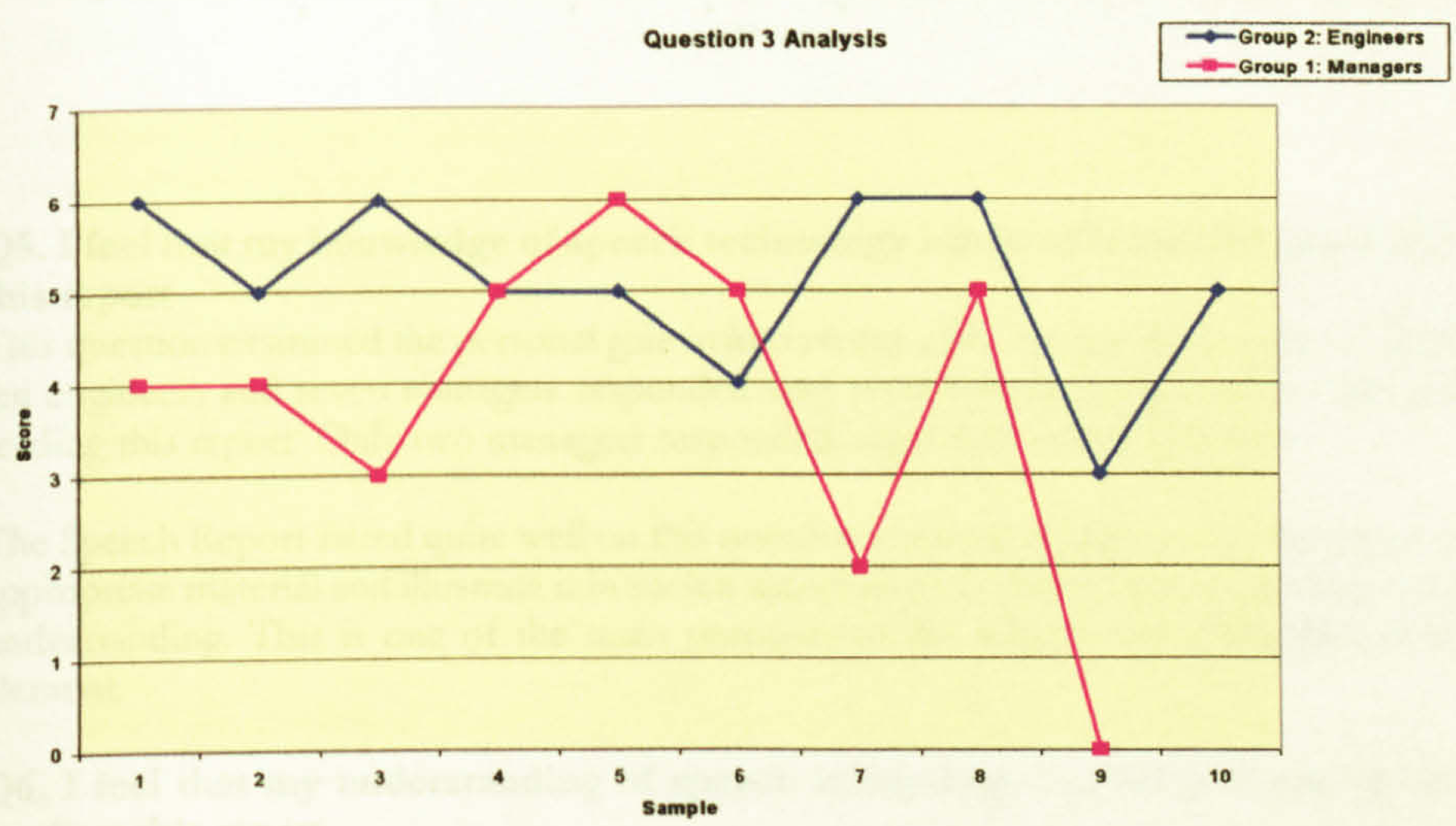


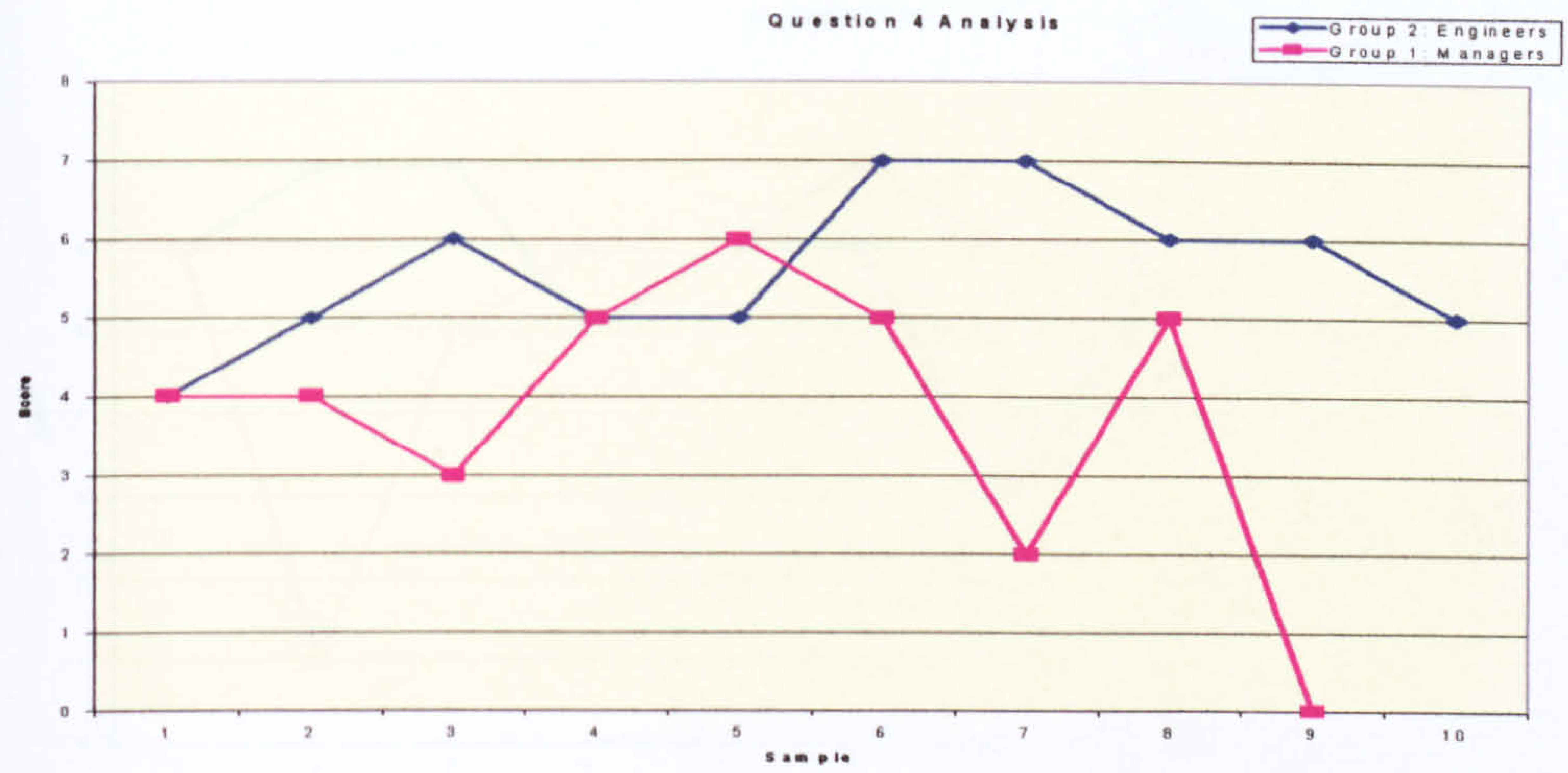
Q3.I will find this report useful for the type of work with which I am involved

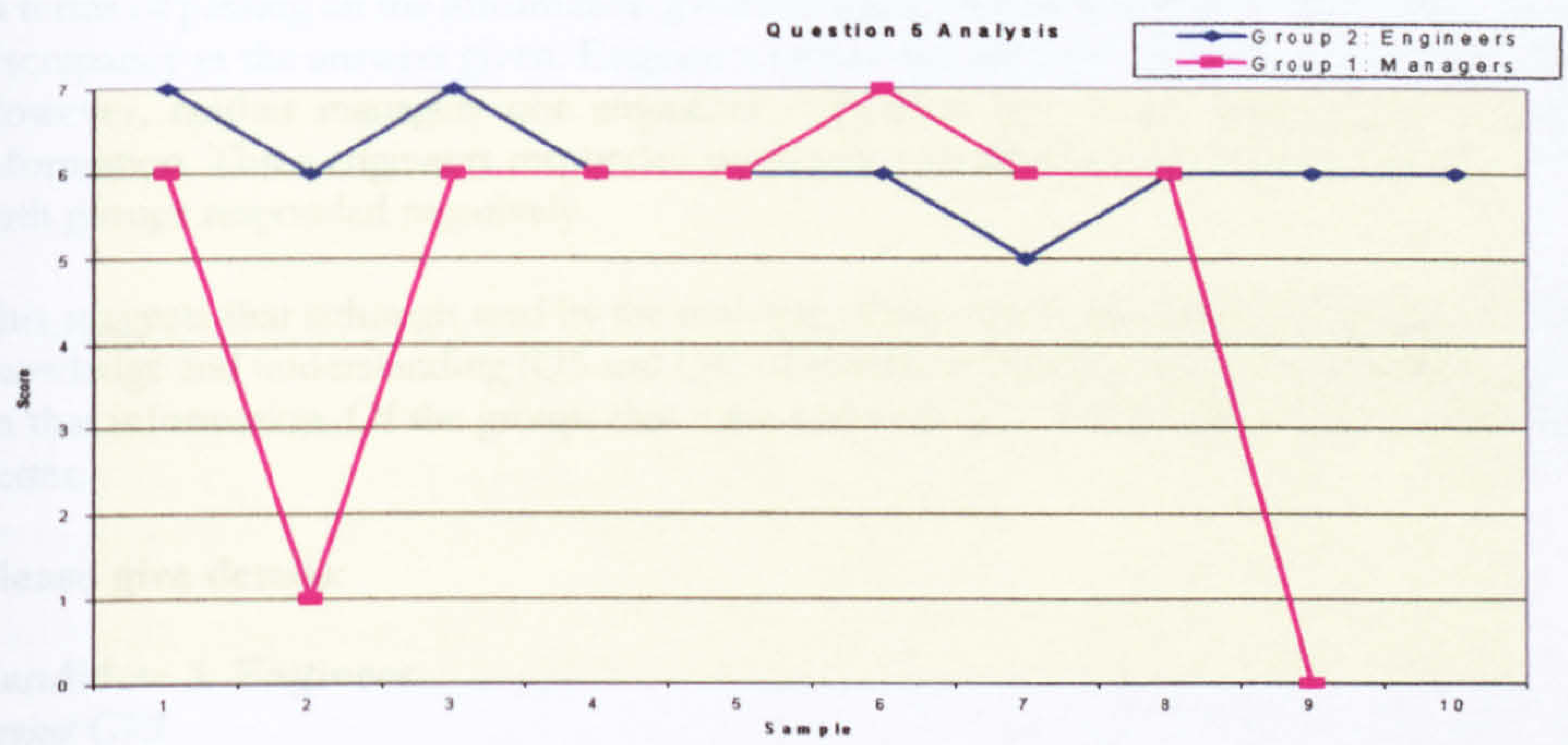
An important question relating to the actual usefulness of the report to individual for doing the work that they are doing, this question raised the following responses. Ten candidates of whom seventy per cent are engineers responded positively to this question suggesting that the material contained in this report would be useful to their work. Three managers responded by disagreeing with the relevance of the technology to their work and three candidates did not know the relevance to their work.

Q4.This report is relevant to my role within BAe

A similar question to question three sought to see the relevance of the Speech Technology material in the report to the Domain Experts role in BAe. In this case the engineers were more positive than the managers were once again. Thirteen candidates of which 69% are engineers responded very positively, whereas three managers responded with negative answers and one other manager did not know.







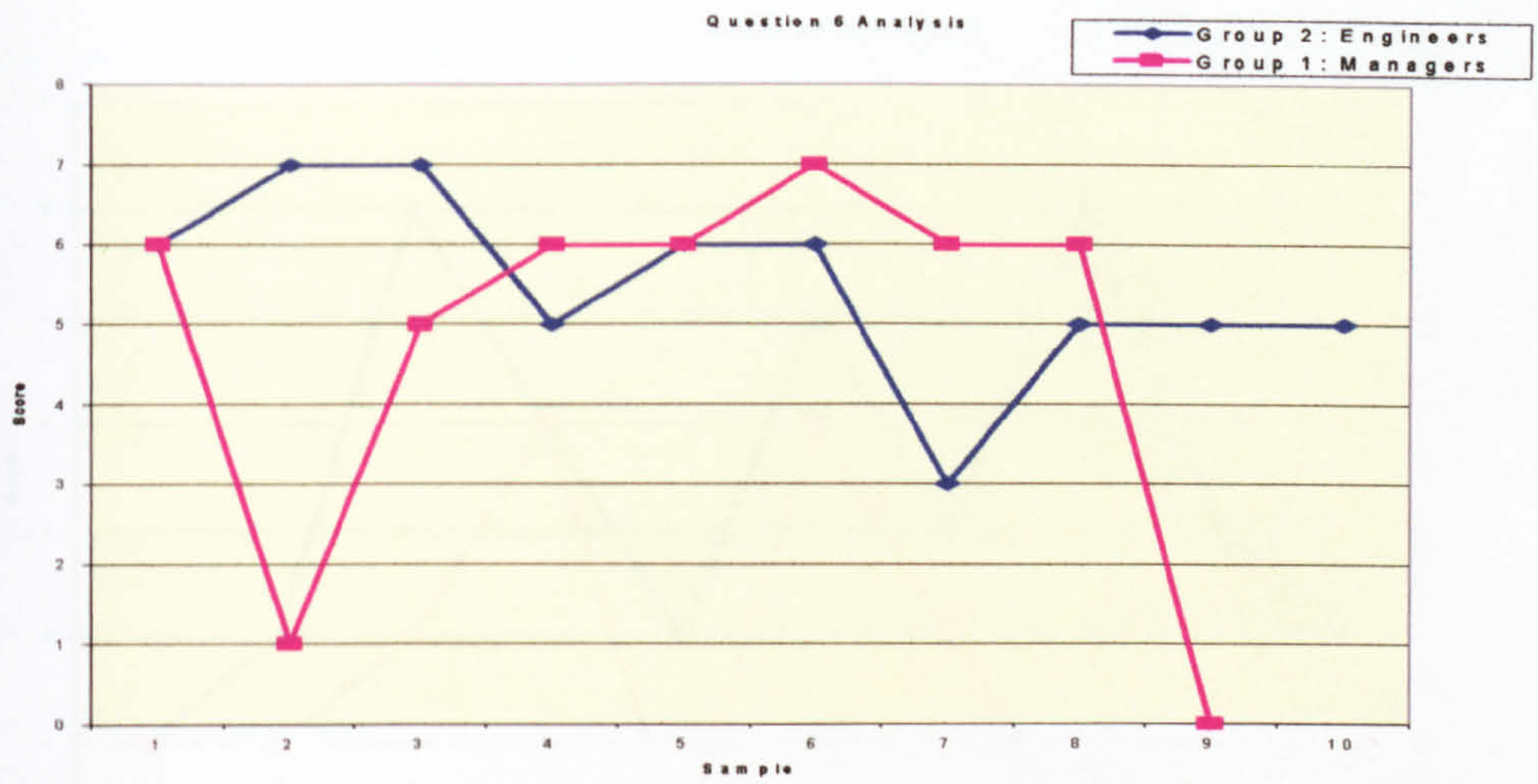
Q5. I feel that my knowledge of speech technology has been improved as a direct result of reading this report

This question examined the personal gain in knowledge after reading the report. In answering this question ten engineers and seven managers responded very positively showing that they had gained knowledge by reading this report. Only two managers responded negatively to this question.

The Speech Report faired quite well on this question showing that it has met the requirement to research the appropriate material and illustrate it in such a way that the Domain Expert can understand it easily and gain understanding. This is one of the main purposes of the Report and it has definitely succeeded in this element.

Q6. I feel that my understanding of speech technology has been improved as a direct result of reading this report

This question examined the increased understanding of speech technology. Here the results consisted of sixteen positive responses made up of nine engineers and seven managers and three negative responses. Once again it shows that both groups gained in their understanding of speech technology.



Q7.I have passed on useful information from this report to other projects

In terms of passing on the information gained from this report throughout the Company there was a bigger discrepancy in the answers given. Engineers responded far better than the managers in taking on this task. However, neither managers nor engineers responded by strongly agreeing that they would pass on information. Three engineers responded positively, two managers did not know and nine candidates from both groups responded negatively.

This suggests that although read by the majority of the sample and positively adding to both of the groups knowledge and understanding (Q5 and Q6) of speech technology very few candidates were willing to pass on that information. Of the groups that were willing to pass on that information - the engineers faired far better.

Please give details:

Candidate 3: Engineer
Project GP3

Candidate 4: Manager
I have the report on file and will certainly be copying out as necessary

Candidate 8: Manager
Not yet but application in noisy vehicle environments is very important.

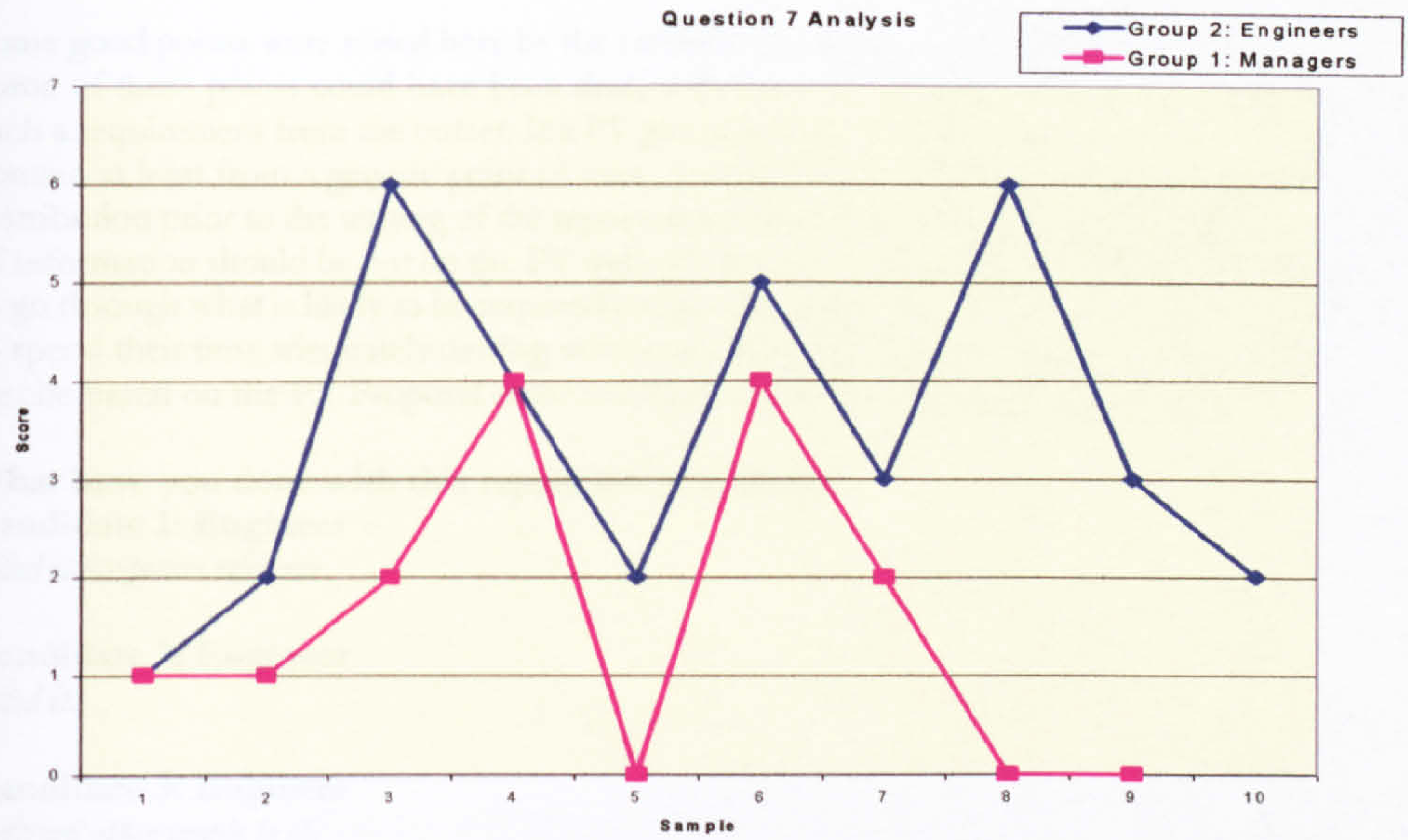
Candidate 9: Manager
Not yet.

Candidate 15: Manager
Not yet but I will do

Candidate 18: Engineer
I have not passed information on to other projects yet but will do if the opportunity arises and it is appropriate to do so.

Candidate 19: Manager
Not yet

The qualitative comments recorded here emphasise the fact that the only real substantial answer is that the report has been filed away somewhere. Therefore if someone else in the Company wants to know what the report was about and whether the information contained in it is useful to them then he needs to go out and find out if it even exists. Unless the Domain Expert or the PV manager records the report somewhere or references it for others to find then the information could lie undisturbed in filing cabinets throughout the site. By passing on the information somehow it will prevent re-work by others in the Company elsewhere and will promote Best Practice principles and effective re-use of that research and information.



Q8.There are areas of this report, which I feel could be expanded/developed

In response to improving the report the sample revealed that five engineers and five managers sought improvements to particular aspects of the report. Some comments captured in their responses include:

Please give details:

Candidate 1: Engineer

I feel that the integration work carried out on the BETA TD project could have been made more visible and the lessons learned from that made available as a technical report.

Candidate 2: Engineer

A vision of where speech technology might be in say 5 to 10 years time would help in determining what we, as a business, should be doing. Report tended to focus on the positive aspects of the DERA solution. Perhaps we need to note that there may be a risk that DERA, as a research organisation, may not continue to develop (or support) the product as necessary for our use. Possibility of partnership with DERA?

Candidate 4: Manager

I needed an overview of speech / voice recognition technology – hence I was overwhelmed by the existing content and therefore could not comment on expansion / further development. This kind of quality as opposed to quantity is always appreciated.

Candidate 7: Manager

Wider range of products assessed – appreciate limited due to funding.

Candidate 8: Manager

More analysis of solutions other than Aurix

Candidate 9: Manager

Did not read to the level of detail which would enable me to make a judgement other than it seems very comprehensive and well written.

Candidate 17: Manager

Business implications
Opportunities for military use.

Candidate 19: Manager

(1) *The report assumes that it is a requirement for speech recognition on several projects such as Bowman and that this is understood by the reader. It does not explain what that requirement is so it is difficult to follow an argument that recommends this route.*
(2) *From a security point of view, its not clear to me why voice recognition should offer any stronger mechanisms than those we already use.*

Candidate 21: Engineer

Accuracy must be a major concern – it would be useful to understand the consequences of 80% accuracy and under what conditions this accuracy was measured etc.

Some good points were raised here by the candidates which can improve future reports of a similar nature. Some of these points could have been dealt with but others could not due to the resources and a lack of such a requirement from the outset. If a PV group were to sit down and go through what the reports should contain at least from a generic point of view, as well as provide the appropriate guidance as to format and distribution prior to the writing of the reports it would provide a more efficient response. Perhaps this kind of information should be put on the PV web site. It may be appropriate to have a discussion group meeting to go through what is likely to be required by specific reports for the company thus allowing the researchers to spend their time adequately dealing with issues that the Company wants uncovered. Reliance should not just be based on the PV Proposal alone – it does not go far enough for report production.

What have you done with this report since reading it:

Candidate 1: Engineer
Filed it for future reference

Candidate 2: Engineer
Filed it.

Candidate 3: Engineer
Referred other people to it.

Candidate 4: Manager
Filed it

Candidate 7: Manager
Nothing. No current applications within my area

Candidate 8: Manager
Nothing yet but I have attended demonstration organised by Andrew Harmer.

Candidate 9: Manager
Nothing although the usage of Bowman UDS and BETA TD is highly relevant to FBMS and Digitisation.

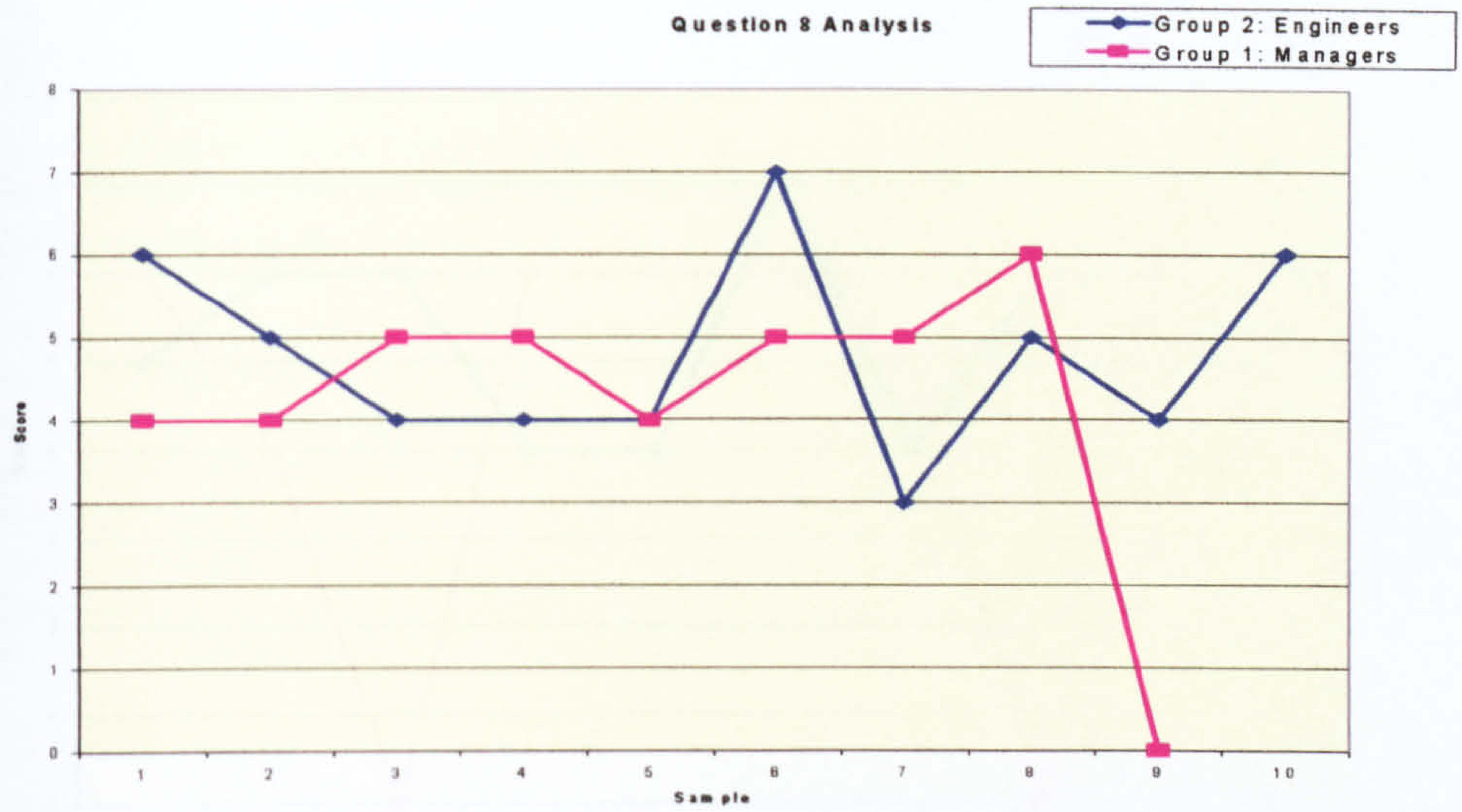
Candidate 15: Manager
Still in my case but I intend to distribute it round the Tactical Radio Laboratory

Candidate 17: Manager
Nothing

Candidate 18: Engineer
The report has been circulated within the Radio Engineering Dept. we have not made direct use of it yet though.

Candidate 19: Manager
Nothing yet

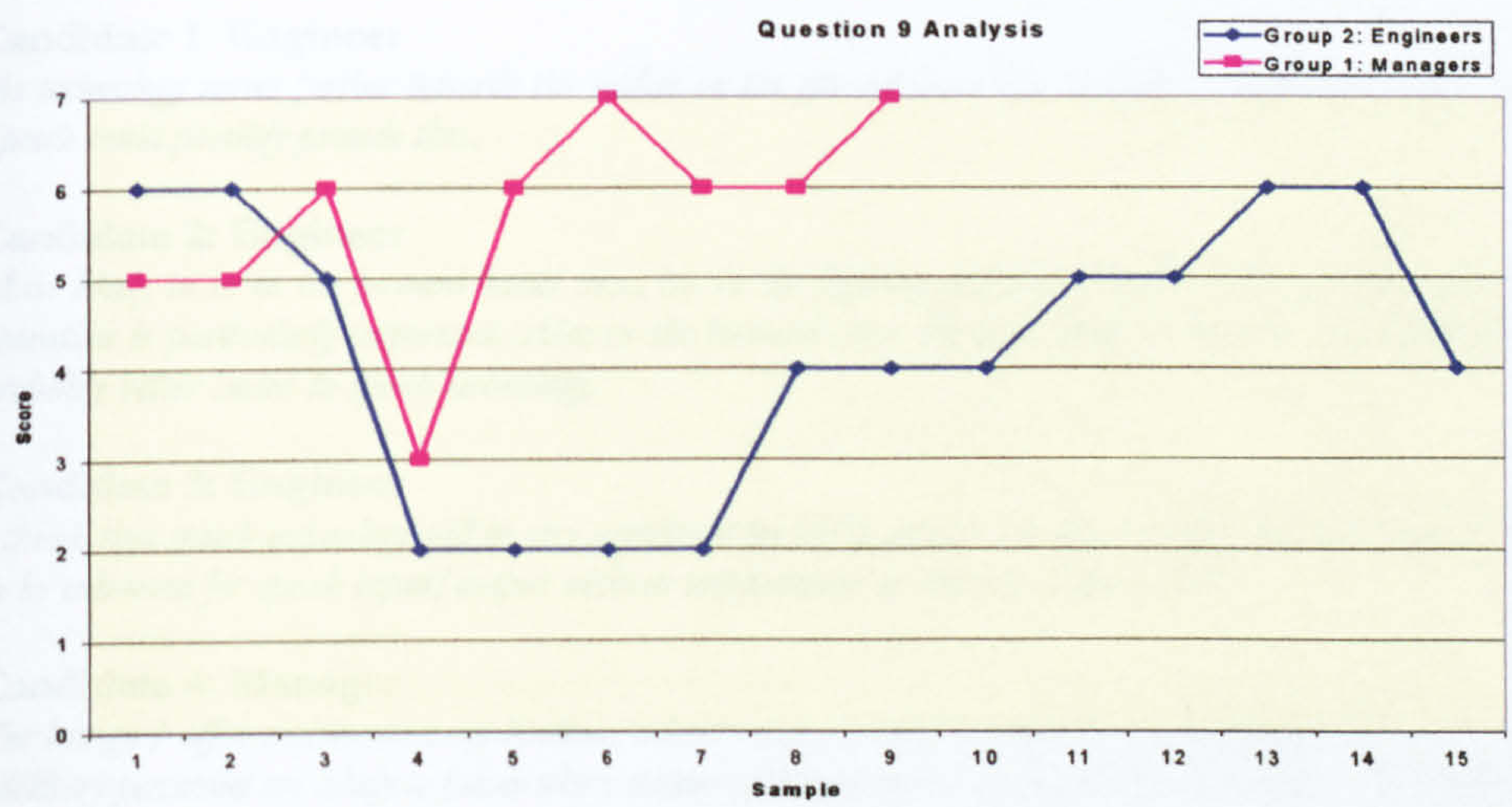
Candidate 21: Engineer
Nothing



In most cases most candidates did little with the report up to nine months after it had been sent out. This just adds weight to my previous answers suggesting that the Company needs to rectify this by putting in a mechanism to deal adequately with such reports and research.

Q9.If given an opportunity to attend a presentation on speech technology I would attend

In determining the interest in a presentation of speech technology the managers responded more positively and the engineers more negatively to this question. Eight managers were keen to attend and one definitely did not want to attend. Eight engineers were interested in attending but four did not know and four definitely did not want to attend a presentation.

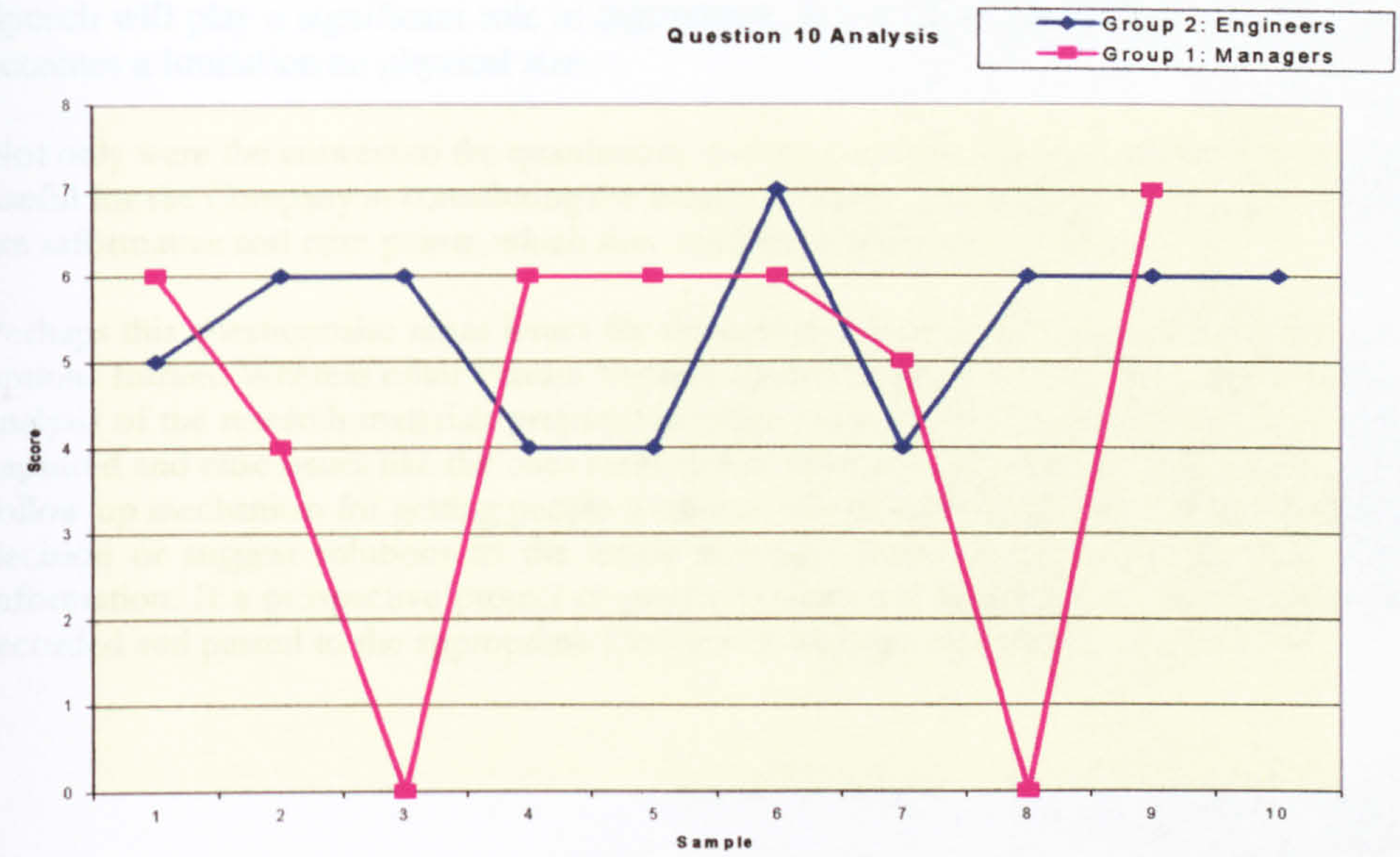


Q10.I feel others within the company may gain value from attending such a presentation

Seven engineers felt there were others within the Company who would benefit from a presentation and three did not know. Whereas six managers thought there were others that would be interested and three replied negatively this question.

Please give contact names:

Several candidates actually named suitable interested parties.



Q11.I feel that speech technology will have significant implications for future BAe applications

All the answers from both candidate groups were very positive to this question. Eighteen candidates consisting of ten engineers and eight managers felt that speech technology has potential within BAe products. Only one manager was not sure.

Please give details:

Candidate 1: Engineer
As technology moves further towards the soldier on the ground there is a need for a single, lightweight and reliable interface. Speech could possibly provide this.

Candidate 2: Engineer
Most likely to be in the forward battle area, i.e. in the fighting vehicles or troops on the ground, where hands free/eye free operation is particularly important. Also in the forward area, the task tends to be much more defined/constrained and so probably better suited to speech technology.

Candidate 3: Engineer
I think that speech technology will be very significant for HCI aspects. Ideally, however, speech technology will allow applications to be enhanced for speech input/output without implications on the rest of the system.

Candidate 4: Manager
For benign / office environment applications take-up will probably be rapid as the 'technology' may be seen as 'this months toy'. Military personnel are likely to follow where commercial applications lead – need to demonstrate the benefits and advantages to them – they don't care how it works, only whether it works and how well.

Candidate 7: Manager
Probably more for CCIS rather than for strategic communications

Candidate 8: Manager
The military combat environment demands hands free information exchange if emerging information technology is to be fully exploited.

Candidate 18: Engineer
Again it is hard to be specific. I feel that it is likely to impact future projects though I have no actual prospects in mind at the moment.

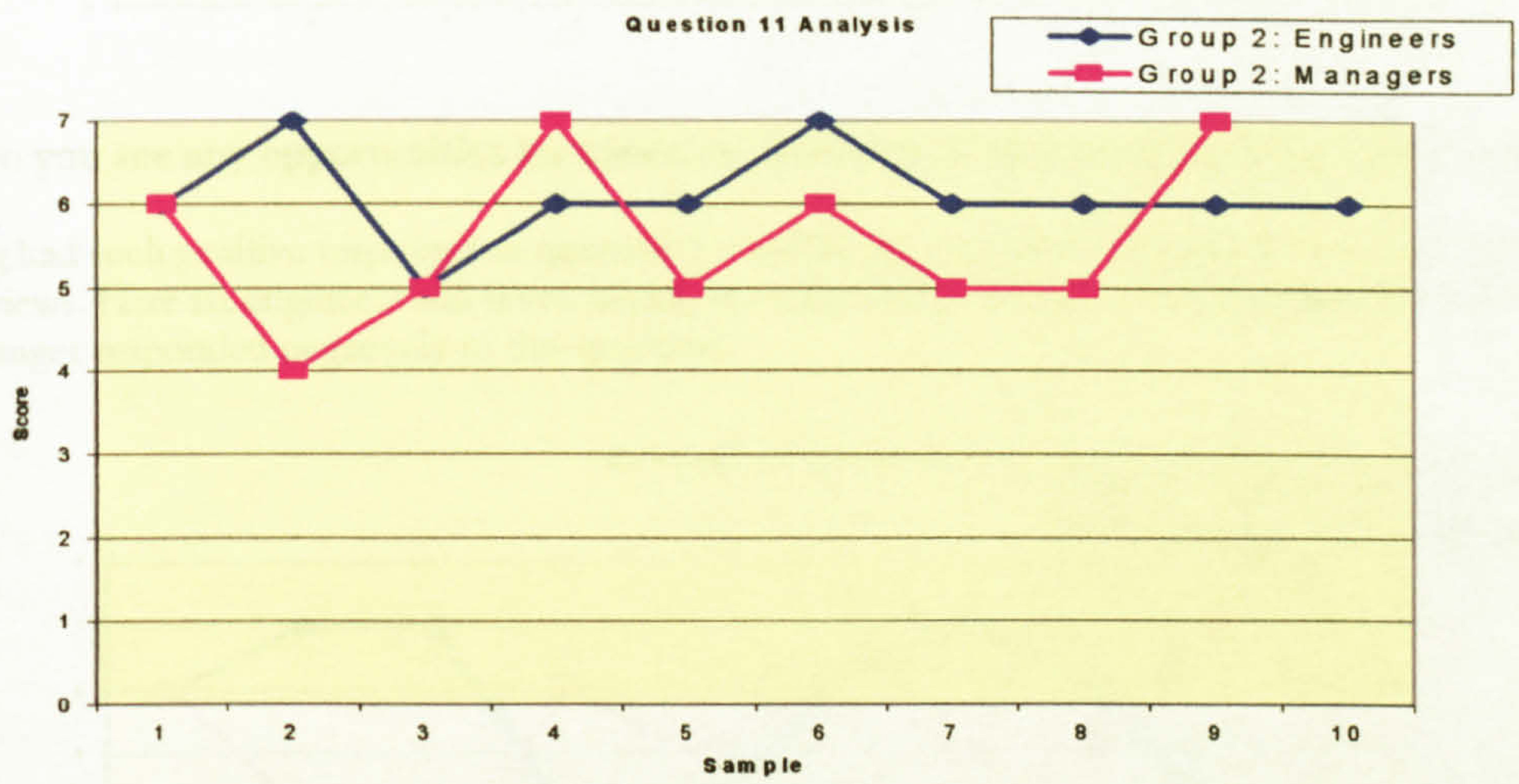
Candidate 19: Manager
For most of our applications there needs to be a foolproof element. There is a danger that we need to provide a fallback of conventional technology as well, which may limit the take-up by customers.

Candidate 20: Manager

Speech will play a significant role in digitisation. It will be of operational benefit where current HCI becomes a limitation on physical size.

Not only were the answers to the quantitative questions good but good comments were made which were useful for the Company in considering the future of Speech Technology. Most suggestions and comments are informative and raise points, which may need to be addressed by BAe.

Perhaps this questionnaire raises issues for discussion, which is advantageous if BAe want to explore the options further. Whereas other Private Venture funded research may not have examined any follow up or analysis of the research materials prepared in other cases, so there is no opportunity to get peoples views captured and raise issues like the ones identified in this case. Also perhaps this suggests there should be a follow up mechanism for getting people to discuss the outcomes of the PV research and perhaps make a decision or suggest solutions to the issues and pass those on to the people who need to have this information. If a prospective project or product comes out of the PV funded research this needs to be recorded and passed to the appropriate Director or Manager to seek the way forward.



Q12.I feel this technology has much to offer BAe

Once again the majority of candidates responded positively to this question. Eight managers and nine engineers gave a positive answer and two candidates did not know.

Please give details:

Candidate 1: Engineer

I do not think this technology will have much impact at the Company level.

Candidate 3: Engineer

It certainly has much to offer the customer. What it offers BAe depends upon whether we have a technology edge or whether we are just a vendor that understands the technology well enough to incorporate it effectively (as a COTS product) into our products. I would think we err towards the latter.

Candidate 4: Manager

No more so than many other 'new technologies'. Still difficult to predict the impact – surely this technology will be available via other commercial suppliers – and BAe will just integrate it with their products. I'm not sure how we can turn speech recognition into a unique selling point – unless we really are ahead of the game!

Candidate 8: Manager

Its use must be examined carefully for use in Digitisation projects such as FBMS, BGBMS, Tracer and Bowman.

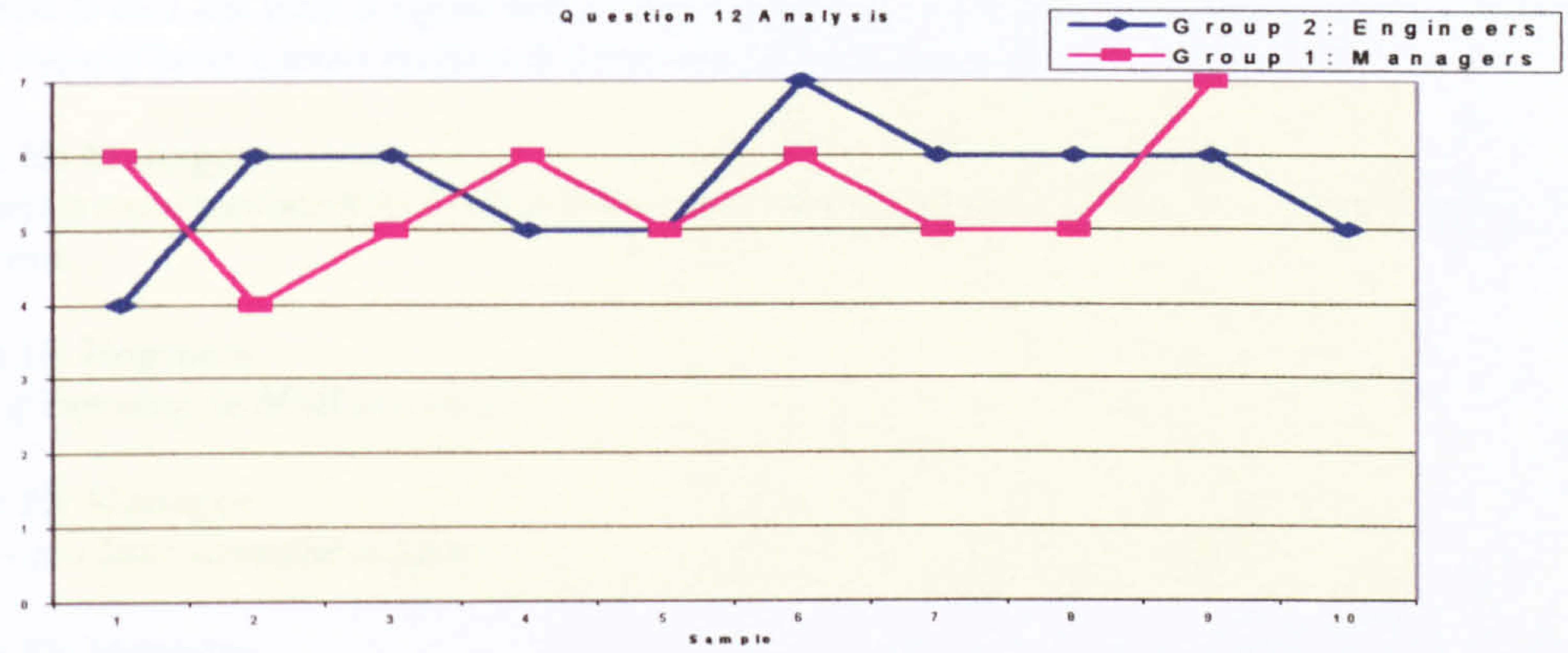
Candidate 19: Manager

For most of our applications there needs to be a foolproof element. There is a danger that we need to provide a fallback of conventional technology as well, which may limit the take-up by customers.

Candidate 20: Manager

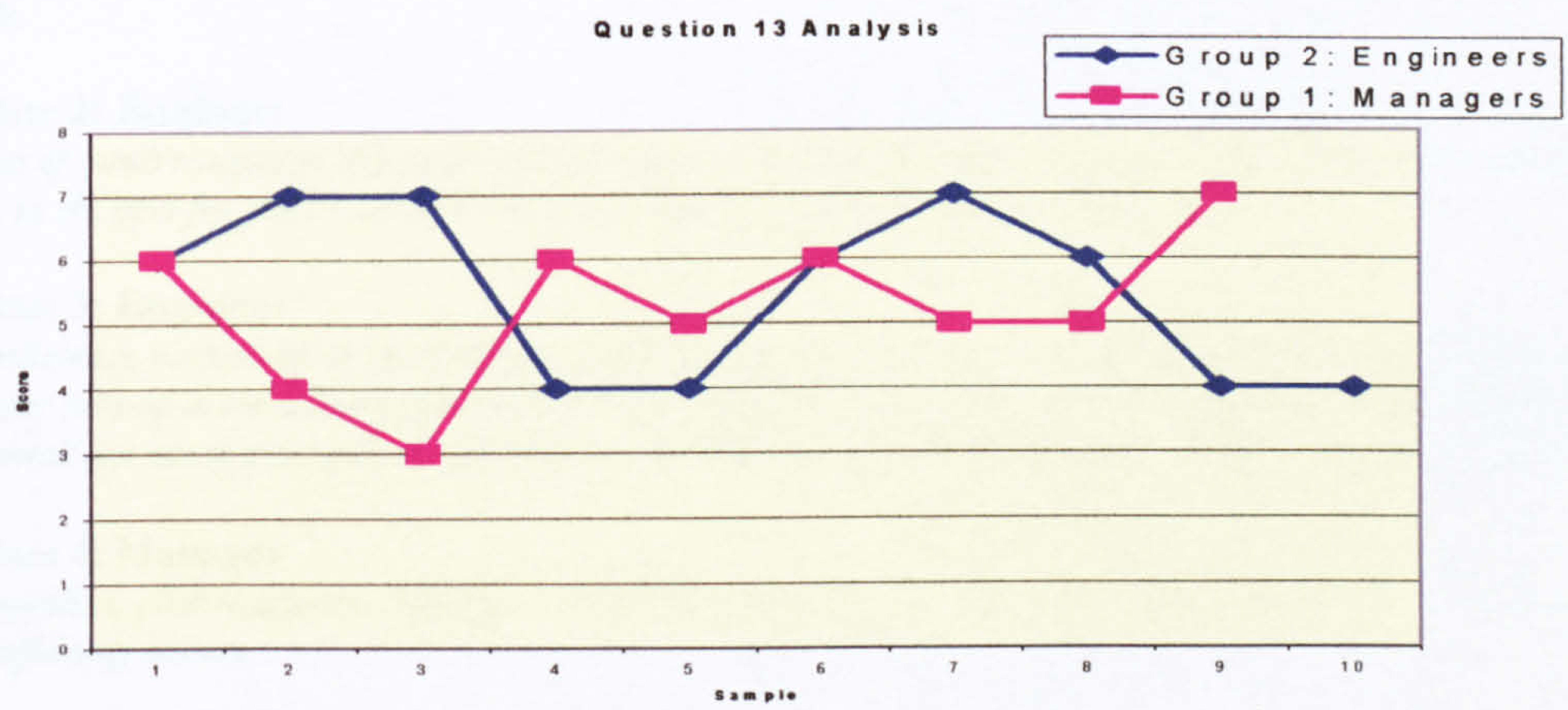
This will benefit many products/projects. Research and investment in this area will also maintain the Company's position in leading edge technology.

This question demands a similar answer to the previous one. Responses to the questions in terms of comments are recorded here but this is just a one off experiment to capture the strengths and weaknesses in the use of information in the Company at this particular level. There needs to be a mechanism for capturing the responses to such research and discussing them.



Q13.Do you see any opportunities for speech technology to be used in current/future projects

Having had such positive responses to question 11 and 12 the answers to this question are also in line with those views. Here six engineers and seven managers responded positively. Five candidates did not know and one manger responded negatively to this question.



Where do you see speech technology best utilised in BAe products and why

Candidate 1: Engineer
In hand-held devices such as personal communications or navigation systems. For most desk-top systems a mouse a keypad will prevail.

Candidate 2: Engineer
The Bowman UDS and the BGBMS are probably the most likely short term prospects. Also possible use in future tactical PABX products for subscribers to request services by voice rather than keypad and for automatic voice messages.

Candidate 3: Engineer
We are already offering it as an option for the production UDS and have included it in our prototype. In the military scenario it is very important because it allows hands free operation and operation in difficult physical environments. Voice annunciation also allows rapid and easy comprehension of information without distracting the user from other activities.

Candidate 4: Manager
Entry of commands into communications management information systems and voice dialling, e.g. 're-route bearers A, B and D to RAF Wortfunk'.....Connections of speech dialling to Directory server on telecommunications systems. This seems to be 5-10 years away to me, but must be human factors dream come true. Commercial world will lead the way – they have the economics to do it.

Candidate 7: Manager
Not in areas directly of concern to me

Candidate 9: Manager
There is a desire in the Land sector to explore both the direct input of voice over radio nets and/or direct voice input to help maintain the tempo of battle. Current hardware is a limiting factor in any short-term aim.

Candidate 15: Manager
Speech synthesis in radios particularly for BITE outputs. Speech operation of radios. Efficient data transfer of speech messages over a radio link.

Candidate 18: Engineer
As a means of improving the MMI to a system

Candidate 19: Manager
Data entry – as a faster alternative to typing

Candidate 20: Manager
As detailed above, small devices that require an extensive HCI are limited in their physical size by the size of readable displays and button/keyboards. Speech I/O will overcome this ones it proves reliable.

What are the obstacles you see in utilising speech on your project

Candidate 1: Engineer
Mainly its reliability. There is still an unacceptably large error rate and providing support for all languages/dialects is still impossible.

Candidate 2: Engineer
Robustness of speech recognition still seems to be an issue and it is not clear to me that the technology is sufficiently mature yet. However, in the next few years I am sure that it will become a key technology on the battlefield.

Candidate 3: Engineer
Lack of reliability, particularly in environments with impulse background noise. For this reason I expect voice annunciation to have a faster take-up in the military scenario than voice recognition. There is an additional cost incurred. This could be turned into an overall cost saving if the voice recognition was reliable enough to allow other data entry mechanisms to be dispensed with.

Candidate 4: Manager
False recognition, poor recognition reliability, limited vocabulary, unreliability. Must demonstrate systems to customer once deemed sufficiently mature.

Candidate 7: Manager
Strategic applications – workload not such as to favour speech over keyboard. Need for accuracy with a range of speakers (e.g. military personnel on shifts) would need to be improved.

Candidate 8: Manager
Criticality of accuracy in translation in noisy combat environments

Candidate 15: Manager
No money!

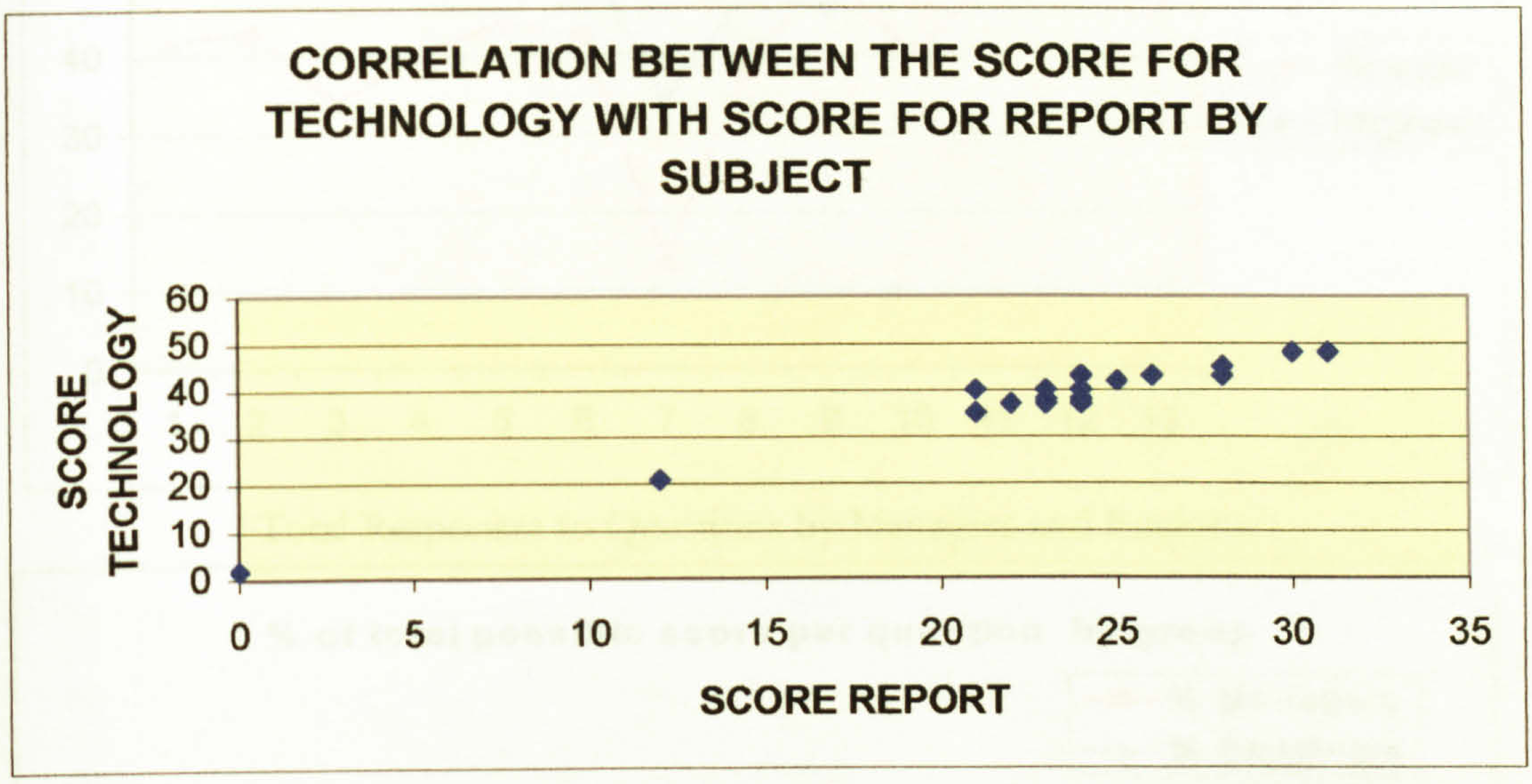
Candidate 18: Engineer
In radio projects in general (Combat Net Radio) the environment in the field is very noisy making the use of this technology difficult.

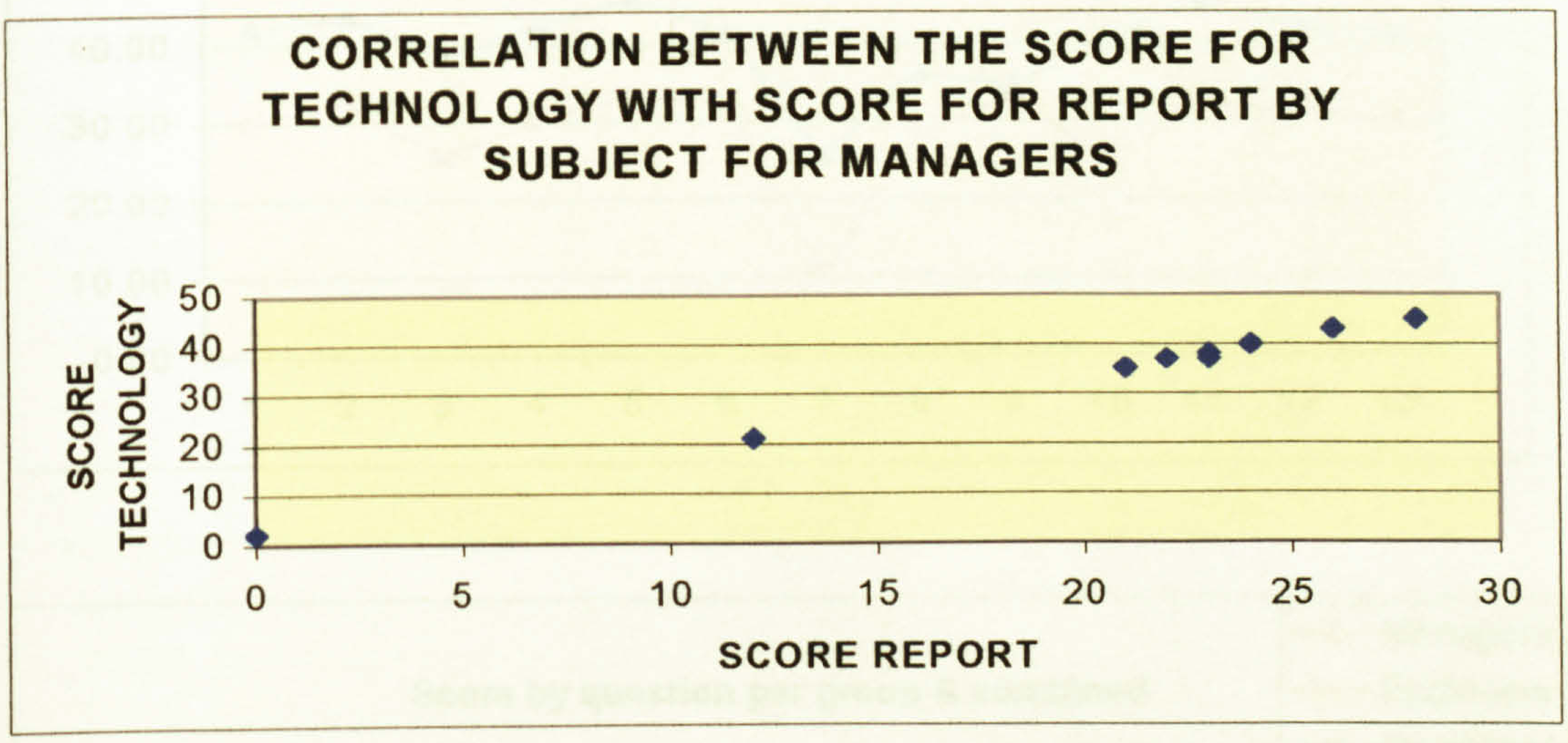
Candidate 19: Manager
Cost, reliability, the need for a fallback and the need for the user community to be convinced.

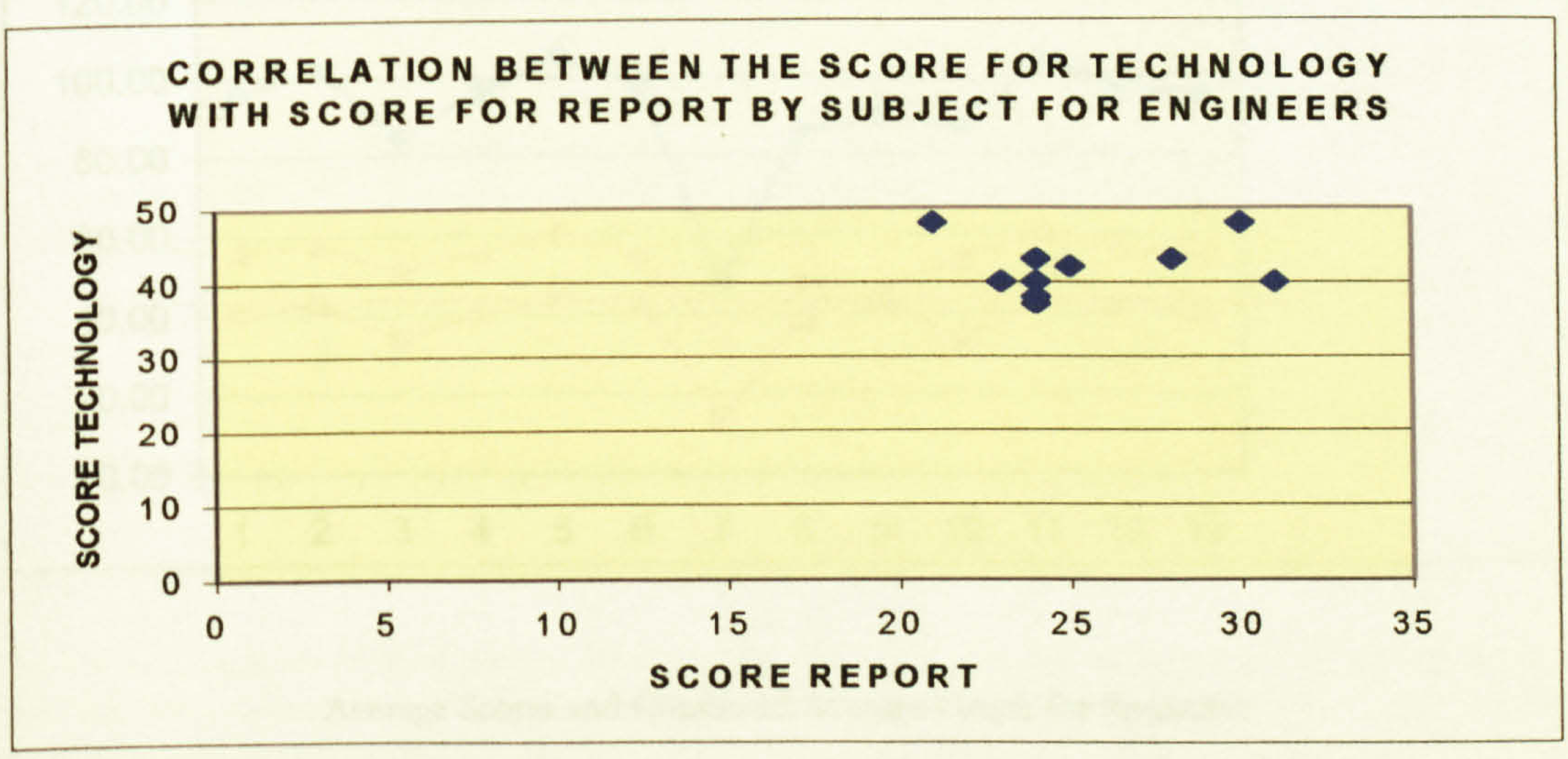
Candidate 20: Manager
The customer's need/view of this technology needs to be worked on. HCI design approach is different with speech and the cost of retrofitting the technology will be expensive.

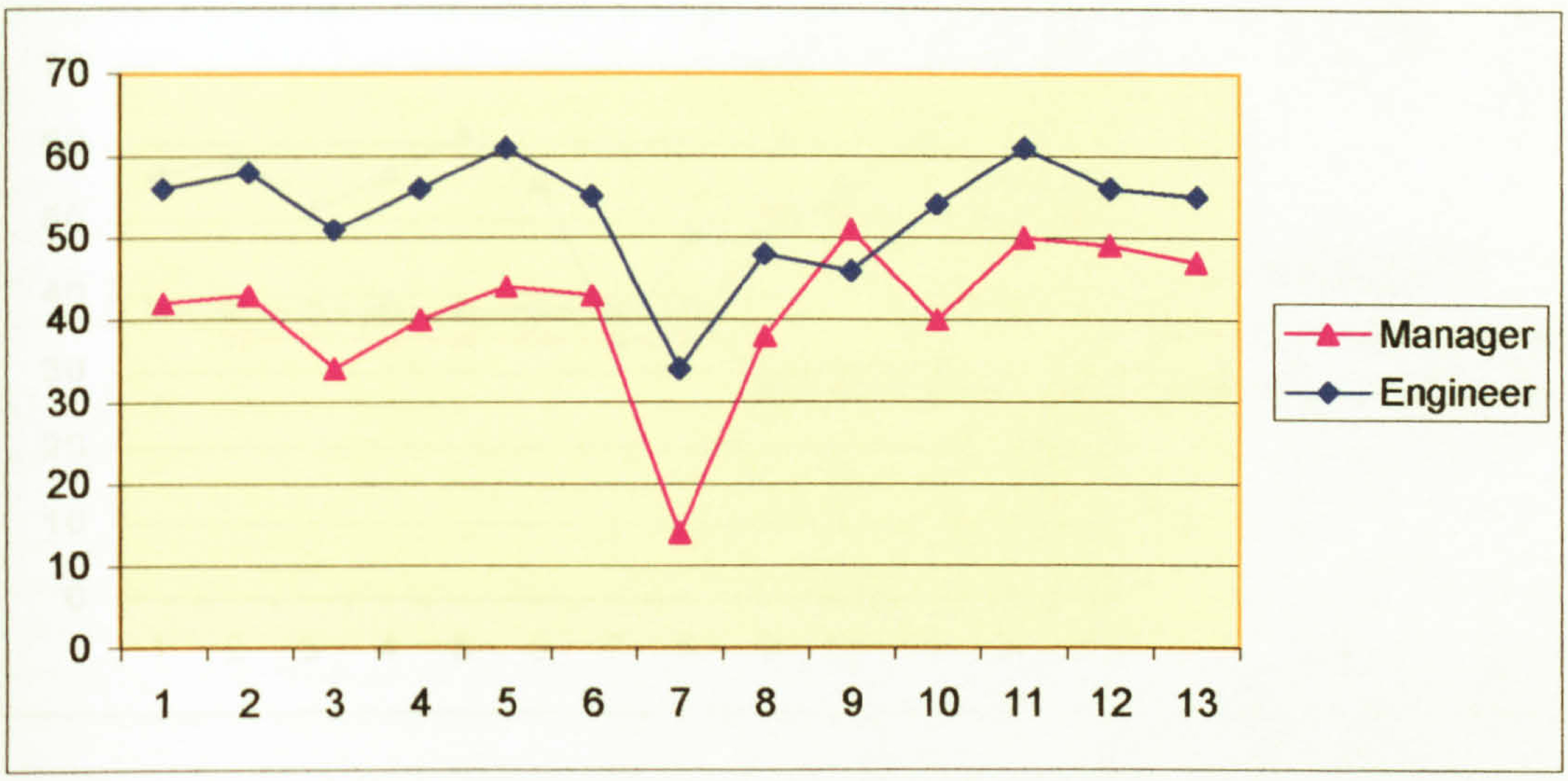
These last questions allow the candidates to respond to them quite openly so that they can say as much or as little as they like in order to suggest alternative product areas and obstacles in developing such products.

Once again these are captured here but they are captured as an exception rather than the rule since as far as I am aware no similar mechanism exists for getting such feedback on other PV funded research. However now that this is captured how will this information be used by the Company to look at the PV process and the information generated by it and make it easily available to others, distribute it correctly and assess it in some way in order to make an appropriate decision.

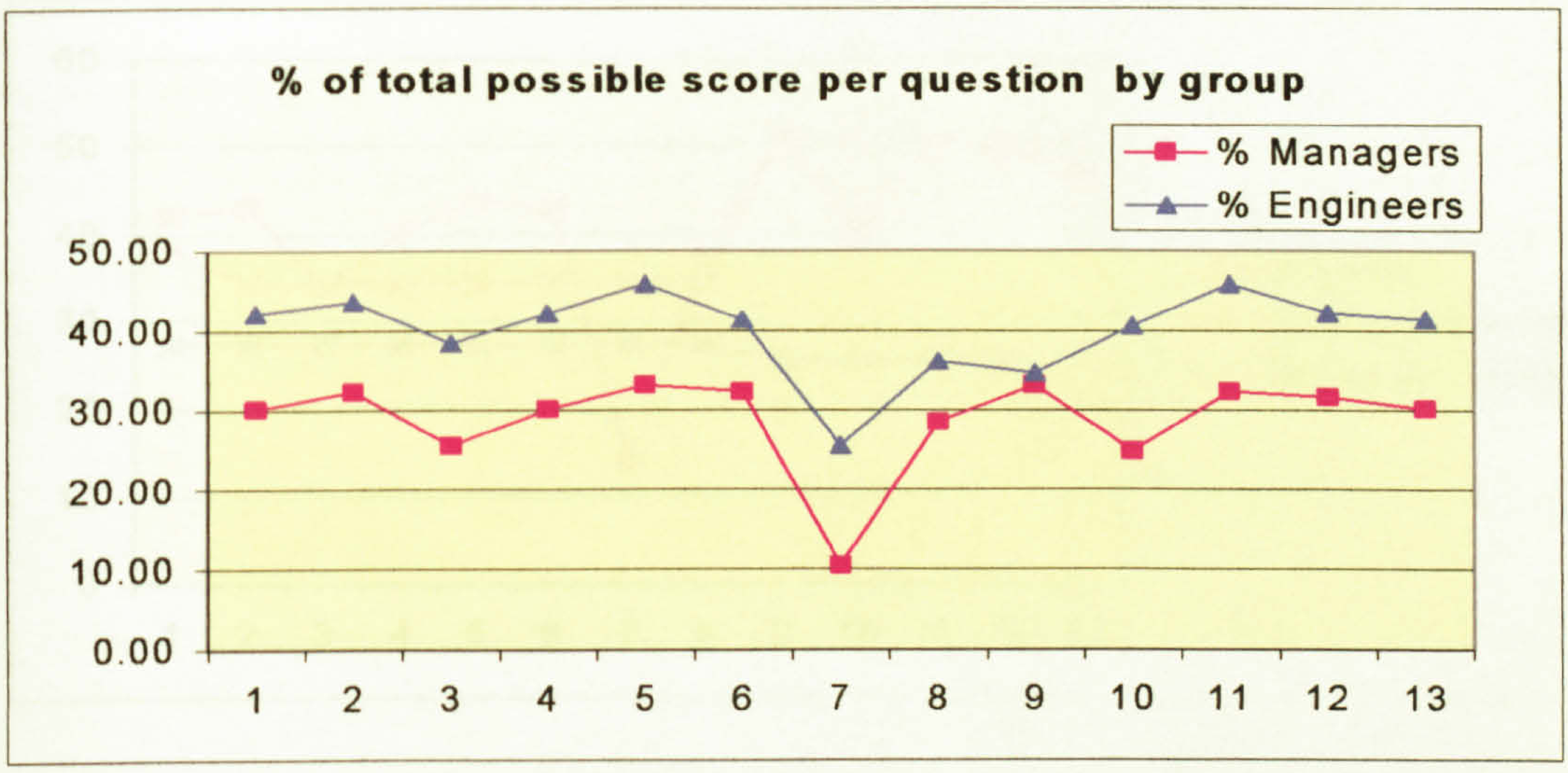


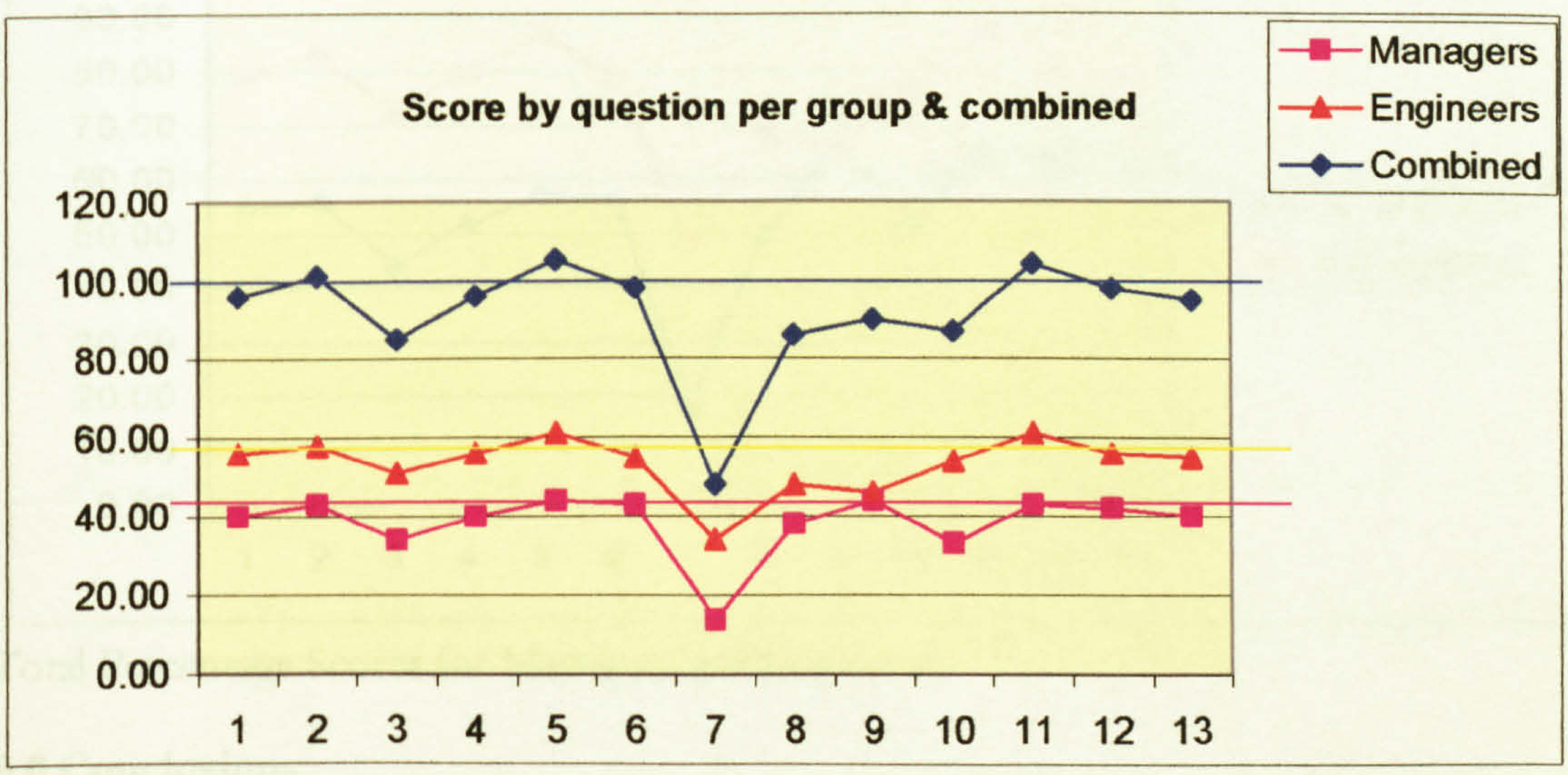




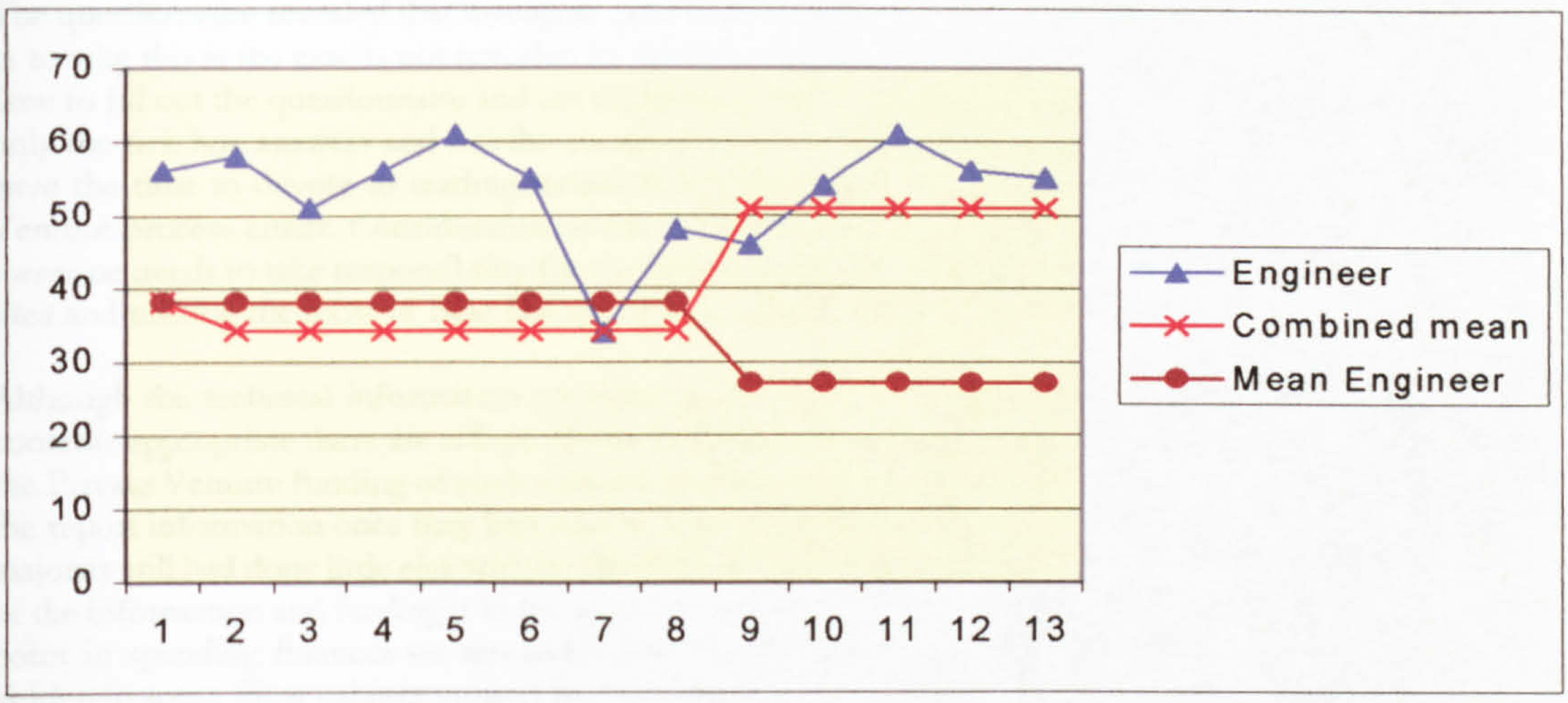


Total Responses to Questions by Managers and Engineers

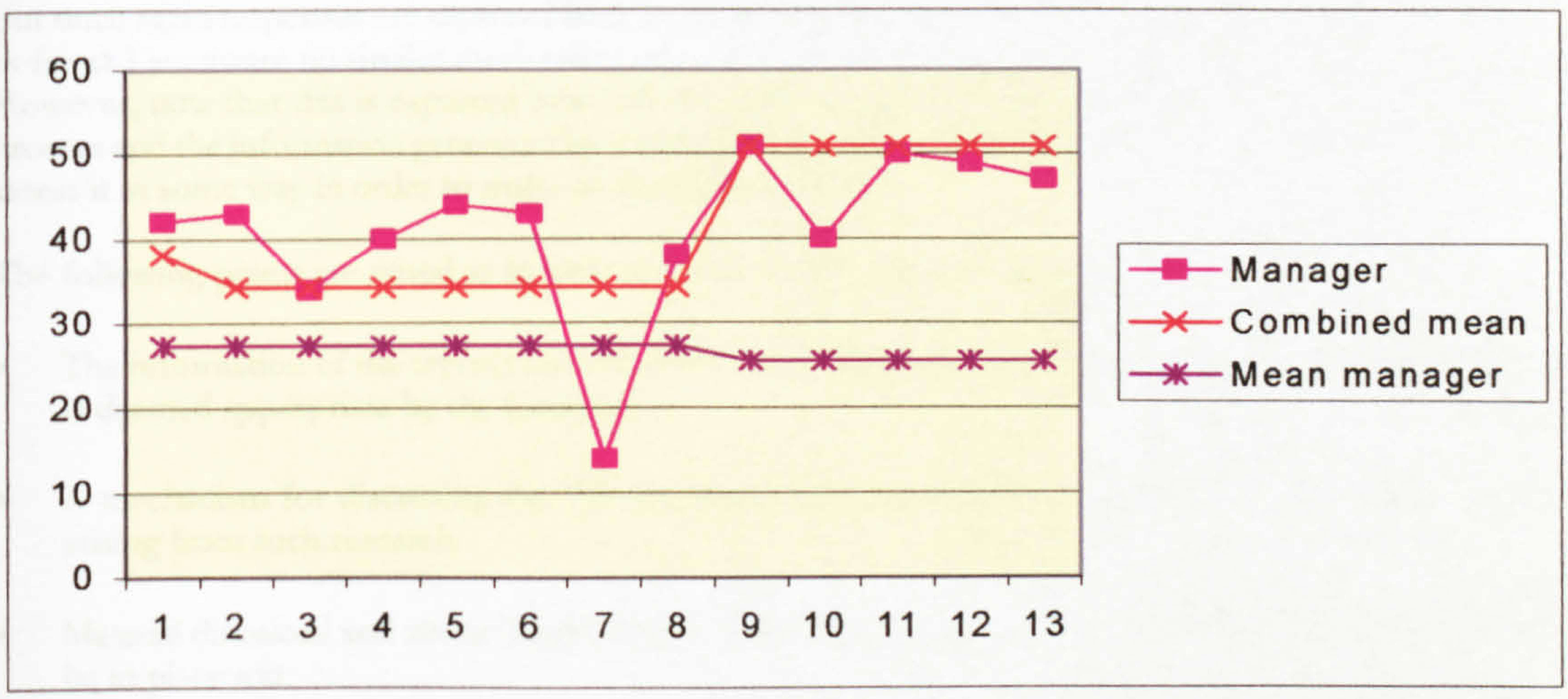


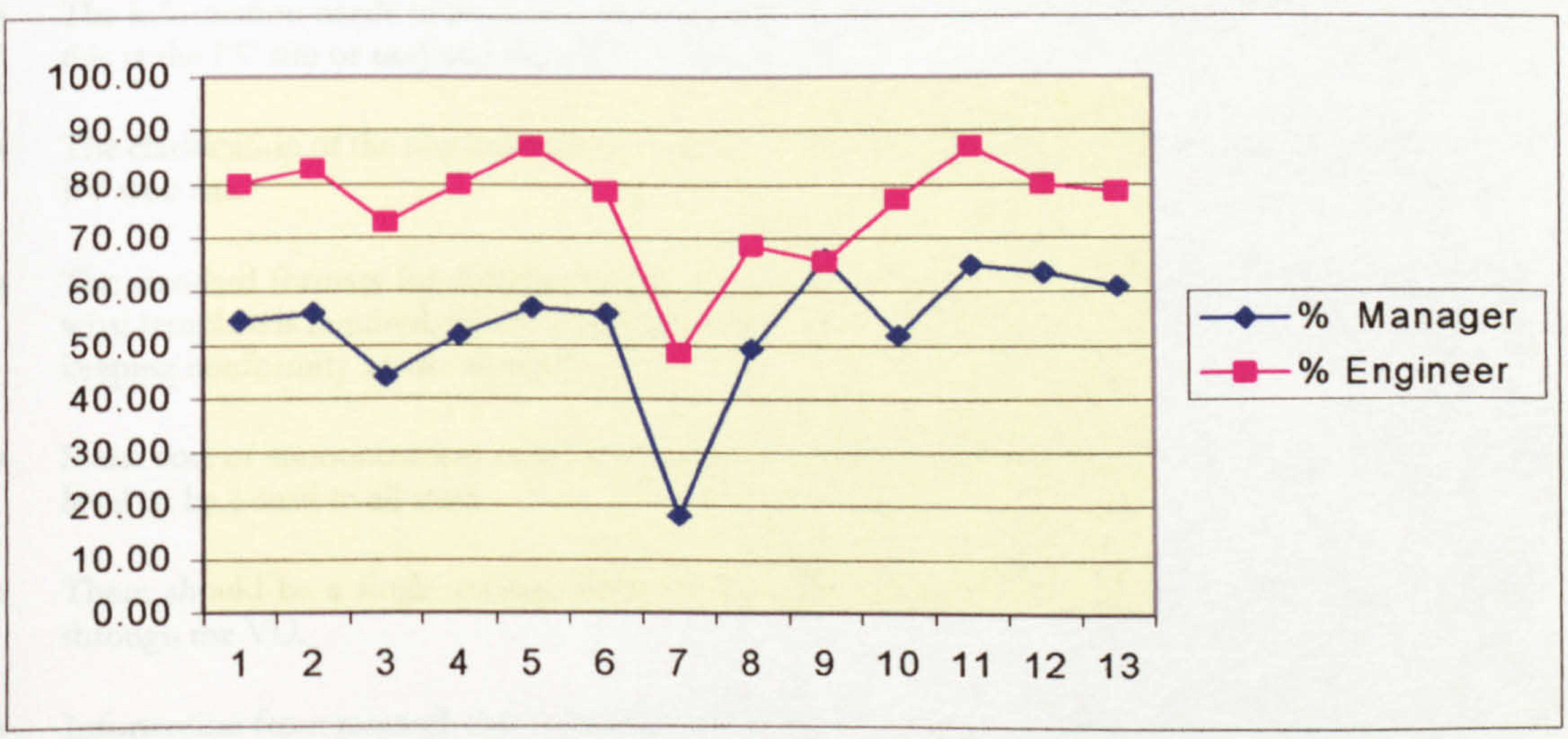


Average Scores and Combined Average Graph for Engineers



Average Scores and Combined Average Graph for Engineers





Total Percentage Scores for Managers and Engineers

3.0 Conclusions

The statistical analysis of these results show that the Speech Report was written in an appropriate manner and contained information which BAe Experts found relevant and which assisted them in both their knowledge and understanding of the technology. The candidates responding had a keen interest in the subject and made useful comments on the usefulness of this technology to BAe and its products.

The questionnaire revealed that managers gave less feedback than the engineers. However, the explanation as to why this is the case is not revealed by this questionnaire. Although four managers stated they had no time to fill out the questionnaire and are excluded in these results. Several other managers responded with only the tick box answers and not the comments for the same reason. The issue as to whether Managers have the time to devote to reading technical reports on new technology is not addressed by the Private Venture process either. Consideration needs to be given to who the report really needs to be read by and someone needs to take responsibility for the dissemination of such information. The issue of re-work across sites and making the most of Best Practice should also be addressed in some way.

Although the technical information provided in the report was marked as being extremely good and the contents appropriate there are still problems with the Private Venture process. The main failing revealed in the Private Venture funding of such research and reports is the fact that very few people did anything with the report information once they had read it. Most people had filed it but over a period of nine months the majority still had done little else with it. The Private Venture process needs a mechanism to deal with the use of the information and feeding it to the appropriate people or at least making them aware. There seems little point in spending finances on researching new technologies and innovation if the information remains hidden in some filing cabinet unused by the Company in any efficient and effective manner.

The comments and the feedback to the Speech Report PV research has been captured by this questionnaire. But once again responses are captured here but they are captured as an exception rather than the rule since as far as I am aware no similar mechanism exists for getting such feedback on other PV funded research. However, now that this is captured how will this information be used by the Company to look at the PV process and the information generated by it and make it easily available to others, distribute it correctly and assess it in some way in order to make an appropriate decision.

The following points are raised as in issue at the time of writing this analysis:

- The information of the reports created in PV funded research needs to be passed on in some way that is deemed appropriate by the Company.
- A mechanism for discussing the PV outcomes would also provide a useful forum to discuss issues arising from such research.
- Material discussed and raised should also be passed on appropriately and a mechanism for this needs to be in place too.
- The information needs to be stored appropriately for easy retrieval and access by other sites (whether this is the PV site or not) and should be made clear.
- The clarification of the requirements for reports being written should be in some generic format on the PV web site.
- The standard formats for documentation should be determined and stated on the PV web site (e.g. what template is required, where you get document numbers and other administrative issues related to keeping conformity across all reports).
- Some sort of announcement as to new research reports should be made – either at briefs at the local level or by e-mail to all staff.
- There should be a single storage place for all research and innovation related materials – perhaps through the VU.
- Information from research that is intended to be used needs to be filtered to the appropriate technical directors or heads of divisions to make a decision.

Appendix E: NVivo Data Analysis

NVivo Analysis of Qualitative Data Collected

The Process

Documentation

1. The interview data captured on tape was transcribed into individual documents
2. The documents were formatted and imported into the NVivo environment

Attributes

Documents and nodes can have attributes – these are data fields/information/values about the document or node and are used to analyse the data.

1. All documents were provided with attributes including the
   a. Name of the individual (private viewing only)
   b. The date of the interview
   c. The status of the interviewee (Manager or Engineer)
   d. Grade

Nodes

These are just a container for categorising and coding data

1. A Manager Node was created and all Manager transcripts were copied into this node
2. An Engineer Node was created and all Engineer transcripts were copied into this node
3. A Problem Node was created to capture all interview data that related to problems raised by an interviewee
4. All transcripts were individually analysed and coded to add all problems to the Problem Node

Searching

The NVivo tool allows for powerful searching and the creation of Search Nodes and sub-sets of information from which issues can be raised and points followed through based upon the analysis carried out.

Cycle one

In cycle one the Search Nodes were created to identify the those relating to key concepts or ideas relating to the problems raised and searched were made in order to group these into Engineer Only, Manager Only or Both. The results of these integrated searches created the details displayed in Table 2 e.g. **Find** "No alternative tool" **in** Manager Node; **Find** "No alternative tool" **in** Engineer Node; **Compare** Search Node Sets (provide NVivo with set node names created by previous search.

Cycle two

In cycle two the same process of integrated Search Node analysis was used to identify the number of occurrences of various word searches that were positive, negative or neutral in order to analyse the types of information captured from the interview data. In this case every search phrase was checked in context by extending the search by 35 characters either side of the search term. In this case negative or incorrect interpretations were removed from the searches. NVivo does not offer this functionality so this was done by hand.

E.g. **Find** "Out of date" **or** "Out Of Date" **or** "out-of-date" **or** "out of date" **in** Nodes **with** Attribute "Manager" **within** "35 characters either side"

Then repeat this but for Engineer.

Then compare both Search Nodes and ask for: **Both** Manager and Engineer

This entire process was carried out for 30 negative word searches, 37 positive word searches and 61 neutral word searches (making a total of 256 searches of the data provided). This data is discussed in cycle two based upon the findings. These word search patterns were used to assist in delimiting the areas of future research.

Another group of documents examined in this cycle were the BAE SYSTEMS Intranet Survey – in this case only the qualitative data was imported into the NVivo tool as a set of Nodes, one for each question asked with a set of replies added. These documents were also coded in the same way as the interview transcripts. Searches in the word patterns were also carried out in the same manner discussed above.

Problems raised in cycle one and how these are analysed.

Each problem (or problem theme) has its own unique identifier (item) number relating to the cycle one information source (Topic area). The issue and who raised it are associated with each together with my perception of the issue. Next whether this research will look at trying to resolve this issue in some manner, possibly partially (Deal with column). Finally, a Node is associated with each issue; these Nodes are identified after this table and represent the clustering of issues into specific themes, which were produced when creating NVivo nodes whilst analysing the data.

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
1.1	RPM	No alternative tool	Manager	If there was an alternative it would need to address the majority of issues arising here otherwise it would not be utilised either. This can only be partially resolved by software agents.	Partial	K	K
1.2	RPM	Time consuming process	Manager	Manager's time is very precious. If they cannot use the tool and it's not easy to use (item 4 & 5), as well as not mandated (item 7) then why would they spend time with it? The tool is reliant upon all managers contributing to the input – if they don't the information picture is incorrect (item 1). The issue of time management will be addressed in this thesis by putting a lot of the onus upon the technology. The RPM issue for increased efficiency has potential to be resolved to some extent.	Yes	K	B, K
1.3	RPM	Tool not intuitive. Tool not easy to use. Poor interface.	Manager	Another important issue raised is the usability of the RPM interface. Interfaces to the most excellent software in the world will not entice a user to utilise it if the interface is unusable (See Nielsen, 1993). This aspect will be revisited in this research as a major element of the final work. The whole issue of usability is key to the interface development of any application.	Yes	K	C, K
1.4	RPM	Information too difficult to access	Manager	Because the interface has poor usability it is also difficult for users to identify and locate the information they need specifically. This issue will be addressed in this research.	Yes	K	D, K
1.5	RPM	Tool relies on subjective judgements.	Manager	Unfortunately there is no other way to input the data into this particular tool. The process devised to assist managers in filling it in helps them if they use it. This thesis does not deal with this issue as the company needs to look at this in the light of item 7	No	H	H
1.6	RPM	Inaccurate data produced. Garbage in garbage out. Data is not up to date.	Both	If data is missing or inaccurate the tool cannot produce accurate information to the user. This will be true for other systems and databases in the company. Out of date data is an issue being addressed by this research. Data being out of date is an issue arising in several other information areas rose during the research – this issue will be addressed by this thesis.	Partial	K	G, K
1.7	RPM	Company does not	Both	If there is no pressure on Management to use the tool and to update the information in it	No	H, I	H, I

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
		mandate that Managers input data into the tool. No comeback if they don't bother.		then what incentive is there for them to spend valuable time using it? This thesis will not deal with this issue as it has been raised to the appropriate executives for their own decision-making.			
2.1	QUEST	Once again based upon individual subjective views	Manager	This is a feature of the application that cannot be resolved unless some quantitative measurement or process is developed to assist those filling in the data.	No	H, I	H, I
2.2	QUEST	Presentation of the data. Too complex data illustrated.	Manager	This is a problem with the application, which cannot differentiate different levels of abstraction of the data for different user types. Software agents working within the QUEST tool cannot resolve this. However, the views of the data abstraction will be considered in the final cycle.	No	H	C
2.3	QUEST	Regularly changing data. May be out of date if not maintained	Manager	This issue really concerns the updating of data and the management of that updating. This is an aspect that can be assisted using software agent technology.	Partial	H	A, G
2.4	QUEST	Poor link between Quest	Manager	Would enhance the usefulness of the information needed by managers. This needs to be resolved by the tool vendor as an enhancement to the application.	No	H, I	H, I
3.1	Newsgroups	Poorly structured information	Engineer	This is another more generic problem area associated with several information sources. This aspect will be investigated in cycle three.	Yes	K	D, K
3.2	Newsgroups	A method for searching the Newsgroups does not exist. It is hard to find the information in amongst the dross.	Both	Suggestions of measuring this aspect of the Newsgroups was communicated to both the CDI and the CARS Intranet Solutions business areas as it was regarded as outside the scope of the resolutions this thesis is currently addressing.	No	J	D, J
3.3	Newsgroups	Lack of usage of Newsgroups.	Both	There are many reasons why employees may not use the Newsgroups facilities. Although several reasons have been supplied at these interviews they are mainly soft science issues and process issues. Because of this it is seen as an inappropriate area to apply software agents specifically.	No	H, I	H, I
3.4	Newsgroups	They are not	Both	The usefulness of the Newsgroups is down to the people using them. If they want	No	H, I	H, I

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
		particularly useful		information that is important to them they have to ask for it. There is encouragement from the company to allow users to create new groups in other areas too.			
3.5	Newsgroups	Little time to spend looking on them	Both	Time management is a major issue with most personnel. If the Newsgroups were seen as useful then employees would re-organise their time to utilise them. Currently Item 4 and 5 influence one another. This aspect will be developed further in this research.	No	H, I	B
3.6	Newsgroups	Employees should not spend time using the social Newsgroups when they have work to do instead. Seen as a place for whinging.	Both	A surprising view of the Newsgroups was aired during these interviews. Some elements of the population are from the culture where if you come to work then that is what you should do work. As a follow on the CDI Intranet Survey 2000 results showed that in a total of 106 comments on what people dislike about the Intranet the Newsgroups accounted for 8% of the total negative responses. This 8% mainly referred to the fact that the Newsgroups are a waste of time and that employees should be getting on with their work rather than writing in a Newsgroup area. But the knowledge management aspects of this will be discussed later in this thesis.	No	H, I	H, I
4.1	CWW	Too much information	Manager	This does seem more appropriate for the Manager as opposed to the engineer. Managers normally hold a significant amount of responsibility and must be careful to use their time effectively. Managers would tend to see too much information as a distraction. They would also see the need for a reduced or filtered view that they can later question if necessary in order to make key decisions. This research demonstrator will address the generic issue of too much information.	Yes	J	E, J
4.2	CWW	Poor physical connection. Slow down times	Engineer	This issue is likely to emanate from the engineering community rather than the managers because issues such as performance of an application are common to the engineers in their everyday work. The issue is beyond the scope of this thesis. I have notified the Intranet Group and they are investigating the alternatives.	No	H	H
4.3	CWW	Not easy to locate information	Both	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.	Yes	K, J	D, K
4.4	CWW	Out of date information. Not maintained well	Both	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.	Partial	J	A
4.5	CWW	Not easy to use/ navigate. Poor usability. Not	Both	Usability is an issue raised across several applications discussed in this research. This issue will be given serious investigation during the pilot phase of the thesis.	Yes	H	C

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
		intuitive					
4.6	CWW	Some information of little value	Both	The percentage of information that has little value has not been measured. This is probably a subjective perspective and has not been addressed for further investigation.	No	H	G
4.7	CWW	Information poorly structured or displayed	Both	Poor structure and display of information can put users off of using the application or facility. This is a generic problem which can be addressed through the usability domain of this research	Yes	K	D
4.8	CWW	Poor search engines	Both	This is a fundamental issue in being able to locate the information sought in the first place. I have notified the Intranet Group within the Company of the search engine issue and they are dealing with this. From a research perspective I will not be addressing this particular issue further.	No	J	B, D
5.1	WWW	Being able to locate the information	Engineer	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.	Yes	J	K
5.2	WWW	Time consuming process	Engineer	Engineers can find that it is time consuming particularly in locating technically specific information. Because there is just so much information on the WWW this is understandable and would also explain why Managers use it a lot less.	Partial	J	B
5.3	WWW	The data is more up to date	Engineer	This is a positive point and this probably relates to technical information as this is the most likely information that Engineers are locating and using.	No	I	K
5.4	WWW	No/ poor physical connection	Engineer	This is an issue that has been highlighted to the Intranet Group and the IT Support Group within the Company – it will not be considered in the rest of this research.	No	H	H
6.1	E-mail	That e-mail although electronic – it is often printed out	Manager	This is another issue whereby the co-ordination of information needs further enhancements. The purpose and usage of e-mail should be stated through the company guidelines. There are many ways to overcome this issue.	No	I	I
6.2	E-mail	Mechanism for passing blame and responsibility	Engineer	It was suggested that the informant sending the e-mails passes the burden on to the recipient for the information or decision etc passed to them. This is an inappropriate use of e-mail and notification has been made to Managers within the Company. This aspect is a social/moral issue that is beyond the scope of this thesis.	No	I, H	I, H
6.3	E-mail	Multiple copies of the same e-mail received. Information	Both	This is a communication and co-ordination issue. The IT Support and Communications groups have been notified as to the problem and some projects are addressing this through a central co-ordinator.	No	I, H	I, H

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
		overload					
6.4	E-mail	Large attachment files	Both	This aspect addresses the knowledge of how to use e-mail efficiently. If employees looked at the size of attachments they could be informed when this is an effective or ineffective way to send that information. Advice on usage and guidance on how to examine and also how to zip files to make them easier to send need to be supplied to users so that they can make the best use of the e-mail system provided.	No	I, H	I, H
6.5	E-mail	Physical memory problems	Both	This is an IT Support issue that has been communicated to that group to deal with. This thesis cannot address this hardware and computer specification problem.	No	I, H	I, H
6.6	E-mail	Time-consuming	Both	This is an interesting view as e-mail is supposed to be a mechanism to lessen the amount of information an employee receives and spends time looking at. This issue is one that relates to item 2 above and may be investigated further in this thesis.	Yes	K	B, K
6.7	E-mail	Too many e-mails/overburden	Both	Both groups mentioned in interviews that they felt they received too much e-mail each day. Managers noted that they felt this was an interruption.	Yes	K	K
7.1	EPF	Poor usability, unwieldy	Engineer	Another important issue raised is the usability of the RPM interface. Interfaces to the most excellent software in the world will not entice a user to utilise it if the interface is unusable (See Nielsen, 1993). This aspect will be revisited in this research as a major element of the final work.	Yes	C	C, K
7.2	EPF	Difficult to amend	Engineer	The mechanism used to control the baseline documents is possibly too complex. This is an issue for individual projects using the tool not for this thesis.	No	H, I	H, I
7.3	EPF	Poor search facility	Engineer	This is a fundamental issue in being able to locate the information sought in the first place. I have notified the EPF Manager within Company of the search engine issue. From a research perspective I will not be addressing this particular issue further.	No	J, K	D
7.4	EPF	Better alternative – CM tools	Engineer	This is not a problem but a suggested solution to the problems identified. This is an issue raised and communicated to the EPF Manager and will not be addressed further in this research.	No	I	I
7.5	EPF	Time consuming, long-winded process	Engineer	The process associated with this tool is quite long and probably adds to the other issues here when an engineer is trying to store a specific document. The Company processes adopted is an issue beyond the scope of the intervention of technology utilised in this thesis. The generic issue of performance and efficiency will be dealt with but not the EPF itself	Partial	K	B

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
7.6	EPF	Difficult to locate information	Both	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.	Yes	K	D
7.7	EPF	Poorly structured data/ illogical	Both	Poor structure of information can put users off of using the application or facility. This is a generic problem which can be addressed through the usability domain of this research	Yes	K	B, D
8.1	Lessons Learned Log	Lack of use of the log	Both	The log may not be used due to item 2 below. If employees are unaware of its existence then they are unlikely to use it. There are also many other social factors which may prevent employees from using this tool e.g. they may be viewed as failures	No	I, H	I, H
8.2	Lessons Learned Log	Lack of awareness of log	Both	This is an issue for communication as is outside of the scope of this thesis.	No	I, H	I, H
9.1	TES	Poor usability	Engineer	Usability is an issue raised across several applications discussed in this research. This issue will be given serious investigation during the pilot phase of the thesis.	Yes	K	C
9.2	TES	Time consuming	Engineer	Time-consuming applications require re-visiting through the Company officials responsible for them. The generic aspect of time-consuming applications will be investigated further through this research	Yes	K	B
9.3	TES	Bug ridden, open to errors	Engineer	The issue of functional errors and bugs are more likely to be raised by engineers as they work in this area of software the majority of the time. They are expected to produce code without bugs and they expect to use code without bugs and errors	No	H, I	G
9.4	TES	Printer configuration wrong	Engineer	This is an IT Support issue which has been communicated to that group	No	I, H	I, H
9.5	TES	No proper training provided	Engineer	This is an Training issue which has been communicated to that group	No	I, H	I, H
9.6	TES	Booking code process is inadequate	Engineer	The whole process requires re-visiting and evaluating by the Company but is outside the scope of this thesis.	No	I, H	I, H
10.1	Estimating Metrics	Company not learning from past mistakes	Manager	This is likely to be due to the estimating points raised below.	No	K	K
10.2	Estimating Metrics	Poorly maintained estimation process website and poor	Engineer	This is another area where the information needs to be available and up-to-date and is not. The process is seen to have little Company support and therefore is less likely to be taken seriously by those asked to do the estimates.	No	H, I	A

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
		company backing of process					
10.3	Estimating Metrics	Poor past estimation recording	Engineer	This suggests that the past records are of no value to the new projects and thus the process is failing to bring improvement to the new Company projects	No	I, H	I, H
10.4	Estimating Metrics	Time-consuming for engineers	Engineer	This is a specific case where the Company should be providing adequate guidance to the employees. The process requires further investigation by the Company to ensure an appropriate and effective implementation. Generic issue of efficient use of time will be addressed in final demonstration	Partial	K	B
10.5	Estimating Metrics	Estimation process not used, not valued	Both	This could be due to items 1 and 2 above.	No	I, H	I, H
11.1	Private Venture	Poorly communicated	Manager	The whole issue of communication is now recorded and being dealt with via a communications strategy through the Company	No	I, H	I, H
11.2	Private Venture	Limited funding	Engineer	The Company may need to revisit the amount of funding available and the true results of the work that has been carried out by the Company. At the moment no proper evaluation of the value of the PV work has been done – this may be dealt with further by this research.	No	I, H	I, H
11.3	Private Venture	Out of date information	Engineer	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.	Partial	K, J	A
11.4	Private Venture	Website(s) information poor and not linked	Engineer	In particular the work carried out needs to be linked into the website so that the information can be shared more widely. The Management have been notified of this fact.	No	I	C, D
12.1	Communication	Poor communication throughout Company	Manager	This view should be monitored through the Employee Opinion Survey. This was suggested and carried out.	No	I, H	I, H
12.2	Communication	Poor communication of Company strategy, holistic view of the	Manager	The kind of information communicated and the levels need to be measured through the Employee Opinion Survey. This was suggested and carried out.	No	I, H	I, H

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
		Company					
12.3	Communication	One-way communication down to engineers	Engineer	This view should be monitored through the Employee Opinion Survey. This was suggested and carried out.	No	I, H	I, H
12.4	Communication	Poor information from direct line manager	Both	This is a personal issue which employees need to discuss with their bosses	No	I, H	I, H
13.1	Culture	Secrecy culture	Manager	This is a strong expression of an engineers view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.	No	I, H	I, H
13.2	Culture	Company pays lip service to its proclaimed culture	Engineer	The culture and values are freely available and visible through the Company literature and key websites. Unfortunately some engineers feel that the Company says one thing and does another.	No	I, H	I, H
13.3	Culture	Company is full of elitist, sexist, cliquish, if your face fits, back-stabbing, status driven individuals	Engineer	This is a strong expression of an engineers view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.	No	I, H	I, H
13.4	Culture	Company is bureaucratic and frustrating	Engineer	This is a strong expression of an engineers view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.	No	I, H	I, H
13.5	Culture	Culture too relaxed	Engineer	This is a strong expression of an engineers view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.	No	I, H	I, H
13.6	Culture	Little loyalty to long-term employees	Engineer	This is a strong expression of an engineers view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.	No	I, H	I, H
13.7	Culture	General negativity	Engineer	This is a strong expression of an engineers view. There are many reasons why they may have said this. From the perspective of this thesis I will not be examining this further except by expressing my own views in the reflective chapter later.	No	I, H	I, H
14.1	Best Practice	The Best Practice	Both	If some best practice is good then the Company needs to communicate it and link people	No	I, H	I, H

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
		ideas are not being re-used in the Company		to those who used it in the first place.			
14.2	Best Practice	People fail to enter anything on the sites	Both	Employees may need encouragement and motivation to do this. Perhaps guidelines should be presented to aid people too. There are many sociological reasons why people fail to share information.	No	I, H	I, H
15.1	Expert Groups	No common sources of expertise within the Company	Manager	Managers and other engineers need to be able to contact and raise issues with the appropriate experts within the Company	Yes	K	F, K
15.2	Expert Groups	Lack of visibility of the experts	Manager	Managers and other engineers need to be able to contact and raise issues with the appropriate experts within the Company	Yes	K	F, K
15.3	Expert Groups	No contact mechanisms for experts	Manager	Managers and other engineers need to be able to contact and raise issues with the appropriate experts within the Company.	Yes	K	F, K
15.4	Expert Groups	Managers fail to recognise and determine the expertise of their own staff	Manager	This is a fundamental failing throughout the company. If this continues then staff will become disillusioned, they will not be adequately rewarded and will be likely to leave.	Yes	K	F, K
15.5	Expert Groups	Technology groups have little value	Engineer	If engineers see little value in their own technology groups then the groups need to be re-evaluated and the engineering community needs to be able to express its opinion of what it expects from such groups to the higher management.	No	I, H	I, H
15.6	Expert Groups	Technology groups poorly supported by the Company	Engineer	Poor motivation and company backing will hinder the sharing of knowledge and expertise throughout the Company (Constant et. al. 1993)	No	I, H	I, H
16.1	Skills Database	No verification	Manager	The data requires verification e.g. based on qualifications – see certificates. This is a lot of work to get a proper baseline.	No	I	G
16.2	Skills Database	Grading structure subjective	Both	There were no clear guidelines of what constituted a particular level of expertise. There should be and there should be a time scale or educational or both equivalent for each level.	No	I, H	I, H
16.3	Skills Database	Lack of full skills coverage	Manager	The skills listed needs re-visiting as some areas were too detailed and others too high level. Some others were not included at all.	Yes	K	K

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
16.4	Skills Database	Poor interface usability	Both	Interface unwieldy and difficult to track where a user is in the program. Long convoluted process to fill in just one single skill. Poor design.	Yes	K	C
16.5	Skills Database	No link to other aspects of career development	Both	A comprehensive view would contain this information and a link to other documentation.	Yes	K	K
16.6	Skills Database	Ownership and visibility of information	Both	Confidentiality is important. Levels and types of access were not determined	Yes	K	K
16.7	Skills Database	Poorly defined skills	Both	Lack of clear guidance in some cases regarding exactly what is meant.	Yes	K	G
16.8	Skills Database	No buy in by employees and no positive company support	Both	There was a lack of completed individual skills data throughout the trials. The Company managers were not actively encouraging employees to fill it in.	No	I, H	I, H
16.9	Skills Database	Data maintenance	Both	Who will keep the data up to date once it is at a baseline? The method for doing this needs to be easy to achieve and not as time-consuming as the original database was.	Partial	K	A, B, G
17.1	Team and Corporate Brief	Difficulty in filtering what needs to be announced for particular audiences	Manager	Subjective level of what individuals think is important to hear – can be difficult to get the balance right.	No	H, I	G
17.2	Team and Corporate Brief	Too much information coming down to the manager in the first place	Manager	Managers don't want huge great documents to decipher, filter and disseminate. They don't have a lot of time to dedicate to these tasks. They just want to see what is relevant to their group and read that.	No	H, I	E
17.3	Team and Corporate Brief	Briefs take far too long	Engineer	Subjective level of what individuals think. Should be tested in opinion surveys	No	I, H	I, H
17.4	Team and Corporate Brief	They are boring	Engineer	Subjective level of what individuals think. Should be tested in opinion surveys	No	I, H	I, H
17.5	Team and Corporate Brief	They are not valued	Engineer	Subjective level of what individuals think. Should be tested in opinion surveys	No	I, H	I, H

Item	Topic area	Issue Raised (Problem Theme)	Manager/ Engineer/ Both	Perception and reasoning	Deal with?	Node	Issue Node
18.1	RDD-100	Imposed toolsets can be a problem	Engineer	Not all tools are suitable for all cases. Sometimes the uniqueness of a project or the level of a project may mean a full blown requirements management tool is inappropriate for the task. Some discretion should be available for engineers in these cases.	No	I, H	I, H
19.1	Training	The data on the training websites were out of date	Engineer	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.	Yes	K	A
19.2	Training	There is a limited stock in the training department	Engineer	This aspect has been reported to the Training Department for them to deal with.	No	I, H	I, H
20.1	Company Standards	Out of date data	Engineer	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.	No	H, I	A
20.2	Company Standards	Finding the right information	Engineer	Once again the location of information is a problem. This is a generic problem across many of the information sources identified during this research. This issue will be addressed in the final cycle.	No	H, I	D
21.1	Role Description	No proper role and responsibilities available	Engineer	This makes the employees life a little difficult when trying to develop a career path; or being unable to determine what is or is not within his responsibility; or being able to get adequate training for that role in areas he is deficient.	Partial	K	E
22.1	SAP	Data is often out of date	Manager	Poor maintenance of data can affect many areas of the organisation and has be identified in many cases. The issue can only be partially resolved using technology however the onus is upon the individual being held responsible.	No	H	A
22.2	SAP	Poor usability	Engineer	Usability is an issue raised across several applications discussed in this research. This issue will be given serious investigation during the pilot phase of the thesis.	Yes	K	C
22.3	SAP	Incorrect and misleading information in it	Engineer	Data is only good if entered correctly. Human errors need to be captured and corrected to make any tool useful.	Yes	K	G

Table 2: Cycle One Analysis Sets Created Using NVivo

Set grouping categories

A. Data out of date. Inaccurate data due to lack of data maintenance

B. Time-consuming process. Not enough time to find information due to time constraints. Long-winded processes

C. Usability issues. Tool is not intuitive. Poor user interface. Tool not easy to use. Poorly displayed material.

D. Difficult to find/locate information or data. Poorly structured data/information. Not easily navigable. Illogical structure of information/data.

E. Too much information/data. No filtering available. Information overload.

F. Lack of visibility of experts/expertise. No commonly identified experts/expertise.

G. Misleading or incorrect data

H. Software agents cannot resolve this issue raised. This could be people related or inherent in a particular application/tool that has its own proprietary rights etc. e.g. SAP, RDD-100 issues

I. Process issue that cannot be resolved by agents either immediately or in the future

J. Software agents already exist for resolving such problems that can be purchased and used by the Company

K. Could potentially apply software agents to resolve this.

Appendix F: SPSS Data Analysis

Correlation of Scores Between Engineers and Managers for Negative Search Criteria

Nonparametric Correlations for ranked data

Correlations

			VAR00001	VAR00002
Spearman's rho	VAR00001	Correlation Coefficient	1.000	.681**
		Sig. (2-tailed)	.	.000
		N	22	22
	VAR00002	Correlation Coefficient	.681**	1.000
		Sig. (2-tailed)	.000	.
		N	22	22

**. Correlation is significant at the .01 level (2-tailed).

Correlation of Scores Between Engineers and Managers for Neutral Search Criteria

Nonparametric Correlations for ranked data

Correlations

			MANAGER	ENGINEER
Spearman's rho	MANAGER	Correlation Coefficient	1.000	.513**
		Sig. (2-tailed)	.	.000
		N	54	54
	ENGINEER	Correlation Coefficient	.513**	1.000
		Sig. (2-tailed)	.000	.
		N	54	54

**. Correlation is significant at the .01 level (2-tailed).

Correlation of Scores Between Engineers and Managers for Positive Search Criteria

Nonparametric Correlations for ranked data

Correlations

			MANAGER	ENGINEER
Spearman's rho	MANAGER	Correlation Coefficient	1.000	.369
		Sig. (1-tailed)	.	.055
		N	20	20
	ENGINEER	Correlation Coefficient	.369	1.000
		Sig. (1-tailed)	.055	.
		N	20	20

Appendix G: VacancyBot Requirements Specification

1.0 Overview

This document is the first draft toward a work specification for BAE Systems. The project described herein uses agent technology to find matches between job vacancies and employees through the ongoing examination of databases. Bots or agents are used to automatically perform this matching, with intelligent behaviour for deducing the best candidates for a project.

For brevity, this project is termed VacancyBot throughout this document.

NQL Inc. is a technology infrastructure provider that specializes in Internet and network communication; data conversion; and intelligent behaviour.

1.1 Capabilities

VacancyBot provides these capabilities:

- Permits entry of vacancies using a Vacancy Editor application
- Scans the vacancy database and finds matches among personnel profile databases.
- Informs managers and employees of project-personnel matches.
- Keeps personal profile databases updated by extracting data from Human Resources, Project Details, Resource Managers, Resource Planning and Training databases.
- Permits an interactive search of vacancies and matching personnel.

1.2 Foundation

This project assumes the presence of NQL ContentAnywhere as a foundation layer. VacancyBot is a custom application that requires ContentAnywhere as a support system. ContentAnywhere provides a general-purpose framework for running agents and interconnecting content throughout an enterprise.

2.0 Architecture

This section describes the overall architecture of the project.

VacancyBot has five primary components:

- A vacancy fulfilment agent
- A profile synchronization agent
- A vacancy editor (interactive application)
- A search interface (interactive application)
- The NQL ContentAnywhere framework, which integrates the other four components into a coordinated system that can be accessed throughout the enterprise

The vacancy fulfilment agent monitors additions and changes to the vacancy database. Detected of new or updated vacancies triggers a search against the personnel databases. As matches are found, e-mail is sent to project managers and to matching employees.

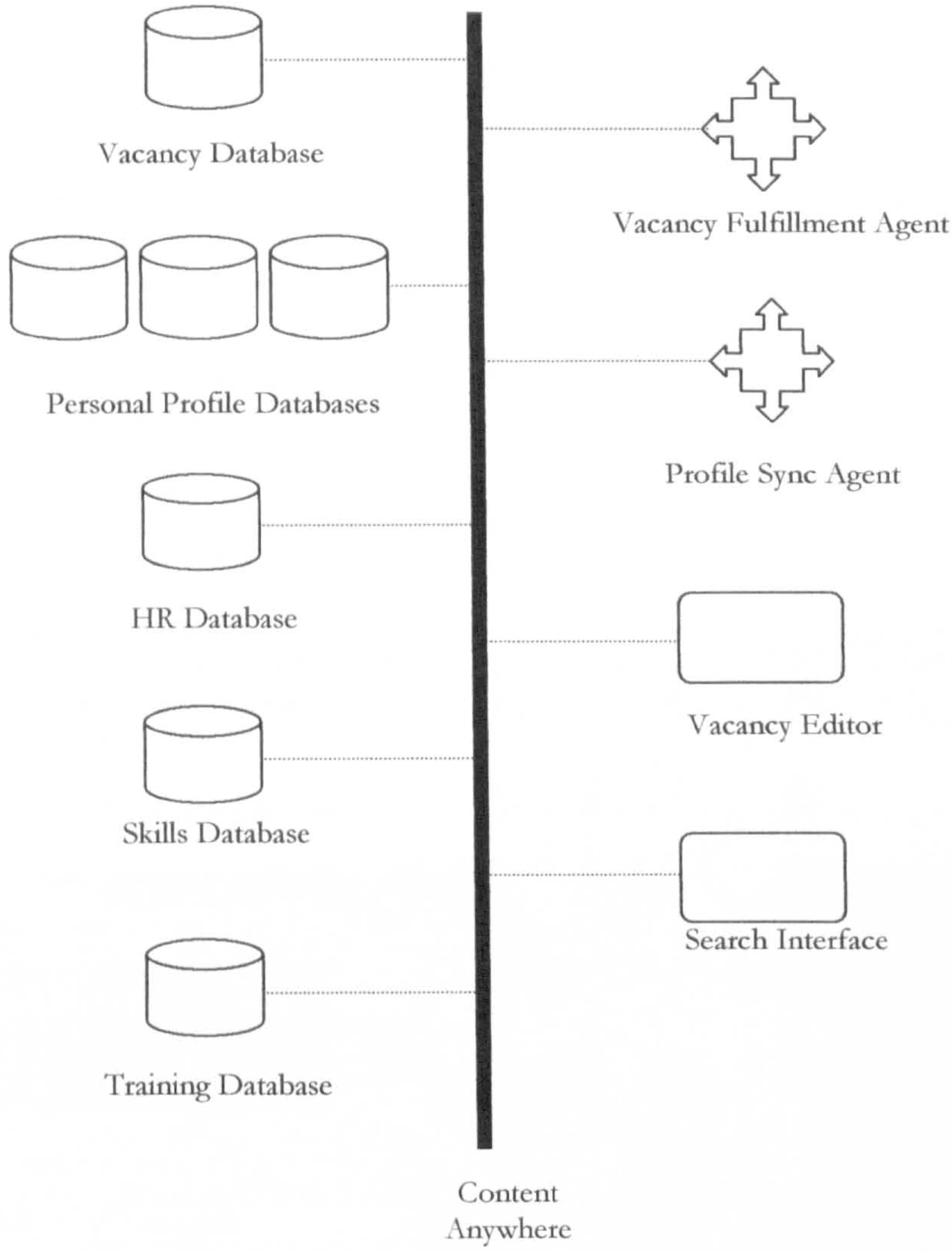
The profile synchronization agent periodically scans the Human Resources, Project Details, Resource Managers, Resource Planning and Training databases and keeps the individual personnel profile databases updated.

The vacancy editor, a desktop application, allows vacancies to be added or revised from any authorized desktop workstation.

The search interface, a desktop application, allows interactive searches to be performed against the vacancy and personnel databases.

The ContentAnywhere framework links the various databases with a central repository, scripted agents, and secure distributed access throughout the network to the client applications.

As per BAE, the databases are Microsoft Access databases. BAE has supplied a representative sample of these databases to illustrate their structure and provide test data.



VacancyBot Architecture

2.1 Vacancy Fulfilment Agent

The *vacancy fulfilment agent* is an automated process whose mission is to detect new vacancies and find suitable matches from the personnel profile databases. The vacancy fulfilment agent samples the vacancy database periodically looking for new activity. Whenever a new (not previously processed) vacancy record is encountered, the following actions take place:

- Each profile database for each employee is scanned.
- A degree of suitability score is deduced for each employee using fuzzy logic.
- For employees that score sufficiently high in suitability for the vacancy, two e-mail messages are automatically generated: one to the manager of the project, and one to the employee.
- For employees that score sufficiently high in suitability for the vacancy, two e-mail messages are automatically generated: one to the manager of the project, and one to the employee.

2.2 Profile Synchronization Agent

- The *profile synchronization agent* is an automated process whose mission is to use a collection of source databases to update personnel profile databases. The profile synchronization agent scans the Human Resources, Project Details, Resource Managers, Resource Planning and Training databases periodically. The personnel profile databases for each employee are populated based on what is found in these databases.

  Specifically, these database operations take place:

2.3 Vacancy Editor

- The *vacancy editor* is a desktop application for viewing, adding, and editing vacancies. The vacancy database is updated as a result of using this application.

2.4 Search Interface

- The *search interface* is a desktop application for quick interactive vacancy matching against personnel. It allows a vacancy to be specified, then collaborates with the vacancy fulfillment agent to find and rank the best candidates. The results are then displayed.

3.0 User Interface

This section describes the user interface of the VacancyBot project. Two of the project components provide direct user interaction: the *vacancy editor* and the *search interface*.

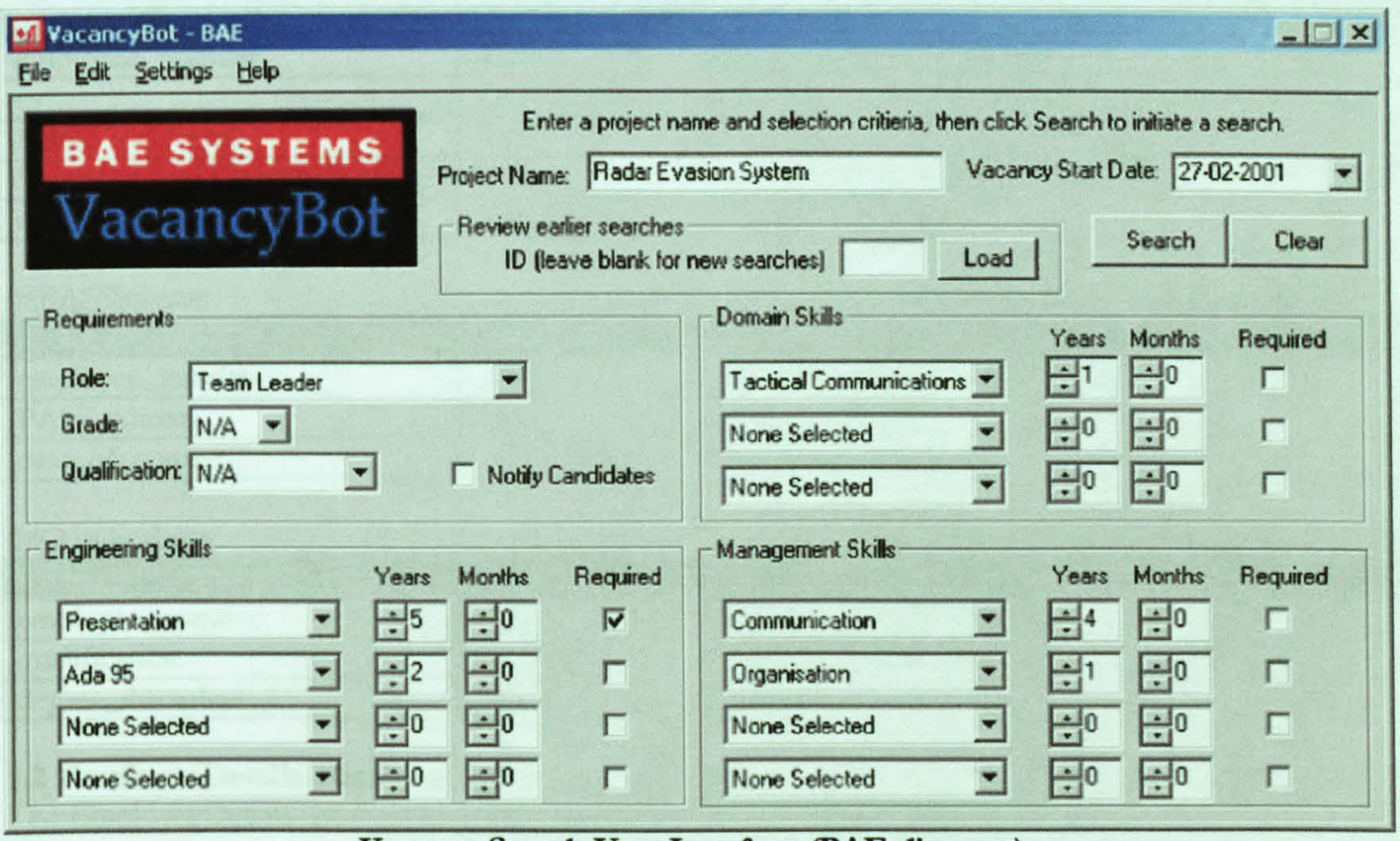
3.1 Vacancy Editor

The vacancy editor is a desktop application that can be used on Windows PCs. It's purpose is to add, edit, or view vacancy records in the databases.

3.2 Search Interface

The search interface is a desktop application that can be used on Windows PCs. It's purpose is to provide a quick, interactive way to search vacancies instead of directly adding a vacancy to the database with the vacancy editor.

As per BAE, the search interface is to have the user interface shown below.



Vacancy Search User Interface (BAE diagram)

Submitting criteria and clicking Submit initiates a personnel search. Results are displayed once the search completes.

4.0 Scalability and Deployment

This section describes VacancyBot's facilities for providing high scalability and flexible deployment.

All viable enterprise solutions need to be able to scale elegantly in order to accommodate large numbers or users, large amounts of data, and/or multiple locales.

Deployment is also a key concern, as the various users, databases, and applications may be spread across an entire enterprise.

4.1 Agent Hosting

One or more servers may run the agents. There are two agents, a vacancy fulfillment agent and a profile synchronization agent. These agents run on a ContentAnywhere content server. Multiple content servers may be deployed if the degree of use warrants it.

4.2 Application Hosting

Any desktop system can run the applications. There are two applications: a vacancy editor and a search interface. The desktop applications are clients that communicate with agents and databases through ContentAnywhere.

4.3 Database Independence

The databases may be of any kind as long as they are well-supported through the Open Data Base Connection (ODBC). The databases may be housed on any system, as long as it can be accessed through ODBC. The databases may be on the content server or on other systems as desired.

5.0 Database Details

This section explains the database environment VacancyBot is designed to operate in. BAE Systems is prescribing Microsoft Access databases and has supplied sample databases.

5.1 HRDatabase Database

The HRDatabase database describes employee's test results, security level, date of last communication, PASS scheme, and qualifications/credentials.

The HRDatabase database contains these tables:

tblHR — occurs once per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
cv	OLE Object	Resume - embedded Word document
Belbin test Result	Text	Category of Belbin utilized e.g. Plant
Security Level Clearance	Text	Category e.g. Full Security Cleared
date_of_last_dlg	Date/Time	Date/time of last dialog

tblPASSScheme — occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
PASS_course	Text	Name of course
date_of_course	Date/Time	Date/time of course

tblQualifications — occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
qualification	Text	Name of skill area
degree_discipline	Text	Degree

5.2 EmployeeDetails Database

The EmployeeDetails database contains detailed information about employees.

The EmployeeDetails database contains these tables:

TblCurrent/PreviousProjectDetails — occurs once per project

Field	Data Type	Description/Formatting
current_project_number	Integer	Unique project number
current_project_name	Text	Name of project
current_location	Text	Location of project
current_site	Text	Site of project

TblEmployeeDetails — occurs once per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
employee_title	Text	Employee's title
employee_firstname	Text	Employee's first name
employee_initial	Text	Employee's middle initial

employee_surname	Text	Employee's surname
employee_address	Text	Employee's address
employee_postcode	Memo	Employee's postal code
employee_tel_no	Number	Employee's telephone number
employee_email	Memo	Employee's e-mail address
grade	Integer	Employee's grade e.g. 1-13
date_of_last_update	Date/Time	Date/time of last update to this record

TblExperienceLevel occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
tool	Text	Name of tool
experience_level	Text	Experience level

TblExperienceName occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
skill_name	Text	Name of skill
experience_level	Integer	Experience level

TblKeySkills occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
skill_number	Integer	Skill number

TblMemberOfProfInst occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
member_of_professional_inst	Text	MIEE, APM, MIMgt etc

TblName/CurrentProjectDetails occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
current_project_number	Integer	Unique project number

TblName/PreviousProjectDetails occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
previous_project_number	Integer	Unique project number
duration_months	Integer	Project duration (months)
duration_years	Integer	Project duration (years)

TblPreferredRole occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
role_number	Integer	Role number

TblRoleName occurs zero or more times per employee

Field	Data Type	Description/Formatting
role_number	Integer	Unique role number
role_name	Text	Role name

TblRoleNotePreferred occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
role_number	Integer	Role number

TblSkillLevel occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
tool	Text	Name of tool

skill_level	Text	Skill level (1=novice, 2=intermediate, 3 =expert)

TblSkillName occurs zero or more times per employee

Field	Data Type	Description/Formatting
skill_number	Integer	Unique skill number
skill_name	Text	Name of skill
skill_level	Number	Skill level (1=novice, 2=intermediate, 3 =expert)

TblSmartObjectives occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
smart_obj_title	Text	Title - description
date_of_smart_obj	Date/Time	Date/time record updated

5.3 PersonalProfileDatabase Database

The PersonalProfileDatabase database contains individual information about employees—one separate database per employee.

The PersonalProfileDatabase database contains these tables:

EmployeeProjectDetails occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
project_number	Integer	Current project number
start_date	Date/Time	Project start date
end_date	Date/Time	Project end date

tblCourseCompleted occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
course_type	Text	Type of course (HNC, Degree, Postgraduate, internal, short-course etc
course_name	Text	Name of course

tblCurrent/PreviousProjectDetails occurs once per project

Field	Data Type	Description/Formatting
current_project_number	Integer	Unique project number
current_project_name	Text	Name of project
current_site	Text	Site of project

tblDomainSkills occurs zero or more times per employee

Field	Data Type	Description/Formatting
domain_number	Integer	Unique domain number
domain_skill_name	Text	Name of skill

tblEmployeeDetails occurs once per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
employee_title	Text	Employee's title
employee_firstname	Text	Employee's first name
employee_initial	Text	Employee's middle initial
employee_surname	Text	Employee's surname
employee_address	Text	Employee's address
employee_postcode	Memo	Employee's postal code
employee_tel_no	Number	Employee's telephone number
employee_email	Memo	Employee's e-mail address
grade	Integer	Employee's grade 1- 13
date_of_last_update	Date/Time	Date/time of last update to this record
current_site	Text	Site the employee is based at

current_building	Text	Building the employee is based in
preference_notes	Memo	Employee's personal preferences
cv	OLE Object	Resume - embedded Word document
belbin_test_result	Text	Category
security_level_clearance	Text	Category
date_of_last_staff_ dialogue	Date/Time	Date/time of last staff dialogue
skill_preferred1	Integer	Preferred skill #1
skill_preferred2	Integer	Preferred skill #2
skill_preferred3	Integer	Preferred skill #3
skill_not_preferred1	Integer	Not-preferred skill #1
skill_not_preferred2	Integer	Not-preferred skill #2
skill_not_preferred3	Integer	Not-preferred skill #3

tblEmployeeDomainSkills — occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Integer	Unique employee ID
domain_skill	Integer	Skill number
domain_experience_months	Integer	Experience (months)
domain_experience_years	Integer	Experience (years)

tblEmployeeQualification — occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
qualification_number	Number	Total of type

tblEmployeeRole — occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
role_number	Integer	Role number
current/previous	Text	Range of values is "current" or "previous"

TblExperienceName — occurs zero or more times per employee

Field	Data Type	Description/Formatting
skill_number	Integer	Skill number
skill_name	Text	Name of skill

TblKeySkills — occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
skill_number	Integer	Skill number
skill_level	Integer	Skill level (1=novice, 2=intermediate, 3 =expert)

TblMemberOfProfInst — occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
member_of_professional_inst	Boolean	Y/N

tblQualifications — occurs zero or more times per employee

Field	Data Type	Description/Formatting
qualification_number	Number	Name of skill area
qualifiication_name	Text	Degree

TblRoleTable — occurs once per role

Field	Data Type	Description/Formatting
role_number	Integer	Unique role number
role_name	Text	Role name

5.4 ProjectDetails Database

The ProjectDetails database contains information about projects.

The ProjectDetails database contains these tables:

tblProjectName occurs once per employee

Field	Data Type	Description/Formatting
project_number	Number	Unique project ID
project_name	Text	Name of project
project_location	Text	Project location
project_site	Text	Project site
project_contact_telno	Number	Contact telephone number
project_contact_email	Memo	Contact email address
project_manager_name	Text	Project manager name
date_of_last_update	Date/Time	Date of last record update
project_description	Memo	Project description
project_start_date	Date/Time	Project start date
project_end_date	Date/Time	Project end date
current_phase	Text	e.g. Analysis, Bid, design, Implementation, closure, test etc
current_size	Number	(Large (£m), Medium (£m), Small(£m))
number_of_teams	Number	Number of teams assigned to project
value_group	Text	Which division of the business
value_stream	Text	Which value stream of business

5.5 ResourceManagersDatabase Database

The ResourceManagersDatabase database contains information about project personnel resources.

The ResourceManagersDatabase database contains these tables:

TblKeyPointofPDP occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
date_of_last_pdp	Date/Time	Date of PDP
key_point_of_pdp	Memo	Completed, Due, incomplete

TbPDPDate occurs once per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
employee_title	Text	Employee title
employee_firstname	Text	Employee first name
employee_surname	Text	Employee surname

5.6 RoleDetails Database

The RoleDetails database contains information about project roles.

The RoleDetails database contains these tables:

TblPhaseInvolvement occurs once per role

Field	Data Type	Description/Formatting
role_number	Integer	Unique role number
phase_involvement	Text	E.g. Analysis, Bid, design, Implementation, closure, test etc

TblRoleName occurs once per role

Field	Data Type	Description/Formatting
role_number	Integer	Unique role number
role_name	Text	Role name
experience	Integer	Experience (1= expert; 2 = intermediate; 3 = novice)
grade	Text	Grade (1 – 13)

TblTools occurs once per role

Field	Data Type	Description/Formatting
role_number	Integer	Unique role number
tool_required	Text	Tool (UML, VC++, MFC, Rational Rose...)
skill_level	Integer	Experience (1= expert; 2 = intermediate; 3 = novice)

5.7 RPMDatabase Database
The RPMDatabase database contains information about project team assignments.

THE RPMDATABASE DATABASE CONTAINS THESE TABLES:

TblEmployee occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
employee_firstname	Text	Employee first name
employee_surname	Text	Employee surname
department_number	Integer	Department number
team_number	Integer	Team number
project_number	Integer	Project number

TblEmployeePresent occurs zero or more times per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique project ID
month	Text	Jan - Dec
present_absent	Integer	Number of days

TblPlannedPersonnel occurs zero or more times per employee

Field	Data Type	Description/Formatting
project_number	Integer	Unique project ID
month	Text	Jan - Dec
planned_personnel	Integer	No. planned personnel
planned_experienced personnel	Integer	No. planned experienced personnel
actual_personnel	Integer	Actual personnel used
unplanned_losses	Integer	Number of unplanned losses

TblProjectNumber occurs once per project

Field	Data Type	Description/Formatting
project_number	*Integer*	Unique project ID
maximum_project_number	Integer	How many *staff needed*
current_project_number	Integer	How many current staff

TblTeamDetails occurs once per team

Field	Data Type	Description/Formatting
team_number	Integer	Unique team ID
team_name	Text	Team name
peak_team_size	Integer	Peak team size

TblTool occurs once per team

Field	Data Type	Description/Formatting
tool_number	Integer	Unique tool ID
tool_name	Text	Tool name

TblToolPresent occurs once per team

Field	Data Type	Description/Formatting
tool_number	Integer	Unique tool ID
project_number	Integer	Unique project ID
team_number	Integer	Unique team ID
month	Text	Jan - Dec
present_absent	Text	Number of days

5.8 Skills Database

The Skills database supplied by BAE contains no tables.

5.9 TrainingDatabase Database

The TrainingDatabase database contains information about training.

The RPMDatabase database contains these tables:

tblCBTDisk — occurs once per training disk

Field	Data Type	Description/Formatting
cbt_disk_number	Integer	Unique training disk ID number
cbt_disk_name	Text	Training disk name

tblCourse/Supplier — occurs once per course

Field	Data Type	Description/Formatting
training_course_number	Integer	Unique training course ID number
supplier_number	Integer	Supplier number

tblCourseDetails — occurs once per course

Field	Data Type	Description/Formatting
training_course_number	Integer	Unique training course ID number
training_course_name	Text	Training course name
course_start_date	Date/Time	Start date of course
course_end_date	Date/Time	End date of course
number_of_attendees	Integer	No. persons attending
cost	Currency	Course cost

tblCourseSupplier — occurs once per supplier

Field	Data Type	Description/Formatting
supplier_number	Integer	Unique supplier ID
supplier_title	Text	Supplier title
supplier_firstname	Text	Supplier first name
supplier_surname	Text	Supplier surname
supplier_company_name	Text	Supplier company name
supplier_company_address	Text	Supplier company address

tblEmployee/CBT — occurs once per training disk used by an employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
cbt_disk_number	Integer	Training disk number
date_of_issue	Date/Time	Date CBT taken
date_of_return	Date/Time	Date CBT returned
Reservation	Yes/No	Yes means a reservation

tblEmployee/Course — occurs once per training course per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
course_number	Number	Course number
booked/waiting	Text	Values are "booked" or "waiting"?

tblEmployeeName — occurs once per per employee

Field	Data Type	Description/Formatting
employee_number	Text	Unique employee ID
employee_title	Text	Employee's title
employee_firstname	Text	Employee's first name
employee_initial	Text	Employee's middle initial

Appendix H: Software Agents Final Feedback

Manager 1

Please make comments as you feel able to on the following:

How useful you think software agent technology could be to the (1) Company and to your (2) role?
Reasonably for Company. Not much for my role

What do you think the technology can contribute to you that you don't have now (or that may be done differently or less effectively now)?
Visibility of information outside of my parochial area

Do you think that this technology can make your job more effective and in what ways?
It could automate tasks within a software project, making it easier to manage it

Do you think there are other areas of the (1) Company and (2) your job where software agents could help? What are these and how would you describe the potential improvements agents could contribute to?
(1) Automating any laborious task.
Building up a database of competitor information without too much human intervention

(2) I would be interested in what new technology is around and perhaps agents can search and cache that data for me, perhaps even do the understanding it and filtering it to my specific requirements.

What potential do you think there is for this kind of technology in the internal company infrastructure and in creating new product lines?
Definitely a role within the company infrastructure but unlikely in the comms domain

Can you please comment on your views of this technology?
I thought the demonstration was very good and proved that agents can do something useful for the resource management process, which is a bit of a mess!

I think that AI has a long way to go in general and I would like to see these agents being really clever

Please comment on the strengths and weaknesses you see in this technology.
Its pretty good that you don't have to go around hunting down all the information you need and that they can filter and sort it out for you. Also that they can work across any kind of data.

The weakness is that perhaps people won't trust the results and if they are just going to check everything every time that really destroys one of the reasons for having them.

Please make any other comments related to any of the above or to issues you think I have missed which you would like to express here.
When can we see the updated version in action in the Company? Have they bought into it or not?

Manager 2

Please make comments as you feel able to on the following:
How useful you think software agent technology could be to the (1) Company and to your (2) role?
I reckon there are lots of places we could use this technology – even in our own product development. I have visions of them roaming about in the system doing valuable work for us whilst we can get on and do other stuff.

What do you think the technology can contribute to you that you don't have now (or that may be done differently or less effectively now)?
I think that agents could be used to automate the laborious and repetitive stuff in my job and then I could do more interesting bits of work and be able to get back into the technology side of the project, which interests me.

I would like to see a lot of the documentation for the projects produced automatically based on intelligent interpretation of the data that gets entered into a project. Engineers would be happier with this too because they like working with the software and being creative rather than doing documenting.

Do you think that this technology can make your job more effective and in what ways?
Could save me time for a start.
Can also make my role more interesting and give me better job satisfaction

It could make me more efficient because some of the work is being done by the agents

Do you think there are other areas of the (1) Company and (2) your job where software agents could help? What are these and how would you describe the potential improvements agents could contribute to?

(1) The training schedules and course arrangements and booking system could be managed by agents. The requirements management process could be managed by agents too.

(2) Already said previously

What potential do you think there is for this kind of technology in the internal company infrastructure and in creating new product lines?

Product ranges could include military management of information and possibly some level of decision-making. This could be incorporated into a number of our products.

Can you please comment on your views of this technology?

I thought the demonstrator did what it was supposed to do and got everyone talking about the technology and its potential.

The demonstrator proved to me that it was suitable to manage the recruitment process much more effectively than it is managed now. I would like to see it fully operational and don't know why the Company wouldn't want to use it.

Please comment on the strengths and weaknesses you see in this technology.

The weakness could be the cost of licences if we used NQL – depends how much it costs really. But we could develop using anything so we could research the alternatives from a cost point of view.

It may need refinement to get the agents to do the right thing properly – people could be frustrated to begin with.

Please make any other comments related to any of the above or to issues you think I have missed which you would like to express here.

<u>Resource Manager 1</u>

<u>Please make comments as you feel able to on the following:</u>

How useful you think software agent technology could be to the (1) Company and to your (2) role?

I was extremely impressed by the demonstrator and would like to see the real fully functional version in operation soon.

What do you think the technology can contribute to you that you don't have now (or that may be done differently or less effectively now)?

They can make my role more effective.

Do you think that this technology can make your job more effective and in what ways?

The agents can do my admin, sort out my electronic paper trail and deal with all the boring aspects of my role.

If trained right the agents can do a lot of the preliminary decision-making on my behalf.

Do you think there are other areas of the (1) Company and (2) your job where software agents could help? What are these and how would you describe the potential improvements agents could contribute to?

(1) I think the procurement and the marketing departments could use a little help from agents to do things like create and manage a competitor database and get the best suppliers and process for the business.

(2) They could be used to sort out all the training needs not just here at Christchurch but across all sites making it more effective and efficient for everyone and probably a lot cheaper too if all the factors are programmed in.

What potential do you think there is for this kind of technology in the internal company infrastructure and in creating new product lines?

Don't know.

Can you please comment on your views of this technology?

I thought the demonstrator was really very good and served a good role in showing us all what this technology can do for us. I had never heard of agents before the demonstration and I thought it was brilliant myself.

Please comment on the strengths and weaknesses you see in this technology.
I can't think of any right now.

Please make any other comments related to any of the above or to issues you think I have missed which you would like to express here.
None really

Resource Manager 2

Please make comments as you feel able to on the following:

How useful you think software agent technology could be to the (1) Company and to your (2) role?
The demonstrator proved for me the capability and functionality of agents for assisting me with my role as a resource manager. I thought it was a brilliant demonstrator that dealt with all of the issues I was expecting and when I came away from the demonstrator I made it my business to tell others who did not or who could not attend the sessions. I was extremely pleased with the way the agents did their searches for me and the way that the application was presented, the interface was so much better than the ones I have been using and it was a breath of fresh air to see that someone had thought about the development of a useful and usable interface which I could use without any difficulty.

The Company could enhance this demonstrator to include the Staff Dialogue process, training, external CVs and even developing advertisements and all the administration documents related to appointments. It would make life a lot easier for HR and me.

What do you think the technology can contribute to you that you don't have now (or that may be done differently or less effectively now)?
I have already answered this in your previous question really.

Do you think that this technology can make your job more effective and in what ways?
I would be a lot more effective and efficient for the Company and particularly to the project managers who need staff that match their needs and this application has already shown me how this could be achieved.

It would certainly cut down my administration and do the early filtering of CVs saving masses of time for several other staff too.

Do you think there are other areas of the (1) Company and (2) your job where software agents could help? What are these and how would you describe the potential improvements agents could contribute to?
(1) The Company could use these agents anywhere where there is administration or repetitive tasks that could be automated.

(2) For me incorporating all the other areas of my role in some way or another may be useful if some of that could be done e.g. filling in forms and writing letters asking people to interviews, creating adverts, updating my records when people change roles or move about in the Company – that would be smashing.

What potential do you think there is for this kind of technology in the internal company infrastructure and in creating new product lines?
Not sure about this area really

Can you please comment on your views of this technology?
It was brilliant and has plenty of potential for smartly dealing with the parts of our jobs we can live without so we can get on with the interpersonal bits which are more rewarding and gratifying.

When are the Company going to follow this up with the real system?

Please comment on the strengths and weaknesses you see in this technology.
Not sure how the agents would deal with updating documentation

Please make any other comments related to any of the above or to issues you think I have missed which you would like to express here.
None

Engineer 1

Please make comments as you feel able to on the following:

How useful you think software agent technology could be to the (1) Company and to your (2) role?

(1) Very useful. I feel that agent technology and knowledge management is the next bit movement in the computer industry. There is so much information available to everyone but no way to manage it. This would be an ideal way to manage the information within the company and be something of a leader in this type of technology.

(2) It would not only help my role but everyone else's within the company.

What do you think the technology can contribute to you that you don't have now (or that may be done differently or less effectively now)?

Searching for relevant information quickly and efficiently.

Searching for jobs.

Searching for appropriate candidates for jobs.

Do you think that this technology can make your job more effective and in what ways?

It can not really be applied to software development unless an engineer needs to search for some previously used code or useful code.

Do you think there are other areas of the (1) Company and (2) your job where software agents could help? What are these and how would you describe the potential improvements agents could contribute to?

Anything that can reduce the ridiculous amounts of process and documentation production

What potential do you think there is for this kind of technology in the internal company infrastructure and in creating new product lines?

The Company should think about using this in command and control battlefield applications

Can you please comment on your views of this technology?

I am resoundingly in favour of the agent technology.

Please comment on the strengths and weaknesses you see in this technology.

I am not sure whether we have the in-house expertise or budgets to get this technology up and running.

Please make any other comments related to any of the above or to issues you think I have missed which you would like to express here.

I found the VacancyBot application pretty clear and easy to use as well as pretty good at solving some of the problems we get when we want to move onto another more appropriate project to use our skills

Engineer 2

Please make comments as you feel able to on the following:

How useful you think software agent technology could be to the (1) Company and to your (2) role?

I think the demonstrator was simple and easy to use and should make resource managers lives easier and effective. The Company could expand the agents to do other things like work out which engineers have the experience to help out on short-term project needs based on their expertise. Engineers don't get any credit for their technical knowledge and they should – this way they get noticed for what they know.

I would like an agent to do all my administration work so I can get on with being an engineer rather than a glorified administrator without the glory!

What do you think the technology can contribute to you that you don't have now (or that may be done differently or less effectively now)?

If agents did my admin I could be effectively helping resolve technical problems and enjoy my job more. Agents would make me more effective then because I would be able to do all the other technical stuff too.

Do you think that this technology can make your job more effective and in what ways?

Yes

Do you think there are other areas of the (1) Company and (2) your job where software agents could help? What are these and how would you describe the potential improvements agents could contribute to?

(1) The Company could invest in agents for searching the web and finding up to date interesting technical information, which may help to keep the products ahead of the competitors.

(2) I already said what I wanted

What potential do you think there is for this kind of technology in the internal company infrastructure and in creating new product lines?
For new products I reckon that agents could be used to manage the real-time aspects of systems like the Radar work to make the radars more effective. They can also be used to improve communications and network systems we develop.

Can you please comment on your views of this technology?
I think its excellent. I would like to develop some agents myself and test them and get something up and running. They could be brilliant to program and to get them to do all sorts for me.

Please comment on the strengths and weaknesses you see in this technology.
Not sure about the weaknesses, I think others are worried about losing their jobs but I don't think agents are ready to do that just yet! They can have mine and I'll collect the pay cheque!

The strengths are the multi-platform., multi programming ability to develop and use them. Communities of agents that cross these barriers have a lot of potential for development of new systems and products in the defence industry if the security aspects are controlled.

Please make any other comments related to any of the above or to issues you think I have missed which you would like to express here.
Not really I said it already