THE COLLABORATIVE INDEX

A thesis submitted for the degree of Doctor of Philosophy

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July 2006

Abstract

Information-seekers use a variety of information stores including electronic systems and the physical world experience of their community. Within electronic systems, information-seekers often report feelings of being lost and suffering from information overload. However, in the physical world they tend not to report the same negative feelings. This work draws on existing research including Collaborative Filtering, Recommender Systems and Social Navigation and reports on a new observational study of information-seeking behaviours. From the combined findings of the research and the observational study, a set of design considerations for the creation of a new electronic interface is proposed. Two new interfaces, the second built from the recommendations of the first, and a supporting methodology are created using the proposed design considerations. The second interface, the Collaborative Index, is shown to allow physical world behaviours to be used in the electronic world and it is argued that this has resulted in an alternative and preferred access route to information. This preferred route is a product of information-seekers' interactions 'within the machine' and maintains the integrity of the source information and navigational structures. The methodology used to support the Collaborative Index provides information managers with an understanding of the information-seekers' needs and an insight into their behaviours. It is argued that the combination of the Collaborative Index and its supporting methodology has provided the capability for information-seekers and information managers to 'enter into the machine', producing benefits for both groups.

Acknowledgments

This work would not have been possible without my extreme good fortune of being surrounded by a fine selection of colleagues, friends and family.

My sincerest thanks to: Professor Mike Norman, for his early belief and his guiding hand; and Professor Robert Macredie, for his tireless and always encouraging support.

My gratitude to AXA Insurance, in particular Ian Pinnock and Dave Sutcliffe for their commitment, and also the rest of AXA's staff for their permission to carry out this research.

Finally, my thanks to Christopher and Emily (my children) for 'nearly' always being quiet and for Sheila (my wife), well thanks is simply not enough. While others have shown the way for this work, she has walked every step and throughout it all never faltered. I can only hope that in the future, I may reflect her strength and return her favour.

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Introduction 1

1.1 Information Storage and Recovery

Civilisations have stored information for others to use for as long as we have had records. It is the main reason for the existence of those records. The quantity and quality of storage mechanisms have grown over time as the available technologies have changed and alternative and preferred methods of data storage have become available. The Dreamtime chants of the antipodean aboriginal can be seen as memory resident stores of information describing all that was known and understood about creation and their culture. This non-technical storage mechanism allowed the information stored to be passed down to future generations through an oral tradition. In this and other cultures, rock art and cave paintings could be seen as more fixed information stores benefiting from the longevity of the geology but losing the advantages of real-time human explanations. In the case of rock art, the absence of an understood retrieval mechanism is so extreme that we cannot be sure if any information, other than pictorial representation, is stored within images. The result of this is that the potential information is either considered lost or exposed to interpretation from the transient context of current understanding (Bahn, 1998) rather than the original context of creation.

A second example from history of information being stored in a manner that would, over time, not be understood by the information-seeker is in the transcripts of the Egyptians. Over time, the hieroglyphic character set used by the Egyptians was replaced with the Demotic character set (Budge 1964). The evolution of the new character set was generated as a result of a climate of production pressures for an increase in the amount of government letters and documents. The original hieroglyphs were slowly replaced by the less

complicated Hieratic character set and then the Demotic character set (Budge 1910). This evolution, combined with the eventual loss of ability to translate the texts, effectively meant that the information stored using the original language was lost. The discovery of the Rosetta stone in 1799 provided a link between the old Egyptian text and the new Egyptian text together with a further translation into Greek. This discovery bridged all three languages and allowed scholars access to a lost language through a known language unlocking previously stored information.

From these examples we can see that information storage must have a recognised and communicated recovery mechanism. When interpretation is the only recovery mechanism then being able to present a definitive understanding is unlikely. Secondly, we can see that interpretation is affected by the context from which the interpretation is made rather than the context of the storage. Finally, the nature of the storage is influenced by the climate of productivity and the technology options.

In more recent years, cataloguing and organising physical information in a manner that facilitates retrieval has been well-documented and can be seen in examples from the library at Alexandria (Hannam 2003) to the Dewey Decimal system (OCLC 2004). This history of information storage techniques interwoven with technological advances from antiquity to the modern day has brought us to a place where globally we store and organise more information today than ever before and the trend continues to grow. It has been estimated that in 2000 the world produced three exabytes of new information (three billion gigabytes) and in the following two years more new information was produced than had been produced throughout the history of mankind (Lyman and Varian 2003).

Digital technologies have provided us with rapid and convenient mechanisms for storing vast amounts of information and in so doing have moved us into a period that has been called the Information Age (Toffler 1980). Many of the stand alone

digital information silos of the early twentieth century have now been linked with open public storage areas across communications networks to provide a virtual single store of information. One of these networks is the Internet.

The Internet can be seen as a global exposition of knowledge, combined with a relatively easy publication mechanism which facilitates the sharing of information to the widest community. Although in some places there are political and financial restrictions on access to this shared information, this could still provide, to those with access, the opportunity to increase education and innovation and advance civilisation based on shared ideas and experience. However, while information continues to be rapidly published, information-seekers are reporting that they are 'lost' within the information (Wexelblat 1999). They use the term 'information overload' (Toffler 1971) to report the problem when they move through the Internet and are diagnosed as suffering from cognitive overload (Kirsh 2000). These complaints appear to be the result of partly failing to find the right information and partly of finding too much information.

If these problems cannot be addressed then the benefits of technological advances of information storage may be lost. Further to this, the information that has already been stored may not be able to be retrieved, echoing the loss of meaning we have seen in primitive rock art and Egyptian texts but in our modern 'high-tech' environment.

1.2 Electronic World Information-Seeking

The problems associated with today's information storage, and subsequent information retrieval from networked systems such as the Internet, are significant and actions have been taken to address these problems. The approaches are outlined below and more fully described in chapter 2.

Attempts to organise the Internet included 'directories' of information which hold links to published information and have been structured into predefined hierarchic organisational areas. This was a simple transfer of librarian skills and procedures without the need to house the referenced material. There are problems with this approach which include: publishers positioning the information into the directory so varying information-seekers can retrieve it; the quality of the reference information which has been published without review; and modification of the material over time which may require the information to be re-categorised. A supplemental approach for directories was to have all the content submitted by publishers reviewed by a collection of volunteers (human) that decided on the context of the content and placed it in the appropriate position with the hierarchy (DMOZ 2005).

Another approach is to access the information as a flat structure, without the need for hierarchy, through direct content comparison with keywords and a 'search engine' interface. Early search engines were content-only based, which produced returned results that matched the keywords but where the content was out of context with the information-seeker's enquiry. For example a search for 'apples' could return large numbers of results including details of fruit shops, a computer company, a local name for New York, etc., where the word 'apples' had been used. A context search would weight the text on its 'meaning' and make a decision on the context of the word 'apples' within the document. Search engines developed context algorithms to better rate the information, but it was found that humans were better placed than computational algorithms to interpret context (Resnick *et al.* 1994, Borchers *et al.* 1998). Advanced search options were also provided, allowing complex queries to be formulated, but it was found that the functionality was not a preferred access method to information (Selberg and Etzioni 1997, Jansen *et al.* 1998)

Combination approaches have also been used. One combination allows information-seekers to filter through directories and then search the sub-directory content. This approach results in fewer returns for the information-seeker to trawl through but it has been found that users of search engines often choose the wrong category to begin their filtering (Neilson 2002). A second combination is to use a search engine over the directories that have been human context-rated. This is the approach used by the commercial search engine Google which receives over 46% of all internet searches (NNR 2005). Google does not provide hierarchical listings directly and its initial presentation to a visiting user is a single input box to allow the entry of simple keyword queries. Google uses the human context rated directory of DMOZ for its index base. This approach appears to be, currently, the most successful combination of search engine technology and human judgement on context, but it is estimated that for every document found by a search engine there are 550 that are missed, the remaining documents being classified as 'Deep Web' or 'Invisible Web' (BrightPlanet 2000).

This collection of approaches, combinations and subsequent benefits and problems suggests that while the technology improvements in storage mechanisms and processes are advancing, the technology for retrieval mechanisms and processes has not kept pace. It also suggests that the human factor of context judgement and the desire to use simple queries when accessing information are important and valuable and that technology alone is not a complete answer. In summary, the problems of information-seeking within networked systems are multi causal (Carlson 2003) and significant.

1.3 Physical World Information-Seeking

Outside the electronic world, people do not just use networked information systems to find what they need. They use a variety of information stores as well as the knowledge and experience of their community to solve problems (Tichy and Fombrun 1979). They do this because the time and intellectual cost of

researching through reference data is much greater than simply asking someone sitting next to you: using social or community experiences is often the preferred choice (Borchers *et al.* 1998). This human behaviour of using the experience of others to obtain information has been defined as Social Navigation (Dieberger 2000) and Social Filtering (Shardanand and Maes 1995).

In chapter 2, we will describe a collection of systems which have made valuable contributions to the field of Social Navigation and Social Filtering. However, no cases report if any observational studies were carried out to understand how people collaborate through seeking and sharing before the systems were built. We believe that a practical understanding of how people seek and share information will inform the design of interfaces that embody and offer the benefits of human collaborative information-seeking in conjunction with the benefits of rapid-access technologies. From this it appears possible that a more accessible and familiar route to information for the information-seekers could be created thereby bringing the technology closer to reducing the feelings of being lost and overloaded.

1.4 Aims for this research

We know from historic artefacts and modern evidence that information storage and provision for information-seeking is an important part of human civilisation, education and progression. The value and accessibility of electronic stored information is reduced by the structures being created from one perspective but with the understandable inability to cater for the varied nature of possible information retrieval criteria. This process of information retrieval is problematic and is causing a mental burden on the information-seeker which eventually leads to information overload. This problem will become more significant as the amount of information stored continues to expand.

We know that the technical solution approaches alone are a significant improvement over simple hierarchic navigational structures and that the simplest searching methods appear to be the most productive. There is further evidence to suggest that these solutions are enhanced by using the ability of humans to judge the suitability of information content and we have seen that people prefer to seek information from each other rather than alternative information sources.

One set of aims for this research could be to investigate alternative algorithms for recovering information electronically, or another to improve the algorithms that identify the context of information content. However, while we recognise that both of these would add value to the current technologies, we believe that people will still prefer to use their social behaviours to access information when possible and that fine-tuning the algorithms may be wasted effort if the interface that initiates their searching action does not allow them to behave in the manner that they prefer. For these reasons this research has an alternative aim.

This research will focus on existing research areas that address the social needs of system users and have generated electronic systems that facilitate social interactivity and collaboration. It will identify opportunities within the research areas for the production of an alternative or enhanced electronic interface that will move seeking and sharing information closer to human behaviours while harnessing the access speeds of today's technology. This approach should reduce the differences in information-seekers' experiences of the electronic world and the physical world, and provide a route to information that could be used in preference to existing routes. Further to this, by translating social techniques into a practical electronic interface, the findings will be reinforced by testing them in a physical world implementation, and the outcomes of the implementation will be of use to a wide range of information architects, system designers and information managers.

1.5 Objectives

We will review the existing literature for this area, identifying opportunities for a new information-seeking interface that will facilitate human behaviours when seeking information.

We will carry out an observational study on a selection of human groups seeking and sharing information and, through analysis of data collected, use the findings to further inform the design of a new interface.

From the opportunities identified within the literature and the observational study, we will design and implement a research system for a target audience and collect levels of data, suitable for later analysis, to assess the value of the interface design.

Finally, we will use the findings and recommendations from the research system to produce an enhanced interface which will be deployed into a full production environment over an extended period. As with the research system, we will collect data to allow later analysis. We will use the data retrieved to conclude on the process by summarising any successes or failures of the interface design. Following this we will recommend future improvements and offer insights into any discoveries made concerning human information-seeking behaviours.

1.6 Dissertation Overview

This research is divided into seven chapters, the remainder of which are outlined below.

Chapter 2: In this chapter we identify existing electronic world approaches to information retrieval, detailing both problems encountered and good practice in design that has aided human interaction while information-seeking and information-sharing. Within this we identify approaches that facilitate information-seeking by allowing social behaviours to be replicated in an

electronic system, and conclude by presenting a set of design considerations for the electronic world.

Chapter 3: In this chapter we review existing research into physical world human information-seeking behaviours and conclude that there is little empirical evidence within this area to support our research. From this, we recommend an observational study be carried out to review human-to-human information-seeking behaviours, to add to the research area and to provide physical world design considerations. The chapter details the actions and results of an observational study carried out on three groups of people and explains the differences and similarities of the groups observed. We will conclude that although the three groups observed had differing needs to fulfil their daily tasks, there were common behaviours in the way that they carried out their information-seeking and information-sharing and that identification of these common behaviours and adaptation into an electronic interface may provide benefits to a wider audience than those observed.

Chapter 4: In this chapter we bring together the design considerations for the electronic world findings from chapter 2 and the design considerations from the physical world observations from chapter 3. The collective design considerations are then reviewed to produce a list of actions that will be required to implement the design considerations, and a set of predicted results to allow a comparative measure to 'validate' this research. Using the Actions and Predicted Results a design for an electronic information-seeking interface is proposed. We describe the design and implementations of a pilot system and carry out observations and data analysis. We call this system the 'Research Pilot'. The analysis of the results of the Research Pilot indicates that the proposal for its design has resulted in an improvement in information-seeking. We show that human seeking and sharing activities have resulted in a new 'Collaborative Index' to the stored information and have indicated that this new index is used in preference to other navigational

routes. From the outcomes of the Research Pilot a modified design is proposed which is implemented over a longer period and aims to capture additional data to 'validate' the modifications.

Chapter 5: In this chapter we describe the review of the recommendations made in chapter 4 together with the modifications required to implement the reviewed recommendations. A new implemented electronic interface called the 'Collaborative Index' is defined and a new electronic data store, within a large financial organisation, is identified.

Chapter 6: In this chapter we review the metrics gathered from the Research Pilot (see chapter 4) and Collaborative Index implementation (see chapter 5). From this we describe the benefits found through the implementation of the Collaborative Index and also the value of the methodology that supported the Collaborative Index.

Chapter 7: In this chapter we review all previous chapters and reflect on the progress made towards the aims and objectives of this work. We identify the research limitations and also the contributions it has made across different groups within an organisation. This chapter concludes with suggestions for future areas of research.

Electronic World Information Seeking 2

2.1 Introduction

Chapter 1 argued that information storage is an important part of human civilisation, education and progression and that while it is not a new phenomenon (Budge 1964, Thom 1971), it has developed new problems as stores of data have been joined together and continue to grow (Lyman and Varian 2003). This information expansion and the pervasive nature of the Internet and other networked information stores have led information-seekers to experience feelings of overload and being lost while trying to navigate to information (Munro *et al.* 1999, Wexelblat 1999) leading to cognitive overload (Kirsh 2000). It has also been shown that people use each other, as well as electronic information stores, to retrieve information and therefore gain their information through social behaviour (Tichy and Fombrun 1979, Wilson 1983, Davenport and Prusak 1998). As stores of electronic information continue to grow, the task of retrieving information will become more difficult and less productive unless alternative mechanisms for information retrieval are implemented. We propose that if an electronic interface could facilitate, or preferably respond in a manner that reflected the way human-to-human information-seeking and information-sharing activities take place, then interface users would benefit from both the retrieval speeds of current technologies and the benefits of human-to-human interaction.

In order to progress this proposal, this chapter will detail areas of research that have generated interfaces to information and those that encourage social behaviour within the electronic world by facilitating interactivity and collaboration. We will investigate current interfaces in order to identify the significance of the affects of Social Navigation and review the current design principles employed for building systems that facilitate Social Navigation within

the electronic world. Finally, we will propose a set of electronic world design considerations for future interface design.

Within this chapter, section 2.2 will review the use of the Intranet Browser application and identify the issues with hierarchic directory browsing. Section 2.3 will discuss the use of search engine applications and outline the significant information retrieval speed advantages of keyword searches. This section will also discuss the issues that out-of-context searching raises and the steps that have been taken, by search engine providers, to counteract the issues. Section 2.4 will examine the use of adaptive navigation as an alternative to both fixed navigational structures and the use of search engines, while section 2.5 will describe the importance of Social Navigation in the physical world and the transference of this form of navigation to the electronic world. Section 2.6 will review existing design considerations for Social Navigation and online community-building and propose a set of electronic world design considerations for the creation of a new interface to information. Finally, section 2.7 will conclude on the findings of this chapter.

2.2 Browser Interface

Within the Internet, the most popular interface for information access is the 'Internet Browser'. This interface does not provide a facility to reorganise or annotate information and has limited functionality for user customisation. It operates across a predefined hierarchic information structural context which allows information-seekers to move through and across information areas with relative ease providing that they understand the organisational structure implemented by the designer. Within the area of usable system design, Benyon (1998) pointed out that history was littered with examples of systems built from the perspective of the designer but expected to work from the perspective of the user. This dilemma has equal, if not more, relevance for information architects of

hierarchical stores as they have to meet the information-seeking needs of an unknown user community with a potentially endless variety of perspectives.

On a larger scale, early attempts to organise many single stores on the Internet to facilitate retrieval included the creation of hierarchical 'directories' of information. These directories held links to the published information elsewhere on the Internet, and were structured into predefined organisational areas. This overt and published structure was a transferred librarian skill from real-world information storage but differed in that the directories did not house the information; rather they simply held links to the electronic location of the information. The directory made no attempt to optimise, rank or promote the content, other than to assign its position in the information hierarchy (DMOZ 2005). New links were added either by the document publisher or through request if a suitable organisation category did not exist. A problem with this approach was the positioning of the link into the directory. The relative position in the hierarchy would be chosen by the publisher of the document. This meant that the document would be linked in a single area that the publisher believed was the most relevant for the context of their work. Therefore, it may have been categorised correctly in their view of the information but remain 'lost' from information-seekers with a different view of the structuring of the directory. A second problem was quality of submission. The information was, in general, not validated by the directory keepers as they only held the links, not the information (DMOZ 2005).

The browser interface uses documents delivered either from hierarchic directories or hierarchic single stores and parses the hypertext to display embedded links to be used as semantic navigation points to connected information. Although the interface itself does not enforce a single contextual view or hierarchic navigation, the presentation to the information-seeker can only show the semantic links set out by the document creator. Once all of the links

have been visited, the information-seeker returns to the top of the hierarchy and has to locate the address of an alternative document.

However, it has been found that directory-based searching does not seem to offer increased relevance over the use of a search engine (Bruza *et al.* 2000) and perhaps the search engine is a better approach for electronic world information-seeking.

2.3 Search Interface

A search engine offers a single route to stored information but, unlike the browser, the original single information store has been re-indexed into multiple categories using automated algorithms across textual content. The approach offers an alternative interface to the browser by stripping away the designer's context of the information architecture and accessing all information based on comparison of keyword selection. Algorithm enhancements may include a thesaurus process, to identify keywords that may not have been searched for but have similar dictionary meanings, and advanced phrase-based query refinement. This provides rapid access to navigable nodes that will lead to information that matches the search criteria but, through their direct approach, will offer very little in organisational structure. This speed advantage over navigating through hierarchic navigable links is considerable in retrieving information aligned with keyword selection, but the advantage it provides by removing the single context perspective of stored information becomes a disadvantage if the keywords selected produce limited or inappropriate results. In these cases, the information-seeker has reached a 'dead end' and can only begin the search again with modified keywords. Another disadvantage of removing the original hierarchic context structure is that people prefer to place information within a framework of relevance (Harper 1999, Munro *et al.* 1999) in order to better understand its meaning and relationship with the information around it. The flat structure search engine approach does not allow this to happen.

Some searches offer hierarchical filtering prior to search commencement, although users of filtering have been found to begin their searches in the wrong place (Neilson 2002). It has also been found that users prefer to start their information-seeking in the simplest possible manner and there is evidence that when presented with advanced search options, such as Boolean operators or filtering, they are not used (Jansen *et al.* 1998). Further to this, it has been found that users of search engines prefer to make one query attempt and then dig through the returned results. They prefer this approach to undertaking a series of trial and improvement query reformulations (Selberg and Etzioni 1997). This suggests, on their first query attempt, that if a user does not know how to ask for the information they seek, or the information that is stored on the internet is in an unfamiliar language, then they are unlikely to find what they seek.

The search engine interface offers the information-seeker an apparently unlimited number of access routes based on automated context interpretation of textual content. However it has been found that humans, and not automated processes, are better placed to carry out context identification and annotation (Resnick *et al.* 1994) and will always give more relevant recommendations than any computer function (Borchers *et al.* 1998). The reasons for this are that people can judge texts on dimensions other than the basic textual content, such as quality, authoritativeness and respectfulness.

To address these human judgement issues, the Open Directory Project (DMOZ 2005) utilises volunteer content approvers; it is the largest human-maintained content directory on the Internet. The value of human judgment in determining the quality and positioning of content has been recognised by large commercial organisations and the Open Directory powers the core directory services for the Internet's largest and most popular search engines. The commercial search engine Google receives over 46% of all internet searches, with its closest rival at 22% (NNR 2005), and it uses human-judged content. Its initial presentation to a

visiting user is a single input box, to allow the entry of keywords, and it does not display hierarchic directory structures.

The technology of the search engine is important to the Internet but even when the content is placed in context by a human it remains a single context view. The need for alternative routes to information is a product of the diverse nature of the information-seekers' understanding of classifications and organisation and the separation of the information architect's view of the same factors. Even a well-conceived information structure would still be unlikely to have sufficient diversity to meet the variety of context needs. This suggests that an adaptive approach to navigation, where the navigational interface would be customised based on the behaviours and preferences of a user accessing the system, may provide an alternative (Höök and Svensson 1999).

2.4 Adaptive Interface

Identifying a user, or use, and modifying the navigational interface to the perceived needs or declared preferences, is a form of adaptive navigation. This approach offers multiple presentation routes within the interface, effectively concealing the context of the information store while leaving the structure unaltered. The adaptive granularity of the interface can be reduced by identifying group profiles rather than an individual's profile and adapting the navigational interface accordingly.

Identifying 'use' of a system is the foundation that specifies the criteria for adaptation (Meyer 1993). Adaptations can be affected by user experience, demographics, user mental models and other attributes of use. One of the ways that this can be achieved is through the direct approach of user-declared identification. This involves a user being known to a system and the identification taking place through direct authentication. A variation on the direct approach is to allow a user to remain anonymous and, through their interactive

selection of grouped information areas, the navigational interface can be altered based on a predefined appearance for those groups selected. This variation supports anonymity and removes the need for the user to be identified individually by the system. As an example: a user identifies themselves either through a logon (authenticated access) or through preference choices (anonymous access) and indicates they have an interest in Sociology and Physics. The interface would then adapt for that individual and only provide links to this type of information. Another example of this approach extends the model to a user affecting more than their profile. In these cases, a user's 'activity' may affect the whole group profile to which the user belongs to and therefore modify the profile of all other members of that group.

An alternative to the above is indirect identification through interface usage and user behaviour. This method involves monitoring user activity as they move through an information store and modifying the navigation based on their searching patterns. To extend the example from above: if the same user took a link from Sociology to Psychology and was identified through system tracking as spending a significant period of time in this area, then their behaviour could trigger the addition of the Psychology information category to their user profile. This would result in either an immediate change to the interface presentation to indicate the group had been added or a change next time this user returned to the interface.

Previous work has found that both direct approaches to user identification are problematic, as anonymity and privacy are user-expressed concerns in networked information systems (Forsberg *et al.* 1998), with examples of medical information being cited as the type of personal information that would benefit from direct identification but where users do not wish to be directly identified during seeking activities. The indirect approach (interface usage and user behaviour) has also been found to be problematic as although monitoring and

tracking of user behaviour can take place during an information-seeking session, the context of the seeking interaction and the resultant satisfaction of information recovery are both unknown. Therefore, it is not safe to assume that the seeking behaviours of one user should generate an adaptation of the interface for subsequent users, as the success and context of the later seeking activity may be different.

In addition to the problems of user identification and appropriate interface adaptations, it has also been found that users of systems do not benefit from a constantly adapting interface (Höök and Svensson 1999). One of the objectives of adaptation is to provide an interface that assists a user to find the information they need without becoming lost in an information space. However, it has been found that a constantly adapting interface generates feelings of being lost as it may differ each time that the user visits the information store and, in extreme cases it may adapt during a single visit. From this it has been concluded that the approaches to adaptive navigation have benefits, specifically for an identified user where the interface can adapt to profile the information in a context of a declared interest, through either direct identification or through direct group enrolment. Overall a changing navigation interface has proved to be more of a distraction than a benefit (Höök and Svensson 1999).

A common factor to all three interface types to information considered so far is that they all provide alternative navigable routes to information. Regardless of their flexibility or technological complexity, the end result delivers a collection of navigable nodes that have semantic relationships to the documents that they promote. Dourish (1994) classified three models of Information Navigation: Spatial Navigation being the most familiar as it drew on our real world experience of up and down, left and right; Semantic Navigation, where navigational nodes are followed because of the connectedness of their content (conventional web browsing); and, finally, Social Navigation which was

described as provoking a user to move through an information space guided by the activities of others.

Spatial Navigation is not realistically possible in the two dimensional spaces of conventional electronic systems, but web site-maps have been used to provide a pseudo-spatial feel to navigation with advantages (Jung and Lee 2000) and disadvantages (Dias and Sousa 1997). We have already explored Semantic navigation through the discussion of browsers and search engines (see sections 2.2 and 2.3). Social Navigation is the result of one person using the previous or current experiences of others to make active choices. As such, an approach that facilitated mechanisms to make visible the active choices of others within an information-seeking interface could provide the opportunity to reuse those seeking experiences. This approach also supports the belief that information-seeking is more than the transmission of information from a system to a solitary user and that the social aspects of information-seeking are important (Churchill *et al.* 1999). From this we believe that an interface that promotes Social Navigation may move electronic interfaces nearer to the preferred actions of human-to-human information seeking behaviour.

2.5 Social Navigation

In the physical world, Social Navigation can be divided into four categories: Direct; Indirect; Intentional; and Unintentional Social Navigation (Forsberg *et al.* 1998). Direct and Indirect Social Navigation are carried out by a person seeking information, while Intentional and Unintentional Social Navigation are the results of actions carried out by a person providing information (see table 2.1).

	Social Navigation Categories			
	The Seeker		The Provider	
Examples of Navigation Activities	**Direct**	**Indirect**	**Intentional**	**Unintentional**
Asking for directions or advice from another person.	☑	☒	☒	☒
Purchases based on looking into another shopper's basket, selections from a popular product list or following a crowd.	☒	☑	☒	☒
Offering directional advice to another person in words or actions.	☒	☒	☑	☒
Leaving tracks in the snow, leaving 'well-thumbed' marks on books or being part of a crowd.	☒	☒	☒	☑
Reading a map, following a paved path, responding to street signs. These are NOT examples of Social Navigation.	☒	☒	☒	☒

Table 2.1 Social Navigation Categories

Direct Social Navigation is asking someone where to go or what to do. It is a direct interaction resulting in the resolution of a question, or perhaps an offer of further navigational advice. Indirect Social Navigation can be seen in an example of people choosing the most popular brand of goods, knowing that others had purchased this product, or looking into another person's shopping basket to see what they had bought. Intentional Social Navigation is a deliberate action on the part of an information provider, such as offering advice, while Unintentional Social Navigation is exemplified by the marks left through human actions, such as tracks left in the snow indicating that others had passed along the same route.

Direct and Intentional Social Navigation can be readily identified within the physical and the electronic worlds. Identification of Indirect and Unintentional Social Navigation activities is also relatively easy within the physical world but is problematic in the electronic world. For example, a well-thumbed book provides us with visual clues that others have been there before. This degradation

of the book's pages indicates that human activity has taken place. It has been shown that humans are attracted to other humans' activities (Munro *et al.* 1999), so a 'worn' book provides visual evidence of human activity and could be described as an Unintentional Social Navigation activity. This unintentional visual evidence then facilitates the opportunity for Indirect Social Navigation. In the electronic world, these marks of activity are largely unavailable to us as an artefact accessed once looks the same as when accessed many times. This failure to show 'wear' limits the opportunities of Unintentional and Indirect Social Navigation in the electronic world.

It has been found that enhancing electronic world systems to record digital-artefact interactions, such as edit and read activities on files and making the interaction history visible to subsequent users, has provided benefit to the users of these enhanced systems (Hill *et al.* 1992). In one system, *Footprints* (Wexelblat 1998), activities were tracked and information annotated that had been viewed to indicate the routes to information that had been taken. This unintentional, or passive, annotation was a result of user activity within the information store. One difficulty with this passive approach was that subsequent users could not identify 'success' in information-seeking as the activity tracked provided no conclusions, but the automatic process of tracking identified the popularity of the route as the tracking marks could not be stopped. In these cases, the system was recording the activity of someone who may have been lost or was retrieving information that was proving unsuitable and others should not be encouraged to follow these unintentional recommendations (Wexelblat 1999b). This was not an electronic world failure to replicate the physical world equivalent, as the same factors are true in the physical world when following 'footprints in the snow'. However, in the electronic world an opportunity for improving the legitimacy of recorded tracks may be to allow direct annotation of information artefacts. By allowing annotation the artefact would display signs of

human activity and allow subsequent users to benefit from the knowledge of others' previous experiences.

In allowing digital artefacts, such as the contents of an electronic information store, to be modified with human experience, either through direct or indirect annotation, the nature of the information store is changed. It ceases to be under the sole ownership of the system designers and becomes enhanced by human activity. The annotation on its own has some value, but when combined with a filtering process it could become an alternative method of navigating, exposing alternative contexts for information-seekers. This collaborative method of filtering by capturing the experience of previous users and their context recommendations (Dourish and Chalmers 1994, Dourish 1999) allows the information store to be enhanced with the notion that someone else was there and they left a mark which others could choose to follow.

Direct annotation of context and value was implemented at Xerox PARC within the Tapestry system (Goldberg *et al.* 1992). The system was developed to provide an alternative method of access to the storage information structures of the organisation's email system. It was understood that a single navigational structure would be unsuitable for all accesses, and users were allowed to assign values to the content of the information that indicated its quality and context. These annotated values were used for filtering when subsequent users attempted to retrieve the information. This approach allowed all of the email information to still be stored, as it was all likely to be of value to someone, while human annotation brought an alternative dimension to email access. The Tapestry system had the advantage of operating in a small community and values assigned to information were from someone that an employee knew. This allowed the system to benefit from the already-established human relationships (Borchers *et al.* 1998). To use the system an information-seeker could ask for content that had been rated highly by a named colleague. The nature of the local community of

Xerox PARC proved to be beneficial to the outcomes of the Tapestry system. In an open community, or a community where anonymity was required, the advantages achieved through existing human relationships would be missing, as a user of the system would not know who had annotated the content.

Group Lens (Resnick *et al.* 1994) drew on the experience of Tapestry and addressed the issues related to having to know other users before benefit could be obtained. Group Lens was built as an interface to USENET news groups for an open community using open technological approaches to promote widespread scalability and provide enhanced methods of annotation and aggregation of multiple ratings. In this development, individuals would not know each other personally, although they would still require identities. Group Lens introduced filtering based on ratings and elapsed time. The first was a value annotation to the article and the second the amount of time that an article was read for, using the assumption that the longer an article was read, the more value it had. Matches and recommendations on news items were made based on an individual's ratings of similar articles. So if a user rated a certain article highly and this matched someone else's rating of the same article, then the user would probably appreciate other articles that the same person had rated that the user had not seen. It was observed that as this collaborative approach to annotation required an interaction from a human before any collaborative benefit could be realised, it was important to encourage information-seekers to make that last, 'altruistic' step to annotate.

At a similar time to the development of Group Lens, Ringo was built as a system for music recommendation (Shardanand and Maes 1995). Like Group Lens, it required users to have identities, and profiles of the user were kept for comparison against music rating. At sign-up, a user would indicate their preference of music from a supplied list and the system would return lists of

automated recommendations based on their choice of music in relation to other people's choices.

Tapestry, Group Lens and Ringo all relied on annotated ratings for comparative analysis and subsequent recommendation or filtered results. Rosetta (Bradshaw *et al.* 2000), a search facility for identification of reference material based on others' associated citations, was another relevant system but it did not ask users to annotate the content; instead it allowed matches based on short, and potentially, imprecise, textual queries. The system identified that the words that people use in the citations of their references are concise and similar in format to the sort of queries that people generate when searching for information, and so building an index based on the words that others had used to cite a paper would be of more value than indexing the full content of the cited paper. The outcomes identified Rosetta as a valuable research tool (Bradshaw *et al.* 2000).

The findings from Tapestry, Group Lens and Ringo indicated that facilitating content annotation within information-seeking systems provides an alternative method of access by allowing information to be annotated with views on quality and alternative contexts. The annotations then act as a filtering mechanism, reducing the amount of browsing navigation required to get to the target information, and in some cases profiling the content for identified information-seekers. All three systems have added significant value to the research area but they do not report any details of pre-design observations taking place to identify the nature of human behaviour when, firstly, seeking information and, secondly, collaborating with other humans. The outcomes of Rosetta have shown that creating an interface that is in tune with the practice of human information-seeking query creation produced a valuable searching mechanism and this result was linked to the understanding of the strategies that humans used when searching for information. Finally, all four systems were created for specific tasks. They were created to filter email, collate news, recommend music and

locate references respectively. Each system is dedicated to its own task and without modification, we believe, could not be used across generic stores of information, similar to those that make up the majority of the Internet.

From these findings we have seen that systems that facilitate Social Navigation within their design bring benefits to information-seekers. From this we believe that the creation of a new interface should support this form of navigation through the techniques of collaborative filtering. It is recognised that the benefits are only made possible if the information interface is designed to allow Social Navigation to take place. Finally, we have seen that understanding how people behave when seeking information is significant to the success of the system.

From this, we conclude that two separate activity threads should be carried out. The first is the identification, from analysis of relevant research, of design principles and considerations to inform the creation of a new interface. These principles and considerations should support the use of the interface across generic stores of information and this will be described in section 2.6. The second (carried out in chapter 3) is to further research how humans seek and share information when carrying out varied tasks to identify any patterns of similar or dissimilar behaviour. The findings from the research could then be used to further inform the design principles and considerations for collaborative systems.

2.6 Design Principles

Information systems should be developed as systems within which people have the opportunity to navigate socially. Social Navigation is not a technology, it is the result of human interaction (Dourish 1999) and this makes technical system construction very difficult. So, design considerations have to be created to assist the designer to build systems that allow Social Navigation to occur and provide warnings for possible areas of concern.

Forsberg *et al.* (1998) documented specific Social Navigation design principles as part of, and to be informant to, the PERSONAS project, which was a collection of investigations and product builds based around the concepts of Social Navigation. Although the last revision was in 2000 (Lonnqvist *et al.* 2000), to date the design principles remain unchanged. The main principles are: Integration; Presence; Trust; Appropriateness; Privacy; and Personalisation. Each of these principles will now be discussed together with comparison to, and support from, other design principles within the area of online community creation.

The aim of the discussion is to build on the work of others' design principles and produce a collective set of design considerations for use within this research to create an alternative interface to information.

2.6.1 Appropriateness and Integration

Making all systems socially enhanced may not be appropriate and identifying appropriate systems should be part of the design process. For example, Svensson (2000: p37) states that "Allowing users to see each other on the AltaVista web site would not necessarily help them in finding the information they need" as the number of people visiting using the system outweighs the potential social benefits. This could suggest that high-volume sites or gateways to information that have a generic attraction are not 'appropriate'. If this was the case, then enhancing a system with a specific appeal may be more appropriate as the audience will have already subjected themselves to a form of filtering through their action of choosing to use the system.

The design principle of Integration recommends that once an appropriate system has been identified then the tools created to implement the social enhancements should be an integrated part of the system. Where possible, the user's activity within the system should be captured as if it were all part of a single interaction. This process of capturing user activity is a form of tracking and has already been

identified as a cause for concern when the tracks are recorded in a passive manner (Hill *et al.* 1992). We suggest that as passive recording is an issue, then seamless integration is unlikely to be achievable as the user must always have the ability to remove their passive recommendation. In this case, the process ceases to be passive and may be simplified by requesting a manual recommendation rather than passive tracking.

2.6.2 Trust

People need to trust the received information and the received advice. If the information is not from a valid source, or may have been altered without an authorative review, then the information may be incorrect. In Kim's (2000) strategies for online communities, she encourages organic growth of empowerment for community members to make better use of the users of the system in addition to the managers of the system. We see that this empowerment may lead to a breech of the design principle of trust if the empowerment included the modification of content. So, while accepting the value of empowering the community, we believe this has to be balanced between the ability to modify the content of the system and the ability to annotate content without modification. Kim (2000) also describes a strategy for 'feedback loops' which ensures that the 'managers' of the system can be informed of issues or problems by the users of a system and can act on their feedback. We see this as another consideration for the design principle of Trust and believe it is linked closely to the empowerment strategy. For example, we propose that a user who is allowed to feedback to the system managers and can see things change as a result of their feedback will 'value' and so 'trust' the system. This feedback loop should foster ownership of the system by the community and is supported by the findings of Lonnqvist and Dieberger (2000) within their research into the enhancement of the Collaborative Web Server.

2.6.3 Presence and Privacy

For a user to feel that others are present, and therefore behave in a social manner, they must have clues that others are present in the same place. This does not have to be a real-time presence; it can be the simple notion of others having been there before and having left some kind of mark. Being part of a social community may have value, but it also has problems as the user will be recognised and their footprint traces will be recorded. This may concern users enough for them not to use a system and from this we recognise that Presence and Privacy have a connected tension.

Clear design decisions need to be taken to protect privacy not only from the technical aspect but also, where appropriate, to allow anonymity to be maintained. Godwin (1994: p73) suggests, within his principles for making virtual communities work, the importance of identity as "you see the same 'faces', know the same personalities, and have ongoing relationships". For this to be possible a form of confirmed identity would be required and this is in conflict with the Social Navigation design principle of Privacy. The later work of Kollock (1999) drew on Godwin's work and emphasised the importance of identity as a key factor in community building as it was shown that without a continuity of identity and an understanding of how someone had behaved in the past, communities could not be built effectively. Identity was again raised as a concern in the principles for Social Translucence (Erickson 2000), where the main principles of visibility, awareness and accountability were all identity-dependant and community-based. To add to the importance of identify confirmation Dieberger *et al.* (2000: p7), in describing eBay, states "A person's reputation lets you evaluate their recommendations and determine how much trust you might want to put in them". So even in the case of eBay, where identity is confirmed through an online pseudonym, the history of actions associated with that identity becomes the online reputation that is used for evaluation. This historical record

of activities removes the opportunity for complete anonymity and does not support the design principle of Privacy.

The observations from Erickson, Kollock, Dieberger *et al.* and Godwin suggest that community is dependant on confirmed identity. We have seen that Social Navigation through collaborative filtering has been beneficial in both anonymous and identified communities (Goldberg *et al.* 1992, Resnick *et al.* 1994, Shardanand and Maes 1995, Bradshaw *et al.* 2000). From this, we conclude that community and Social Navigation may be linked but are not bound by the same mechanisms for identity and so within Social Navigation there is no need to know who a specific person is, just that *a* person went this way.

2.6.4 Personalisation

Although not connected in the design principles, we believe that Personalisation is also part of the Presence and Privacy tension. If a system is to respond in a manner that suits a specific person, it needs to 'know' who that person is, or 'be aware' of the type of person. We have seen the issues surrounding anonymity and have concluded that unique identity is not required to benefit from Social Navigation techniques. Forsberg *et al.* (1998: p6), while describing navigational personalisation, state that "advice-givers tailor their navigational instructions to the advice-seeker" and concludes that "if we can match the right giver and seeker the likelihood of success increases". This would suggest that to improve the success of a user navigating to information, the advice being offered must be, in some way, specifically relevant to them, without the constraints of identify confirmation.

2.6.5 Design Principles and Consideration Conclusions

In sections 2.6.1 to 2.6.4 we have reviewed the current Social Navigation design principles (Forsberg *et al.* 1998) and recommendations for systems that are to be socially-enhanced or promote community (Godwin 1994, Kollock 1999,

Erickson 2000, Dieberger *et al.* 2000). From this review, we will now suggest a set of design considerations that encompass the design principles and the relevant recommendations of community-building. Some of the researched recommendations for community-building are 'system specific' to the community that they were intending to promote. For example, Godwin (1994: p73) in his description of building a news community, recommends that designers, "provide places for children" and "don't impose length limitations on postings" which are specific news group recommendations and so are excluded from the generic design considerations suggested by this research.

(i) Appropriate Integration: This consideration combines the design principles Appropriateness and Integration but rejects the elements of passive recommendation as a mechanism for integration. It is proposed that when a socially-enhanced system is created it should be integrated into an environment with a specific appeal and an active (not passive) recommendation process. For clarity, the design considerations suggested are 'generic' but this design consideration recommends that appropriate integration includes the identification of a system with specific appeal.

(ii) Anonymous Presence: This consideration combines elements of the design principles for Presence, Privacy and Trust. It is proposed that anonymous access to a system's information should be supported, and the use of others' annotations should provide a suitable feeling of 'others having been there before' which should reinforce social presence (Riedl 2001). Passive recommendation or annotation through movement tracking should not take place. Finally, privacy of anonymous users should be maintained and communicated, which should then support the consideration of Environment of Trust.

(iii) Environment of Trust: This consideration combines elements of the design principles of Trust and Personalisation. To encourage and promote an environment of trust, both in information and received advice, the base

information of a system should not be changeable by an unauthorised source. However, there should be a facility to allow annotations to be associated with the base information and it is proposed that this facility takes the form of feedback loops (a term used in Kim 2000).

(iv) Feedback Loops: The consideration of feedback loops is supplemental to the consideration of Environment of Trust and is combined with elements from the design principle of Trust. A mechanism should be created to allow the information annotation of base information. The annotations should be visible to all, providing a communication route to other users within the system, 'social presence', (Riedl 2001), and a direct communication with the managers of the system.

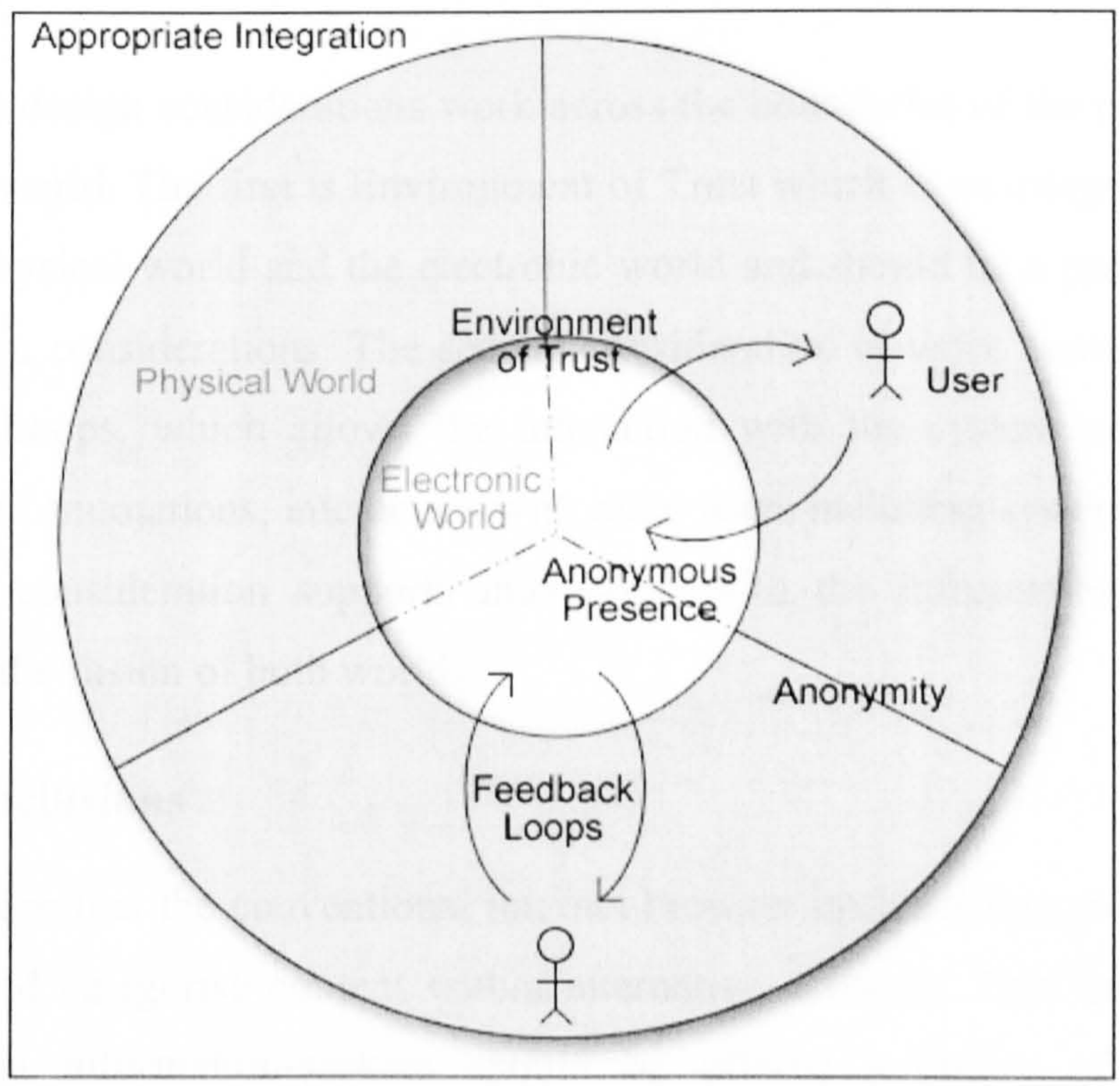

Figure 2.1 Design Considerations within the Physical and Electronic Worlds

The relationships of the combined design considerations are illustrated in figure 2.1. The figure shows a bounding container representing Appropriate Integration, emphasising the importance of this consideration. The outer ring represents the physical world, and the inner circle the electronic world. The three segments of the ring and circle are illustrative of the separation that is present in the physical world and should be extended into the electronic world. For example, the state of physical world Anonymity is marked as a clear boundary between two users. This represents that we know others exist in the physical world, but we may not know what they are doing or who they are. Through the design considerations, this boundary is then extended into the electronic world and becomes Anonymous Presence, which is reflective of the physical world state rather than the alternative of enforced electronic world isolation as a result of complete anonymity.

Two of the design considerations work across the boundaries of the physical and electronic world. The first is Environment of Trust which is an integrated part of both the physical world and the electronic world and should be a product of the other design considerations. The second consideration to work across worlds is Feedback Loops, which allows the interaction with the system and, through tracking and annotations, interaction with other users including system designers. This final consideration supports interaction with the information store and stimulates the fusion of both worlds.

2.7 Conclusions

We have seen that the conventional internet browser interface has an inability to organise and categorise content within alternative contexts. This has led us to believe that information-seekers should be offered a choice of using the conventional internet browser for information structures that they understand or an alternative interface if they require alternative views of the same content. We have found that search engines have a significant speed advantage over browsing

a hierarchy but are not a complete solution on their own. We have also seen that an interface that adapts its mechanisms for users is only of limited value for information-seekers as its adaptation as a result of use can add to the complexity of the process, but that context adaptability is a definite benefit. We have found that allowing information-seekers to annotate content has benefits and that such benefits can be obtained providing that the annotation method is appropriate, resulting in alternative routes to information.

We have identified that the systems reviewed were successful through the use of filtering information based on annotations of value and context. We have also identified that the systems were produced to carry out a single task and we believe that this specific focus makes them unsuitable for the generic processes that would be required across larger information stores such as the Internet. Within this finding we have also seen that understanding how people behave when seeking information is significant to the success of the system.

Finally, we have discussed the existing design principles for Social Navigation and recommendations for community-building. From this, we have suggested a set of design considerations to inform the creation of an alternative interface to information which we have grouped into Appropriate Integration, Anonymous Presence, Environment of Trust and Feedback Loops.

Having, in this chapter, reviewed and analysed existing research into electronic world information-seeking and information-sharing, chapter 3 will research and review existing work into physical world human information-seeking and information-sharing behaviours. It will be argued that there is limited empirical evidence of human-to-human information-seeking behaviours being considered in the design of information stores and recommend that an observational study into these physical world behaviours be conducted in order to inform this research through the identification of further design considerations.

In chapter 4 we will combine the electronic world design considerations from this chapter and the physical world design considerations from chapter 3 into a single set of design considerations and create and deploy a pilot system interface to facilitate further research.

Physical World Information Seeking 3

3.1 Introduction

Chapter 2 investigated existing research into the behaviours of humans using electronic world information systems (see sections 2.2 to 2.4) that facilitate social interactivity and collaboration (see section 2.5). The chapter identified collective design considerations (see section 2.6.5) to facilitate human seeking and sharing behaviours in an electronic environment and identified that understanding how humans seek information was beneficial to system success.

This chapter investigates established research into physical world human-to-human information seeking and finds that there is little empirical evidence to inform this research. The lack of evidence suggests that it would be useful to conduct an observational study to be carried out to observe and report on human-to-human seeking and sharing behaviours. The outcomes of the observational study will then be used to further inform electronic interface design through the creation of additional design considerations.

Within this chapter, section 3.2 will investigate the existing research area of human-to-human information-seeking and information-sharing and section 3.3 will describe which task groups should be observed. Section 3.4 will identify which team was chosen to represent each task group and section 3.5 will outline how the observations were made. Section 3.6 will detail the type of observations made and section 3.7 will report on what was observed. Section 3.8 will review and analyse the findings to identify generic behaviours across task groups. Section 3.9 will provide a summary of this chapter.

3.2 Initial Research

Information-seeking and collaboration is a recognised behaviour but it has been observed that "[researchers] have for the most part, focused on designing systems that support information seeking activities rather than examining the phenomenon itself" (Reddy and Dourish 2002: p2). In one case, Wilson *et al.* (2000) have taken considerable steps in defining and demonstrating the principles involved in information-seeking through the perspective of human 'uncertainty'. Their work draws on human cognitive styles during seeking activities, but the final evidence for their principles, while important to the field, is unsuitable for our research as they were gathered through metrics from a human-to-computer interaction. Pejtersen and Fidel (1998) document a case study of students seeking information, in support of their Framework for Cognitive Work Analysis. However, although well documented, the observations are of students seeking information from a machine, which again are unsuitable for our research. This pattern of human activity, being observed either through electronic metric gathering or through observational studies of people using machines, continues through many other references. All of these are valid research methods, but are unsuitable as a foundation for this human-to-human part of our research into physical world behaviours. These findings are further supported by Reddy and Dourish (2002: p2) who stated that "we have very little empirical knowledge of how individuals collaborate to find information" and so owing to this absence of research material we conclude that a field study of human-to-human information-seeking should take place and the outcomes should be used to inform this research and the research area.

3.3 Where to Observe

It was believed that people working in teams would seek and share information from each other and so the focus of our observational study would be on a collection of teams. To identify which teams to observe, it was hypothesised that

the nature of the tasks that a team carries out may impact the way in which seeking and sharing takes place. Within the established research there are references to others' investigations into the nature of team and task role information-sharing. For example, Poltrock *et al.* (2003) describe the nature of information-sharing within the task role perspective of a Design Team Member for Microsoft and the same task role within The Boeing Company. They found that despite the organisations producing very different products, the Design Team Member task role had similarities within both organisations and the behaviours of individuals reflected this similarity. This observation indicates that by identifying a task role and addressing the needs of the people within that role, the resulting outcomes are likely to be applicable to the same task role in a different organisation.

One approach for our research could have been to identify the most popular single task role within all organisations and address the behavioural needs of the humans within that role. The outcomes of this approach should then benefit all those who share the observed behaviours. An alternative approach could have been to review more than one task role and identify similarities and differences across the task roles. By taking this second approach the similarities could then be used to inform an interface design that should benefit a multiple task role audience. We believed that identifying generic factors across multiple separate task roles offered a better opportunity for producing generic design considerations and so we progressed the observational study based on this choice.

To obtain a wide selection of task role groups which would provide the opportunity to identify generic factors that existed across the diversity of their roles, it was felt that a large target organisation was required. The organisation had to be large enough to have independent and defined task roles to provide clear separation of task role identities. This was thought to be important, as it was feared that a small organisation may not have had a clear separation of task roles,

as individuals may have spanned areas and as a result modified their information-seeking and information-sharing behaviours affecting the observational results. AXA Insurance UK provided the opportunity to carry out the observational study at their Lytham office, which employed 600 personnel within multiple departments and separated task role groups.

3.4 Who to Observe

Telephony was chosen as the first task role group, the second group was Information Technology and the final group the Human Resource Department. The groups were chosen for their diversity of information-seeking and information-sharing needs and the potential breadth of their task role differences. Once the groups had been identified, appropriate mechanisms for observation needed to be established.

3.5 How to Observe

The Information Technology Task Group (ITTG) spent long periods of time carrying out the same task and would switch between tasks only occasionally. It was decided that this task group could be observed using video recording and the analysis be carried out at one minute intervals without losing significant amounts of task information. The Human Resource Task Group (HRTG) fitted this pattern of longer task periods and so they too could be video recorded and sampled every minute. However, the task periods for the Telephony and Reception Task Group (TRTG) were smaller, with a telephonist handling four to six transactions a minute. So to reduce the loss of data through one minute intervals the telephonist's time interval analysis was set at a period of 15 seconds. TRTG were located in an open reception area, where video recording would not be allowed. So, as a result of these security and confidentiality restrictions, they were recorded using a manual note-taking process. To complement the observational

techniques, all three task groups agreed to post-observational interviews to clarify potential anomalies.

3.6 What to Observe

The aim of the field study was to observe people carrying out their tasks within their task groups and record information about their seeking and sharing behaviours. We believed that information-sharing was likely to be generated by information-seeking and that identifying where to seek information was an important factor in the combined process. This gave us two behavioural categories to observe, one of seeking information or knowledge and the other of knowledge provision or sharing. We did not think that this was the only way of identifying differences in task roles, just that this was the area we would be recording to see if there were similarities in these task role behaviours.

To ensure comparisons could be made across all three task role groups, a common set of collectable data representing observed activity categories was defined.

Activity to Observe	**Reference**
Knowledge Application	KA
Knowledge Seeking	
Internal to the Team	KS-T
External to the Team	KS-X
Knowledge Provision	
Internal to the Team	KP-T
External to the Team	KP-X

Table 3.1 Task Group Activity Categories

Table 3.1 defines the categories of activity that were to be observed and recorded within each task group. Knowledge Application was observed to identify how much of a task group's time was spent without seeking or sharing information.

This category represented the task group member doing their job unaided. Knowledge Seeking was defined as seeking information in order to solve a problem and this category was segmented into seeking from a team member or from an external colleague. The division of the category was made in order to identify if behaviours internal to a task group differed from external behaviours. Knowledge Provision was observed to identify how much time was spent sharing information and, as with Knowledge Seeking, was segmented into provision to a team member or provision to an external colleague.

3.7 The Observations

The observations were analysed to produce charts representing the profile of each individual (see appendices A, B and C). These profile charts were suitable for individual task group member comparison, but a separate level of detail was required to review and compare across task groups. To provide this higher level information each task group's team member values were combined and averaged to produce a profile chart representing the behaviours of that task group. This averaging process was carried out for each task group producing a set of profile charts at task group level (see appendix D). While it was recognised that averaging values within a task group could have potentially distorted the nature of a task group's unique team dynamic, it was believed that this approach would provide one mechanism for cross task group comparison. It was hoped that within the constraints of the observed behaviours, the equality of process applied to each task group would provide representative behavioural trend information at a level suitable for cross task group comparison.

In addition to the individual behaviours within a task group, observations were also made on the choice of team members that were used to collaborate or share information (see appendices E, F and G). These observations produced results that indicated that task groups have two types of specialist and this is explained in more detail in the sections 3.8.2.

When the analysis was complete, the individual task group members were approached and presented with the findings. They were asked for their thoughts and an indication of if they believed the observations were representative of their actions and their views on any unexpected observational findings.

3.7.1 Telephony and Reception Task Group (TRTG)

This task group spent 35% of their time seeking information, which was the largest seeking percentage of any of the observed task groups. Within this they only spent 5% seeking information from other team members, which is by far the smallest percentage of all three task groups. This group relied on external sources (30%) in the form of a rapid access system which provided them with the information that they required to carry out their tasks, resulting in an absence of cross-team information-sharing. During the process of observation, the length of time for each transaction was measured. As defined in section 3.6, the transaction time was measured in two categories: seeking information internally and seeking information externally. Seeking internally had an average transaction time of 28 seconds and seeking externally had an average transaction time of 42 seconds. This indicates that external sources, on average, took longer than internal sources to provide information and this observation would repeat throughout the other task groups observed.

3.7.2 Human Resources Task Group (HRTG)

In this task group, the percentage of time answering enquires using in-head knowledge (KA) was 59% and the total time spent seeking information was 23%. This indicates that this task group relies on good in-head knowledge to resolve problems but also uses internal and external knowledge-seeking to supplement their own lack of knowledge, possibly in specialist areas. As with TRTG, during the process of observation the length of time for each transaction was measured in two categories. Seeking internally had an average transaction time of 146

seconds and the seeking externally had an average transaction time of 250 seconds. These figures were proportionally similar to the TRTG figures for balance between internal and external seeking time, but the average amount of time per problem solving episode, when compared to the TRTG, was more than five times greater.

3.7.3 Information Technology Task Group (ITTG)

The subjects in this area were observed to use in-head knowledge the most out of all three task groups, representing 68% of their identifiable time, while the time they spent seeking information was the lowest of the three groups at only 15%. Within this, only 3% of the seeking time was from external sources. This was not unexpected as these subjects are the specialists for their area and have limited options for further enquiry. As with the other two groups during the process of observation, the length of time for each transaction was measured. Seeking internally had a average transaction time of 104 seconds and seeking externally had an average transaction time of 148 seconds.

3.8 Analysis and Findings

3.8.1 Comparison

The Telephony and Reception Task Group were less reliant on in-head knowledge to carry out their tasks than other groups. The nature of their task enforced the need for a fast response, having to problem solve in time periods of less than one minute. They had to have systems which provided them with small amounts of very specific information (e.g., telephone numbers and addresses). The Human Resources Task Group relied to a greater extent on their experience and training in internal process and policies and this was shown in their in-head knowledge figures. They also used external and internal sources, but their problem solving was on more complex problems that required a deeper level of

information seeking. The nature of their work allowed them a longer time scale to solve internal and external referencing and the average for both was around four minutes. The Information Technology Task Group used in-head knowledge to a much greater extent than the other two sections and their use of internal and external reference sources was not a significant part of their daily work. All three sections displayed distinct differences in their reliance on in-head knowledge and internal and external information-seeking together with query solving transaction times.

3.8.2 Subject Specialist

It was found that certain members of each team were the preferred choice for enquiries from external sources (i.e., people seeking information from outside the team; see appendices E, F and G). This team member was spending more of their observed time carrying out this task than any other member of the task group. We have named this person the Subject Specialist for External Enquires (SSEE). Additionally, the analysis revealed that there was another subject specialist on each of the teams; this person was the preferred choice for enquiries from internal sources (people seeking information from within the team). We have named this person the Subject Specialist for Internal Enquiries (SSIE). It was also observed that the SSEE was the most experienced member of the group, while the SSIE was less experienced but still the preferred choice for information-seeking from fellow team members. The SSEE on other task group teams was also used for enquiries across groups. We have called this specialist the Off Team Expert (OTE). We recognise that 'one team's OTE, is another teams SSEE' but the demarcation was required for the clarity of later discussion.

3.8.3 Transaction Times

The time period between a seeking transaction beginning and ending differed widely across the three task groups. The TRTG had the shortest time period, and

ITTG had the longest. This was not unexpected, as it was thought during the selection of the initial groups that ITTG would have more complex problems to solve and require longer periods to deal with them, while TRTG would be very quick at solving problems and provide a fast response. However, the analysis showed that in all three groups there was a significant difference in the proportion of time taken to satisfy an enquiry from an external source over the time taken for an internal source and the recorded information alone offered no explanation of this difference. The explanation for the difference became apparent in the follow-up interviews.

3.8.4 Post Observational Interviews

All three groups generally agreed the findings as being representative of their work. TRTG explained that the limited number of communications within the team was a result of their electronic telephone directory system enabling them to answer a high percentage of their calls without reference to other team members. We suspect the use of this electronic system had removed or at least limited the need to establish an SSIE. ITTG explained their understanding of the SSIE and SSEE in a similar manner to the subjects within HRTG, who explained that they were not initially aware that they had different people for internal and external enquiries, but once discussed it was agreed that this was the case. They described that the SSEE (who was the most experienced member of the team, as well as the External Subject Specialist), was often busy with external staff and so the enquirer would ask someone else hoping that they would have the answer. They also said that they (the enquirer) often did not need a full explanation of something as they already knew most of the answer, so rather than ask the SSEE or an OTE they asked someone who would know what they were trying to achieve and give them just the quick answer that they needed. This feedback raised two points. The first was that it appeared that, even when asked a question from a fellow team member, the SSEE was providing an answer that was fuller

than required; they were 'over explaining'. This may have been a result of their more common activity of answer provision to non-team members who would potentially need more information, but they appeared to be failing to identify the differences. The second was that when using an SSEE or OTE to provide answers to questions the perception of response must not have been 'quick', so to quantify this the transaction times of complete enquires was reviewed.

The transaction times for problem solving indicated that the use of an OTE always took much longer than using someone on the same team. It was found that using one's team SSEE for an internal enquiry was on occasions slower than using the SSIE, which supported the feedback described earlier, but the OTE transaction times were significantly longer. Through further discussion, it was found that this 'longer time' was an issue with using a common language. If someone wanted to ask a question on their team, the team would already have an established language, terminology and jargon. It was the environment and the nature of their task that had allowed this common vocabulary to develop. As such, when a question was asked, very little question reformulation was needed. The opposite was true of an expert on an external team (OTE). Therefore, before the problem could be solved a point within a common language had to be established, which added to the overall transaction time and problem resolution. Telephony supported this through examples of customer calls, demonstrating that finding a vocabulary that both parties could understand was essential before a caller could be transferred to the relevant section, as in this scenario the telephonist was the OTE to the customer.

3.8.5 Task Group Similarities and Differences

Task group behaviours differed in the proportion of use of in-head knowledge, information-seeking and provision of information and in their expected transaction time when problem solving. This will directly affect the speed of information retrieval required for each task group. It was shown the HRTG (see

section 3.7.2) and ITTG (see section 3.7.3) both took longer to solve problems than the TRTG (see section 3.7.1), and so while the time taken to complete a transaction is important it is not a generic factor across task groups. As a result of this we will not include 'speed of response' as a physical world design consideration.

There were two factors that were found to be generic across task groups; they are:

(i) Alternative Routes to Information: Task groups used different types of specialist to find what they need (see section 3.8.2). The SSIE, although not the most experienced member of the group, would answer questions quickly. This would often be an appropriately sufficient depth of response. The SSEE would be consulted if they were available, or if the first enquiry was not successful, and on some occasions the provision of an answer would take longer than asking the SSIE (see section 3.8.4). These specialists would potentially provide the same information if they had it, so the information itself was not the factor that determined which specialist to use. The decision of choice of specialist was made based on the possibility that a 'quick' answer could be provided by the SSIE. If the first enquiry failed then an answer could be obtained from either an SSEE or an OTE, but these last two specialists would take longer to answer. These alternative human routes to information were observed as a generic factor across task role groups.

(ii) Local Language Information Seeking: When consulting with experts off the team (OTE), the length of time taken to find an answer would be much greater than asking a team member a question (see appendices E, F and G). This was a result of the time taken to establish an understanding of the questioner's language in order to find a point from which to start a problem resolution discussion. This indicated that an important part of information acquisition, within a seeking and sharing scenario, was the 'alignment' of the enquiry to a

common language, which was accomplished by using the local language of the questioner. The use of a local language born out of proximity, as employed when speaking to an internal team member, provided a foundation that facilitated rapid initial query alignment, which in turn resulted in a faster response and resolution (see section 3.8.4). We believe that it is not practical for all information-seeking and information-sharing to be carried out in a predefined common language, but would suggest that the ability to negotiate the protocol of communication is an important generic factor across task role groups.

3.9 Conclusions

This chapter, through the investigation of established research into physical world human-to-human information seeking found that there was little empirical evidence that could inform this research. This lack of evidence prompted an observational study to be carried out to observe human-to-human seeking and sharing behaviours. This observational study provided two generic factors from the physical world. These generic factors will now be carried forward to chapter 4 as physical world design considerations. They will be combined with the electronic world design considerations from chapter 2 and collectively will inform the design of a pilot system interface to facilitate human information-seeking and information-sharing activities.

The Research Pilot 4

4.1 Introduction

Chapter 2 reviewed existing research into electronic world information-seeking interfaces and their social and community issues. The chapter concluded with a proposed set of electronic world design considerations drawn from an analysis of relevant literature.

Chapter 3 reviewed existing research into physical world information-seeking. It was found that there was only limited existing research in this area and so an observational study of human-to-human information seeking behaviours was conducted. From the conclusions of the observational study, two further design considerations were identified from the perspective of the physical world.

An overall aim for this research is to reduce the difference in experiences between physical world and electronic world information-seeking. In this chapter the electronic and the physical world design considerations are combined to be representative of the needs of both worlds. The combined considerations are then discussed to identify specific 'actions' which will be facilitated, within the design of a new interface, to encourage the use of relevant physical world behaviours within the electronic world. The first action will be described as 'Rating on Quality', which will provide a user with the functionality to judge the quality of information from their perspective. The second action will provide the user with the functionality to add their own annotations to the information, to allow subsequent users the opportunity of identifying the information through alternative contexts. This action will be called 'Annotating on Context'.

To provide the opportunity for later analysis, the results of facilitating the identified actions will be predicted and, within the areas of predicted results, metrics will be gathered. The first predicted result of facilitating the described

actions will be that an 'Alternative Navigation' will develop within the interface and this new navigation will be built by previous users. This will happen when users define the context of their found information, using their own local language. The annotations will then be used to match the information-seeking queries of subsequent users. The subsequent user will align their own information needs with the good experiences of previous users searching for similar information from a similar context perspective. This action will be called 'Local Language Alignment'.

Using the combined design considerations, predicted results and actions a design for an electronic interface to information will be proposed. The design will then be used to inform the choice of a suitable information store within which a Research Pilot interface will be built and deployed. Following a trial period, a review will identify whether the actions proposed for integration into the Research Pilot have produced the predicted results and have been subsequently beneficial to interface users.

The chapter will conclude with recommendations to modify the Research Pilot design and suggest that a second interface be deployed to allow further research into scalability and longevity of the interface design that was not possible during the initial Research Pilot.

Within this chapter, section 4.2 will detail the combination of the design considerations from chapters 2 and 3. Section 4.3 will describe a set of 'actions' that should be integrated into a new interface design and a set of 'predicted results' that should be expected as a consequence of facilitating the actions. Section 4.4 will detail the definition of the Research Pilot design. The section will describe the identification of a suitable, existing information store for use by the new interface and outline the nature of the metrics that will be gathered for analysis. As the Research Pilot design will appear to share similar functionality to other existing interface designs, such as Frequently Asked Questions and

Search Engine Synonyms, section 4.5 will discuss the differences between these alternative interface designs. Section 4.6 will provide a description of the way that the interface design will be integrated into the identified information store and provide illustrations of the visually low impact appearance of the new interface. The section will also describe the processes involved in using the new interface and the integrated help and support. Section 4.7 will outline the mechanics of delivering the Research Pilot to the identified audience. Section 4.8 will discuss the general findings from the Research Pilot, but will defer the detailed findings to chapter 5 where they will be analysed in comparison with a modified Research Pilot interface, which will be proposed and recommended in section 4.9.

4.2 Combined Design Considerations

The four design considerations from chapter 2 for socially-enhanced electronic systems and the two further considerations from observations of human seeking and sharing behaviour from chapter 3 are described in full in their source chapter sections (see section 2.6.5 and 3.9.1) and can be summarised as follows:

(i) Appropriate Integration

(ii) Anonymous Presence

(iii) Environment of Trust

(iv) Feedback Loops

(v) Alternative Routes to Information

(vi) Local Language Information Seeking

The considerations have been combined to, firstly, bring together the electronic and the physical world considerations to inform the design of a new socially-enhanced interface and secondly, to 'move' the design from the theoretical

'considerations' to a practical research interface. To progress this movement from theoretical to practical, a number of possible actions that could influence an interface design will now be discussed. To better understand the relationships of the design considerations across both electronic and physical worlds, the design considerations will not be discussed in the fixed order that they were identified, but as an interdependent and integrated set of considerations.

We have seen that **Appropriate Integration** is a key design consideration for socially-enhanced systems (Forsberg *et al.* 1998). For this research we considered appropriate integration to include: the intended audience; the choice of information system; and the technological integration of the new interface between the audience and the system.

We have seen that systems that integrate social enhancements through a level of invisibility, while being of minimal impact on the tracked users, create issues with passive recommendations (Hill *et al.* 1992, Wexelblat 1998). To avoid this, this research's design did not follow an invisible approach. We chose to 'integrate' visual elements to the interface as part of the existing information store design, rather than a technical integration providing invisible monitoring and recommendation. The design had recognisable new features without unnecessarily impacting the established flows of user behaviour and interactivity. The impact of this choice on the users of the system would be that they had to carry out additional activities rather than the seamless integration of passive recommendation.

We have seen that interfaces that automatically adapt to users are problematic (Höök and Svensson 1999), but they should facilitate information context adaptability and provide **Alternative Routes** to the same information. We believe that one way of meeting this consideration is to incorporate three approaches to information-seeking. The first is the conventional browser interface allowing hierarchic navigation for familiar information contexts. The

second is a search interface for content and quasi-context information-seeking. The third and final approach is the main body of this research, which is the ability to reuse the marks made by others' activities while information seeking. This approach will provide **Alternative Routes** but requires further enhancement to meet the consideration of **Local Language**. The first two interface approaches, hierarchy browser and content search, are conventional and will not be discussed any further. The third approach will now be described.

A user can only benefit from the information-seeking experiences of others if they can identify previous activities and so a mark has to be made by these activities. We believe that knowing that someone has been 'there' is only part of understanding the experience and it is equally important to know 'why' they were there. We see this as a flaw in passive recommendations, as described in chapter 2. We propose that if a user knew why someone was seeking information, they could align the original intent with their own and make an informed decision on whether to follow. Making marks that others can use as visual clues indicates that other people are, or have been, present within the system. This approach embraces the consideration of **Anonymous Presence.** The consideration of **Feedback Loops** would also be met if the information marking took the form of feeding-back ratings on quality or annotations on contextual placement of content. The annotation could then provide the final element of access in a **Local Language,** by capturing the language of the individual making the annotation. We believe that if an information-seeker, firstly, rated the information and then, in their words, explained why they were seeking the information, this would allow others to align the annotations with their own intent. By doing this, the annotations could provide an alternative navigational route, in addition to the existing browser-delivered hierarchy and the conventional content-based search engine results.

The remaining consideration is **Environment of Trust.** Allowing existing information to be modified through interaction would not satisfy this consideration as the information could be changed by an unauthorised source and so may not be seen by users as trustworthy. However, allowing information to be supplemented by annotation, rather than modification, would, we believe, be acceptable in relation to this consideration. We further believe that the annotations themselves, especially in an anonymous community, may need monitoring in some way to ensure that there are no abuses of the interface or accidental errors in navigational recommendations. Without monitoring of some form, the trust in the environment may be damaged, but over zealous monitoring, for example by the removal of genuine annotations, may also have the same effect.

The combination of considerations from the earlier chapters has provided, through review, one possible 'theoretical' approach to interface design. To develop the theoretical approach to a practical user interface we will define a set of 'identified actions' that an electronic interface should facilitate. We will also identify a set of 'predicted results' that should be the product of facilitating the actions.

4.3 Identified Actions and Predicted Results

This section will describe a set of actions that will be integrated into a new electronic interface to comply with the combined and reviewed considerations from both the electronic world and the physical world. It will also outline what is expected to happen when the actions are integrated, through a set of predicted results. By identifying the actions, a practical interface design can be established and by predicting the results, a position for the comparison of expectations and outcomes can be established.

4.3.1 Identified Actions

Providing an alternative route to information may require the functionality for users to 'make a mark' within the electronic environment. The need to make a mark will be required to allow annotation and rating. It is also likely that for anonymous presence to be observed, within an electronic environment, some form of mark will need to be allowed. As such the need for a facility to make a mark is a repeating requirement within many of the design considerations and so making a mark will be the foundation of our proposed Research Pilot. We have indicated that, for our interface, making marks will be divided into two categories: rating on quality and annotating on context.

(i) Rating on Quality

Allowing a user to rate a web page of information with their assessment of its quality allows others to, firstly, use this as a form of collaborative filtering and, secondly, see that others are (or have been) present within the system. By making their mark, through the process of rating, they are declaring found information to be worthwhile. This process has been shown to be valuable (Goldberg *et al.* 1992) and will be our first identified action. However, we have seen examples where the credibility of the rating is reinforced by knowing who made it (Borchers *et al.* 1998). We wish to develop a generic interface that may be used in variety of information systems. It is possible that some of these information systems and it will be part of an enforced anonymous environment. As such, identification of the individual would not be possible. Without identification of the individual, the perceived value of the annotation or rating would be reduced. Therefore we propose that one possible mechanism to improve the perceived value of rating is to know why a previous user chose to rate a piece of information. We will now describe this mechanism as 'Annotation on Context'.

(ii) Annotation on Context

We proposed that capturing the context of an enquiry may be a valuable way of supplementing the perceived value of a rating factor. We had seen that capturing the context of content through an automated process is problematic and that people are better at judging context than computers (Resnick *et al.* 1994, Borchers *et al.* 1998). As a result, we propose that allowing a user making a rating to position it within the context of their enquiry would be more appropriate. We believe that the simplest mechanism for this is to ask the user to annotate the details of the problem that they were trying to solve when they found the information so useful. The annotation and the rating will jointly provide a quality and context indicator for any subsequent users. Annotation of context is therefore our second identified action.

4.3.2 Predicted Results

Building the Research Pilot provided an opportunity to review the considerations and design decisions in a practical environment. In order to assist the final review, we predicted two results that should become visible as a consequence of activity within the Research Pilot. The first was that an alternative navigation structure should develop that was a product of the annotations made by other users. The second was that this new navigation would allow a user to match the context of their information-seeking, to the context of a previous user's annotation, through the alignment of their local language. Both of these predicted results will now be further explained.

(i) Alternative Navigation

In the initial research (see section 1.2), it was identified that search engines have significant speed advantages over hierarchic browsing but were not a complete solution in their own right, and it was argued that human context judgement was more effective than automated context judgement. The cumulative body of

annotations made by users in our Research Pilot system should be used as an information store of human context judgements. This could then become an alternative index of information when used by a search engine to return matching references to a search request. This approach would match the language (keywords) used by the enquirer against the multiple languages used by annotators, rather than the conventional search approach of using the language of the content designer. By using these annotations in this way, the user has the opportunity to match through similarity the good experiences of previous users and to benefit from their earlier problem solving activities.

(ii) Local Language Alignment

The content of an annotation would contain more than the question that the original user was trying to solve. It would also contain the language in which the user chose to formulate the question while seeking the information. So, by capturing the annotation the system would also capture: the local language of the seeking user; the perceived context between language and information; and, through the rating, the perceived quality of the information. Throughout this process the original information would have remained unchanged but would have been supplemented by the annotation. This would ensure that the information itself could still be 'trusted' and was not altered by an unauthorised source. Over time the annotations would provide the opportunity for information-seekers to align annotations with their own local language, allowing them to place the information within their context of understanding rather than relying on the initial information designer's context.

4.3.3 Progressing the Research Pilot

The design considerations from chapters 2 and 3 have been combined and discussed in this chapter. This has identified the human actions that we should facilitate in the design of a socially-enhanced electronic interface and we

predicted the results that should be observed. These actions and results are summarised in Table 4.1.

Identified Actions	Action 1	Rating on Quality
	Action 2	Annotating on Context
Predicted Results	Result 1	Alternative Navigation
	Result 2	Local Language Alignment

Table 4.1 Identified Actions and Predicted Results

To progress the Research Pilot system, we used these actions and results to plan and build a new interface. We identified an appropriate information store within which we could integrate the Research Pilot interface and defined how the Research Pilot would facilitate the actions of rating on quality and annotation on context. We put in place metric-gathering functionality to support the comparison of actions versus predicted results in relation to Local Language Alignment and Alternative Navigation. We implemented the Research Pilot as a visually low impact integral part of the host information store for a declared time period. Finally, we reviewed the gathered metrics and concluded on the outcomes. This process will now be discussed in detail.

4.4 Defining the Research Pilot

4.4.1 Identifying an Appropriate Information Store

We believed that generating an Internet web site specifically for the purpose of the Research Pilot would produce artificial results and so we approached AXA Insurance, the company who hosted the observational study (see chapter 3), and were given the opportunity to use their company intranet for the Research Pilot study. We felt that implementing a theoretical and untried interface for use on a business critical intranet was beyond a reasonable risk and chose to identify a single area of the intranet for our research. An intranet area needed to be

identified that would be used by as many people as possible, as this would cover many task group models (see section 3.3) and provide information that was likely to be of specific interest to its audience. The Human Resources intranet site was identified as the most suitable for this purpose. It contained all of the details and policies that applied to the employment of staff and also presented the company principles. The audience for the site was AXA Insurance's 3800 employees. The gender split was approximately 50/50 and contained a mix of ages and positions held within the organisation, together with a geographical split across most regions of the UK. By coincidence the Human Resource Task Group (HRTG), who had previously been the subject of research observations (section 3.7.2), used this site extensively, but there was no direct connection between this observed group and the research choice of this intranet site. One condition of use was that, due to the personal nature of the content on this intranet, anonymity had to be preserved for all users. This meant that post-implementation interviews with users of the system were not possible.

4.4.2 Designing for the Identified Actions

The Research Pilot interface was created to facilitate both rating on quality and annotating for context. A user was allowed to rate quality by 'voting' for the found information. This was instigated by the user clicking a voting indicator that had been made available on all web pages. Each page contained a question asking "Has this page answered the question you were trying to solve?", and the voting indicator would allow a range of answer choices from "Not at all" to "Completely". Only if the user clicked the voting value for "Completely" would this be considered a good experience and so they would then be given the opportunity to comment on why they felt the information was useful to them by answering the question "What question did this page answer for you?" By promoting this interaction protocol, the interface facilitated the action of rating on quality and annotation on context through an integral in-line process. The

Research Pilot interface then stored the annotation, the quality rating and a linked reference to the subject information without modifying the underlining information store. We will see that this store of quality and annotations becomes an alternative index to the underlying information store. The Research Pilot interface was designed to capture only the good experiences of system users. Capturing the bad experiences may also have had value, but we chose to concentrate the Research Pilot's processes around the generation of navigable points to quality information rather than virtual 'road closed' signs. This would later become a problem that had to be addressed during the Research Pilot test period.

4.4.3 Preparing for the Predicted Results

The predicted results of 'Alternative Navigation' and 'Local Language Alignment' were dependent on the use of the existing intranet search engine. The search engine was used to further integrate the Research Pilot by indexing the textual content of the base information store in a conventional manner but also directing its searching process across the Research Pilot's annotation index. When the search was requested to carry out conventional text search, any matches in the annotation index would be displayed first, allowing a user to chose, by clicking, the annotated experience of a previous user, described in the annotator's local language. This delivery process was produced to mimic the findings of the observational study (see section 3.8.4) where a Subject Specialist for Internal Enquiries was consulted in a local language before the enquirer chose to reformulate their enquiry with another person. This Research Pilot functionality allowed the information-seeker a chance of solving their enquiry through local language alignment before considering the language of the system designers.

The base information of the intranet remained unchanged by the annotation process, but there was no control on the content of the annotations. The company

specified that any annotations received from users of the Research Pilot had to be validated by the content managers before publication. This requirement posed a threat to the integrity of the details of the questions being asked. It was feared that content managers would modify the words in the questions and this would be a significant flaw in the research. It was accepted that open anonymous publishing would not be allowed by the company, so a compromise was found. To ensure that an over-zealous annotation monitoring and housekeeping policy was not implemented, thereby affecting the considerations of an environment of trust (see section 2.6.5), the research team ensured that the annotations entered into the annotation index were appropriate for publication within the organisation. However, for the documentary benefit of this research the following housekeeping and monitoring policies were agreed in the hope this process would stop any possible issues with 'graffiti' type annotations. In later chapters these policies combined with the collection of metrics will be referred to as an 'informal' methodology.

No words that were significant to the annotation would be changed. Spelling mistakes would be allowed but obvious typographical errors would be corrected. Correction of capitalisation would be allowed, as the presentation would be more professional and the search engine was case insensitive. Where questions shared the same words but in a different order and linked to the same page they would be rationalised to just one question. Annotations that were not in a question format or took the format of a statement would be altered (subject to the other monitoring guidelines) to convert them to a question format. Annotations that were unprofessional or inappropriate would be removed.

4.4.4 Gathering Metrics

To support the validation of the predicted results, metrics to be gathered were identified. The annotations submitted were collected, the number of times an annotation was offered as an option for alternative navigation was counted, the

number of times the annotation was followed as a link to content was counted. The total number and value of each rating and the distribution of the rating values were collected. The number of times the opportunity to annotate information was taken and the number of times that it was ignored were also recorded.

4.4.5 Technology Choices

The technology choices for the research system were dictated by the existing system within the host organisation. Due to the restrictions of system integration, described earlier, the interface was delivered in web page format XHTML and complied with the look and feel of the company intranet. Below the presentation layers, the existing intranet processes were XML, XSL and JAVA transformations with a data store based on an XML object store and so the Research Pilot was created using these technologies. The possible increase in data store 'writes' generated concern, but a compromise involving memory writes with an end-of-day single data store write was agreed.

4.5 Comparison with Synonyms and FAQ

The proposed Research Pilot had similarities with some existing technologies. The first was Search Engine Synonyms. Synonyms are used within search engines to help designers capture specific words that a user might search for which is different than a word the designer used while creating the information content. For example, the designer may choose to add 'laptop' as a synonym for 'computer'. By doing this when a user searches for computer, they would also get results for matches on laptop. The approach is similar to the use of a Thesaurus.

The second existing technology was the more common web site tool, Frequently Asked Questions (FAQ). A FAQ is not an additional element of Search Engine functionality in the way that synonyms are. Generally, a FAQ does not have a purpose built search tool; it does not indicate if a question is 'frequently asked'

and the questions, like the Search Engine Synonyms, are added to the FAQ by system designers, not the users of the FAQ. To 'contaminate' a FAQ further, in the cases where the FAQ contains common questions that are frequently asked, they are generally not the words of the user making the enquiry, but the words used by the organisation in providing the answer. An example of this was supplied by the Human Resource Task Group (HRTG) who, when asked for popular questions, said that they were asked about maternity leave, but on closer examination the users asking the questions had actually used the phrases "I'm pregnant" or "I'm going to have a child". These subtle differences in local language indicated that FAQs constructed by system designers were prone to this level of language contamination. The synonyms approach may have provided a better result in this 'maternity' example as if the designer had included the word 'pregnant' as a synonym for 'maternity' some results would have been returned. However, the difficulty with the synonym approach is that the decisions to determine associations of words are still carried out by the system designers or an automated process and not the users of a system.

To conclude, the key factors are that both the Search Engine Synonym and the FAQ are in the control of the system designers and, as such, will suffer the same issues of language as those already demonstrated for the fixed hierarchic navigation structures (see section 2.2). The Research Pilot interface, however, put control in the hands of the users of the system and presented navigational information using their own language.

4.6 Integrating the Research Pilot

This section describes the integration of the Research Pilot into the host information store. It details the interface designs, screen flows and the supporting help processes.

4.6.1 Integration within Pages

The key artefact within the Research Pilot was a voting bar. Visually, its inclusion had to be low impact and not interfere with any of the formatting of the existing intranet pages. This was important from the company's view point as they wanted the minimum time spent gathering information and to be sure that the new system did not impede existing site access. From the research point of view, it could not be too low impact or the bar would be over-looked. The use of colour was decided to be the best approach and a red and green faded bar was created which stood out against the corporate blue of the existing intranet site.

It was acknowledged that the use of colour may have presented difficulties to a small percentage of intranet users and so a text description of the extreme points was included (Neilson 2002). To add further non-coloured visual clues to this voting bar, each segment that could be clicked was provided with pop-up text indicating the value that it represented. Every page in the Human Resources web site would include the voting bar in the top right of the intranet page content area (see figure 4.1).

Figure 4.1 The Voting Bar

4.6.2 Online Help and Contact Information

To access the online help (see figure 4.2), the question mark or the question text could be clicked using the established process of a right click mouse action and the established delivery method of a pop-up window containing the help information. The pop-up help content reused the text and icon to confirm why this help was visible and then followed this with details of the help subjects. The voice used within the help text was in line with the voice used for other help within the intranet. The positioning of the help pop-up window was below the voting bar, keeping it in view, and to the right of the menu structure. It was hoped that this approach would allow the user to maintain their navigational position by allowing them to see both the original menu structure and the voting bar.

Once the help had been read, the user was asked to close the help window. This approach was adopted for two reasons. The first was that it was believed that the user should remain 'in charge' of the navigation and windows opening and closing, to maintain their feeling of not being lost. Secondly, the intranet also used this manual approach to closing windows for other help screens so the approach ensured consistency.

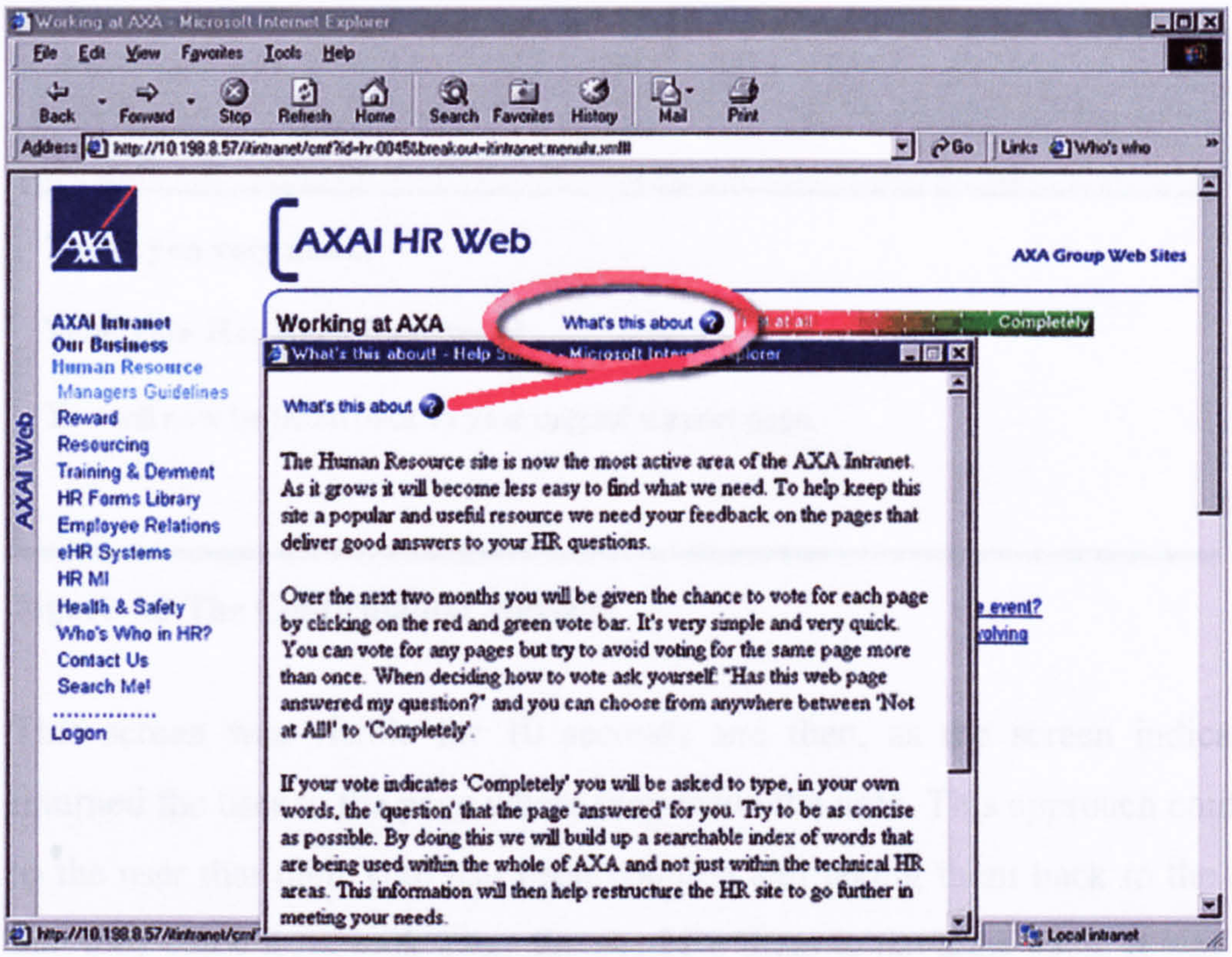

Figure 4.2 The Help Icon and Help Window

4.6.3 Voting and Confirmation

Once the help had been read the user was able to carry on reading the conventional intranet page or decide to vote for the page by clicking the voting bar. Within the help, the user was instructed to ask themselves "did this page answer your question" and so the voting ranged from "Not at all!" to "Completely" with a series of points in between. By using the mouse, the user could click on the voting bar and if they did not vote for the top marks then they would be presented with the Confirmation Message (see figure 4.3) or if they did vote for the top mark they would be presented with the Annotation Window (see figure 4.4).

Figure 4.3 The Confirmation Message

This screen was visible for 10 seconds and then, as the screen indicated, it returned the user to the page where they made the vote. This approach confirmed to the user that their vote had been counted and taking them back to the screen that they came from took away the need for them to navigate back. It was hoped that this approach would reduce the complexity of navigation.

On the occasions where a user voted for the top score denoted by the caption "Completely", a pop-up window (see figure 4.4) was displayed inviting them to enter the details of the question that this page had answered for them. This pop-up window maintained the same separation from the navigation on the left but was placed over the vote bar so that the user could not vote again until the comments had been filled in or the window closed. To further reduce the visual impact of the intent-gathering screen, it was overlaid on the page leaving transparent areas around the window to ensure that the user did not feel that they had moved from the original page and so could not feel 'lost'.

On completion, the Confirmation Message (see figure 4.3), was displayed and the user returned back to the page they had voted for, as in the earlier example.

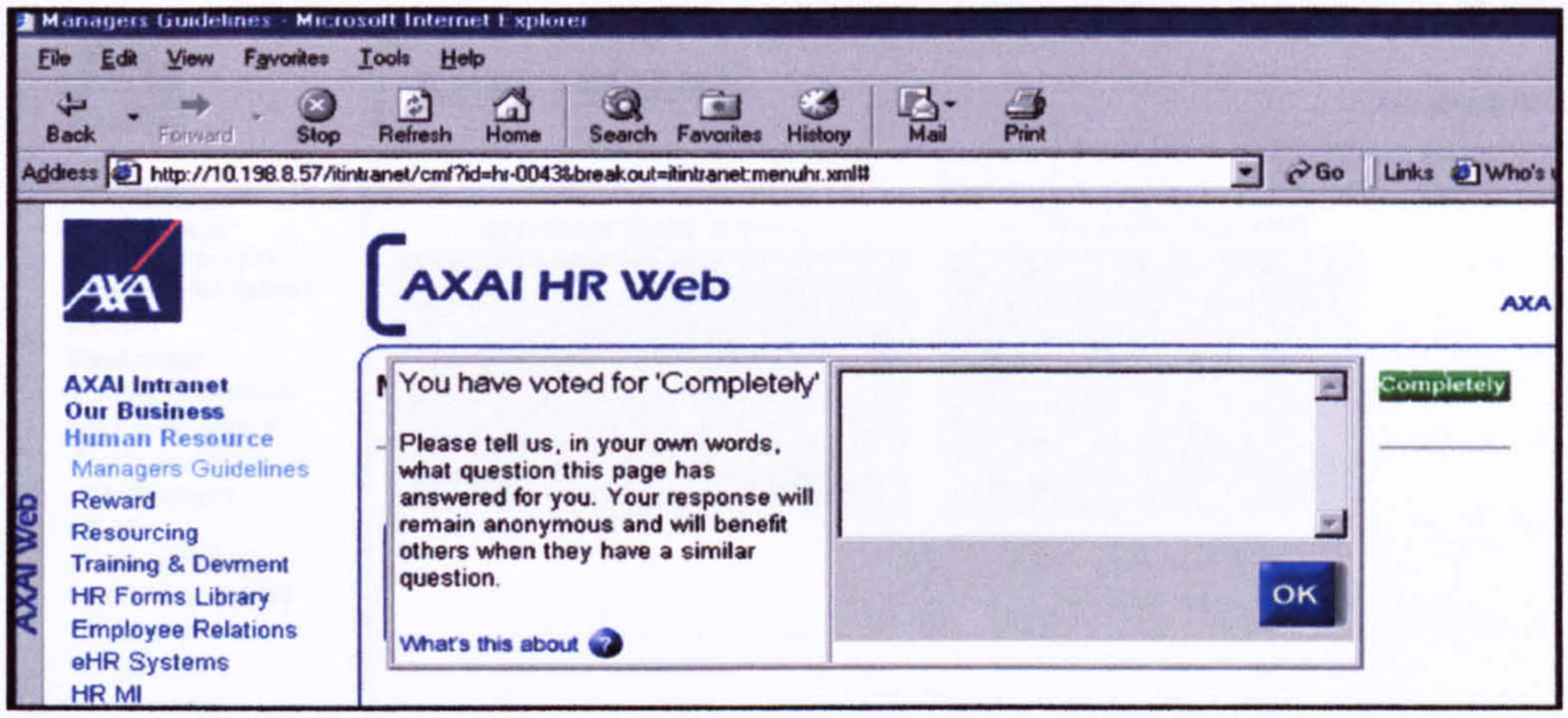

Figure 4.4 The Annotation Window

4.6.4 Search Access

Within the existing HR intranet web site, the search engine interface could be accessed through the navigational menu item 'Search Me!" and, as originally specified, the Research Pilot used this interface to access the information, gathered through voting, from within the annotation index. The interface was simple and delivered low functionality. The input area had two options for searching (see figure 4.5), one for any combination of words and one for an exact phrase. The area on the right of the interface indicated the areas that were to be searched. In this case it was the AXA HR intranet. Initially, it had been considered to add another entry in this area, indicating that the annotation index would be searched but it was felt that this would only add confusion to the process and that the search should be carried out seamlessly, so the interface was not changed.

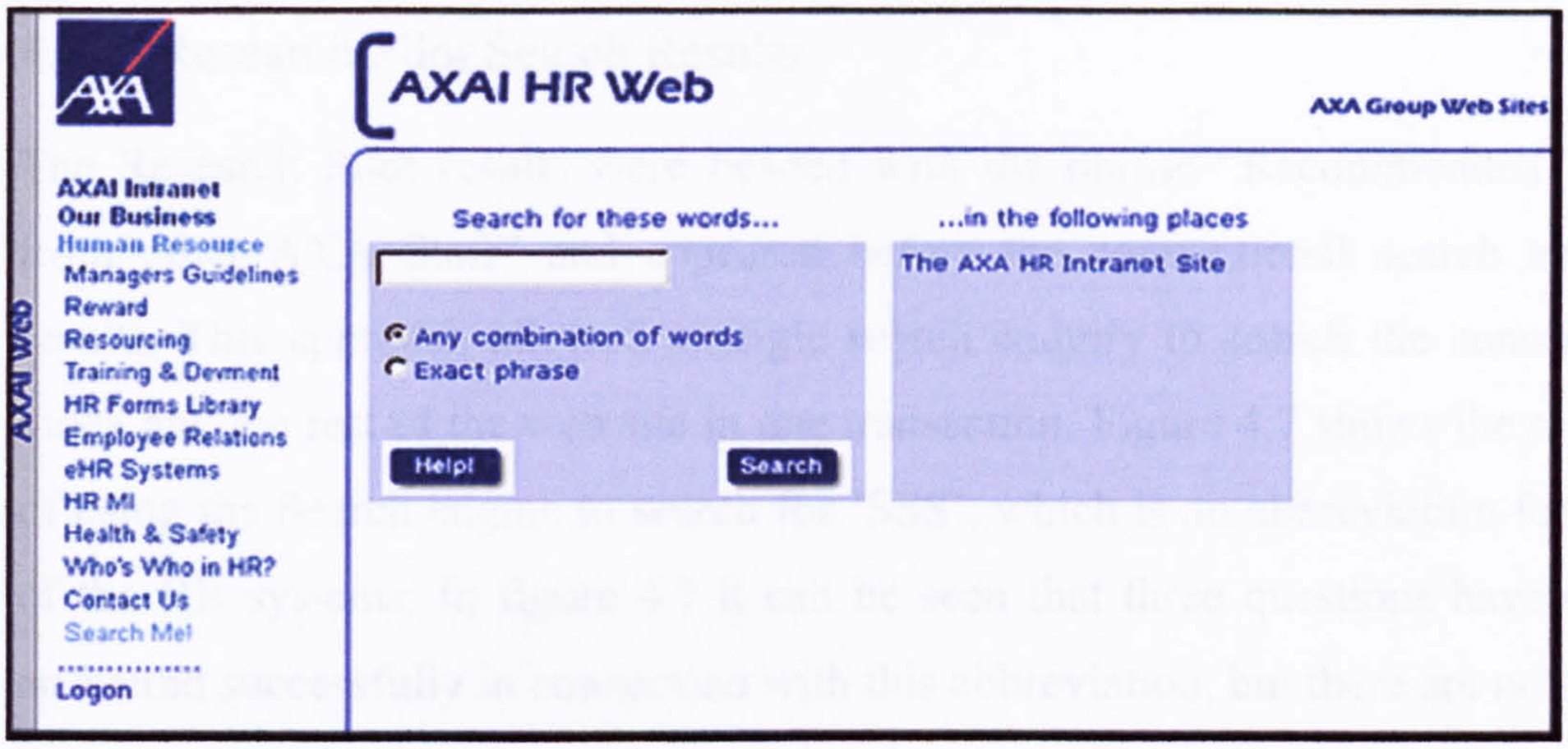

Figure 4.5 The Search Window

4.6.5 Intranet Search Results

The results from the existing search were displayed within the context of the web site and as a hierarchy of navigational nodes (see figure 4.6). A user could click on any one of these nodes and be taken directly to the page indicated. The contents of the annotation index were not stored as a hierarchy of navigational nodes and so the results were displayed in a flat structure.

Figure 4.6 The Original Search Results Page

4.6.6 Research Pilot Search Results

The Research Pilot results were headed with the phrase "Recommended links from other AXA Staff" and appeared before the conventional search engine results. This approach allowed a single search enquiry to search the annotation index and the rest of the web site in one transaction. Figure 4.7 shows the results of using the Search engine to search for 'SSS', which is an abbreviation for one of the HR systems. In figure 4.7 it can be seen that three questions have been answered successfully in connection with this abbreviation, but there are no other links on the web site using the conventional web search engine. If there had been any, they would have appeared below the annotation index results. The action of placing other people's annotations before the conventional results was an attempt to place more emphasis on human activity rather than simple text searching. Although it was felt that this approach may bias the results because the annotation index results appeared before the conventional text search, it was considered that this closely mimicked the observed human behaviour of looking for others' experiences before going to find the information from elsewhere (see section 3.8.4).

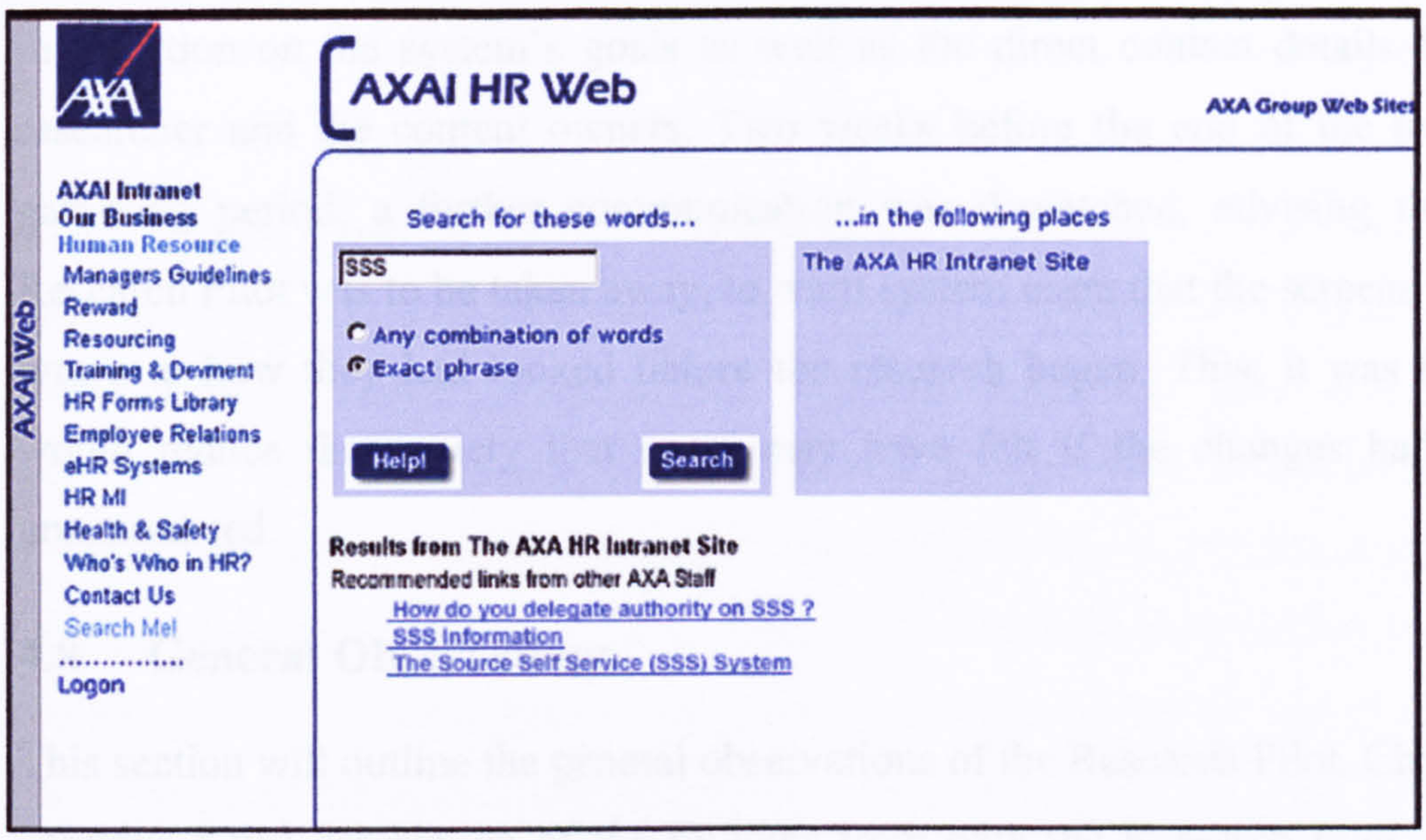

Figure 4.7 The Research Pilot Search Results Page

4.7 Delivering the Research Pilot Interface

The Research Pilot was built in September 2004 and, following technical approval and a signoff process, was accepted for delivery to the organisation's production intranet in mid-November 2004. The system was made available for a period of eight weeks and was reviewed each day. To allow an uninterrupted period of research analysis and testing, the owners of the target intranet site agreed to hold back any changes to content or structure during the research period. The users of the target intranet were informed of the availability of the Research Pilot through an in-house communications process. This communication was intended to be an early warning that the system was about to become visible and to explain why it was there. The communication was supported by the system's own on-line help system, with reinforcement of the reasons for its presence and confirmation of the anonymity of use. The on-line help system described the whole process of using the research system and provided human contacts for queries for any problems that were not covered by the help. Telephone numbers and email addresses were provided for more

information on the system's goals as well as the direct contact details for the researcher and the content owners. Two weeks before the end of the metrics-gathering period, a further communication was dispatched, advising that the Research Pilot was to be taken away, to warn system users that the screens would return to how they had looked before the research began. This, it was hoped, would reduce the anxiety that users may have felt if the changes had been unannounced.

4.8 General Observations

This section will outline the general observations of the Research Pilot. Chapter 6 contains a full description of the findings from both the Research Pilot system and the 'to be built' production system. Due to this future analysis and comparison, this section will be limited to general observations and the reasons why a full production system was recommended.

The users of the target intranet accepted the new voting and annotation gathering process without complaint and used the new screens to add their ratings, either good or bad. There was no visible hostility towards the Research Pilot. The system was monitored on a daily basis assessing user interaction with the research system, any problems arising and general observation of the types of comment being made within the annotation gathering screens. It was found that users were using the positive response input screen to enter negative responses, because there was no negative response screen. The reason that there was no negative response screen was that the research wanted to capture annotations of 'good' experiences rather than bad experiences (see section 4.6.3). This unexpected use of the question gathering-screen threatened the metrics and consequently the research system, so the system was modified to allow capture of negative comments and the help system modified with the new information. The system modification corrected the use issue and the negative responses were passed directly to the web site content owners to address once the research period

came to an end. During the life of the Research Pilot, no additional changes were made as a result of monitoring.

Metrics were gathered using a methodology that ensured the timely and systematic extraction of information in a prescribed manner at the end of each week. General visitor traffic on the web site increased. This was neither considered to be an indication of success through greater activity nor failure through users needing to search through more pages. The conclusion drawn was that the increased activity was most likely to be a result of the advertising and explanations of the new system that were communicated before and during the early phases of the research. With these factors distorting the everyday activity, it was felt that these statistics would not provide anything useful to the research and were given no further consideration.

The Research Pilot's human contacts, who would have dealt with enquiries or questions about how to use the Research Pilot, reported that they had very few calls from users. From this we conclude that, as there was clear evidence the Research Pilot was being used, it had become a part of the intranet and did not present a challenge to the users who were rating, annotating or searching.

In the eight weeks that the Research Pilot was in place, there was a level activity, through rating and annotation gathering, which demonstrated that the Research Pilot was being used by the visitors to the site. The annotations gathered from the users' local language input provided evidence that the words that intranet users look for and use are different than the words used by the system designers. The annotations needed only small amounts of amendment to make them suitable for use, but they did need modification. The annotation and use metrics indicated that in most cases the annotations of others were reused by subsequent users and in some cases consistently used in preference to other routes to the same information. 81% of the annotations were displayed again within the research period as a result of a search request from a visiting user, while 55% were chosen

by the visitor and the link followed to the rated information. This is evidence that the recommendation of information from others, using the language of the individuals searching the intranet, is a valuable navigational mechanism.

As explained (see section 4.7), all changes to the intranet were stopped during the research period to ensure that the arrival of a new section to the intranet site did not affect the metrics gathering. During the research period, both negative and positive rating and annotations were shared with the content owners of the intranet who expressed interest in the results and showed a desire to make immediate changes. The changes were not made at the researcher's request, but this situation is unrealistic for a real-world situation and needed to be addressed before any further deployments beyond the period of the Research Pilot.

4.9 Recommendations

The key recommendation arising from this Research Pilot was that another intranet be identified and a new version of the Research Pilot implemented over a longer period of time. The reasons for this are explained in section 4.9.1 to section 4.9.5.

4.9.1 Smoothing the Results

There were 'curiosity' peaks of use during the initial set up of the Research Pilot and, then again, when any announcement went out about its progress or use. These peaks affected the metrics gathering and it was felt that an implementation over a longer period would help smooth them out into more meaningful data, reinforcing the potential for the new interface design as part of a sustainable system.

4.9.2 Stabilisation

During the first four weeks of the Research Pilot, system changes were made to accommodate the trend of using the positive annotation area for negative

annotations. This firstly caused metrics to be gathered that were misleading and, secondly, forced a system change which had to be announced and which resulted in more web traffic, possibly through curiosity. It was felt that a new interface, created using the findings of the Research Pilot, could remain unaltered for a longer period of time, providing more consistent metrics.

4.9.3 Scalability

The collection of annotations grew as the Research Pilot progressed and this raised concerns that over a longer period the number of annotations may result in the same information overload that information seekers were already experiencing. If this was the case then the Research Pilot's approach would only be moving the information overload problem to another information store, that of the annotation index. It was believed that a longer period of study would give a better indication of the scalability of the index and a clearer understanding of the growth in annotations. It was further believed that a longer period would offer an opportunity to identify the 'scalability' of contributors' interest in the end-to-end annotation and search process.

4.9.4 Wider Metrics Gathering

The metrics gathered were sufficient to identify the possibilities of the Research Pilot's interface design, but it was felt that additional metrics should be put in place to capture detailed web traffic figures to help identify trends in the whole intranet traffic rather than just the Research Pilot pages. We saw from the Research Pilot how many times annotations were offered for reuse and subsequently followed, but there were no metrics on how many searches were made to place our figures in the wider picture of intranet use. We also identified (but had no metrics) that 'followed' annotation links were being stored in users' favourites and we thought it important to identify how often this occurred to understand the wider impact of this action.

4.9.5 Methodology

During the research period, all content and structure changes were stopped, but this was an unrealistic expectation for a production system. To introduce the concept of a changing environment, in a managed way, it was believed that the next implementation should allow changes to occur. The changes allowed should only be changes that were a result of the general analysis, of the annotations and ratings that had been supplied, through the new interface. By doing this, a 'review cycle' would be created and included into the process established for metric gathering to develop into a methodology to support the electronic system.

It had been found during the metrics gathering of the Research Pilot that an informal methodology was becoming established, where extracts would be made at a certain time and processed in a certain way to provide consistent comparable results. It was also found that the results from the Research Pilot were of significant interest to the system designers and intranet mangers and it was believed that a formal methodology that included the distribution of the findings to interested groups should provide an educational effect on the understanding of these peripheral groups and, over time, may impact the thinking on the creation and running of the rest of the intranet.

4.10 Conclusions

This chapter combined the design considerations of the physical world with those of the electronic world. It described the review and identification of specific actions that would be required to produce a new electronic interface to information. This chapter also described the predicted results of the creation and use of the new interface and, through comparison and analysis of the gathered metrics, it has been identified that the Research Pilot's design approach to a new electronic interface, has proven to be beneficial to information-seekers.

To progress this research further, and to explore the opportunities defined within the recommendations of this chapter, it was felt that the Research Pilot's design should be modified to provide additional metrics for research analysis. It was also felt that the modified interface should be implemented over a longer period of time. This longer duration should provide metrics on the overall scalability of the Research Pilot's design approach.

The recommendations from this chapter will be carried forward to chapter 5 and, through review, will be acted upon to produce a modified Research Pilot interface. The interface produced from the modified Research Pilot's design will be called the **Collaborative Index.** The metrics gathered from this chapter and the metrics gathered from chapter 5 will be carried forward for comparative review in chapter 6.

Implementing the Collaborative Index 5

5.1 Introduction

In chapter 4 the design considerations generated from chapters 2 and 3 were combined and analysed to produce a set of actions and predicted results. This informed the creation of a new interface, the Research Pilot. The Research Pilot was made available to a large audience of intranet users, was in place for two periods of four weeks, and the outcomes indicated that the interface the Research Pilot provided was beneficial to information-seekers. At the end of the research period, further design enhancements were recommended to facilitate additional metrics gathering, and it was also recommended that a longer period of research be carried out. It was hoped that the enhancements to metrics-gathering would provide details of the scalability and sustainability of the interface design and that the longer research period would help 'smooth' the overall metrics. The enhanced interface was called the Collaborative Index to distinguish it from the Research Pilot, and in recognition that the alternative index to information that the interface provided was created through the collaboration and experience of other system users.

This chapter begins with section 5.2 reviewing the recommendations from chapter 4, suggesting alternative strategies for implementing the recommendations and describing which strategies were chosen for use within the Collaborative Index. Section 5.3 describes the selection of a new information store and the integration of the Collaborative Index. Section 5.4 describes the delivery of the Collaborative Index. Section 5.5 describes the collection of metrics generated by the Collaborative Index and the wider generic metrics of intranet activity. Section 5.6 provides observations on the use of the

recommended methodology and, finally, section 5.7 concludes on the implementation of the Collaborative Index.

5.2 Recommendation Review

Chapter 4 provided recommendations from the experiences of the Research Pilot. The most significant recommendation was that another interface to information should be created. It was suggested that this new interface should be created through modification of the Research Pilot to encompass the recommendations from chapter 4. Each recommendation is now described and alternative strategies for implementation compared.

5.2.1 Smoothing the Results

During the Research Pilot there were a number of communications to the target audience announcing the introduction and changes to the Research Pilot (see section 4.9.1). After each announcement, the activity metrics indicated peaks of short-term interest. This activity was called a 'curiosity peak'. Each curiosity peak was recorded by the metric monitoring processes. The result of this was that it became difficult to identify any trends of activity as they may have been masked by the bursts of interest.

One strategy to limit these curiosity peaks in the Collaborative Index would have been to stop any announcements. This would allow the discovery of the Collaborative Index through everyday intranet use and word of mouth. This strategy was considered but rejected because the time scale for the research was likely to be limited and there was an uncertainty on how long it would take for the wider intranet audience to make use of the Collaborative Index.

Another strategy would have been to estimate the probable activity effect of these curiosity peaks and delete the activity statistics for that period. It was believed that the second option of modifying recorded metrics was not appropriate as the

deletion of recorded values could contaminate real peak activities and would invalidate the research.

A third strategy would have been to limit the communications about the Collaborative Index to a single announcement of its arrival. This strategy was chosen as the mechanism for implementing the recommendation as it would not contaminate the results and did not require values to be manually modified. Additionally, the system designers were asked how, in general, a new application would be introduced into their intranet and it was discovered that common practice was to announce its presence and then let the user audience find it. So this strategy fitted with normal organisational practice.

5.2.2 Stabilisation

During the use of the Research Pilot, changes to the system had to be made because the users of the system were using the positive annotation comment areas to enter negative annotations (see section 4.8). This occurred because there was no negative annotation comment area. This unplanned-for activity threatened the accuracy of the metric gathering. As result a system change was required to allow negative annotations to be entered. This necessary system change interrupted the research period and resulted in two four-week periods of research rather than one consecutive period. The initial concern for the research was that the metrics for the first four weeks had to be reviewed to identify correct positive annotations and remove the metrics for negative annotations. Another concern was that additional announcements had to be sent out indicating the changes. These announcements added to the issues described in sections 4.9.1 and 5.2.1.

Identifying unplanned system usage is, by definition, not possible, but one strategy for dealing with this in the Collaborative Index would be to leave the system without changes unless the system actually failed. Another strategy would

be to allow changes to occur and allow the research period to 'restart' from the launch of the modified changes.

In practice, the availability of the research system was governed by the host organisation and it would not have been acceptable to restart the research in an open-ended manner. Due to this, the strategy that was chosen was to ensure that no changes were made to the system during the research period and the Collaborative Index remained uninterrupted for three months during which data was collected and no technical system changes were allowed.

5.2.3 Scalability

During the Research Pilot, the number of annotations grew at a relatively steady rate (see section 6.4.1). As the Pilot was in place for two limited time periods, a recommendation was made to extend the time period in order to identify if the number of annotations continued to grow. The concern was that if the annotations continued to grow then the use of the annotations as navigable points may become more difficult. If this were the case, then the issues of feeling lost in information may move from one place to another (i.e., from the information store to the Collaborative Index).

Two possible strategies to accommodate this recommendation were considered. The first was to extend the research period for several months rather than have the equivalent of two four week periods used in the Research Pilot. The second strategy was to keep a short research period but to increase the number of 'active users', thereby potentially increasing the number of annotations that might be made.

It was decided that identifying what criteria constituted an active user of a system in an anonymous environment was likely to be problematic. A further issue was that by choosing an intranet with a large audience, there could not be an assumption that there would be a large active user audience. A proportion of the

audience may not be active within the Collaborative Index, nor even the intranet itself.

The first strategy of extending the time period to allow a longer period of exposure to the Collaborative Index was the chosen strategy and was already the preferred option for stabilisation. By defining a three-month extended research period it was hoped that the Collaborative Index would provide annotation count details that would indicate if annotation growth was a significant issue.

5.2.4 Wider Metrics Gathering

The Research Pilot was implemented in a single area (see section 4.4.1) of an intranet and the metrics gathered were focused on that area. The recommendations from the Research Pilot included the recommendation to monitor more than just the immediate research system to ensure that intranet-wide trends in user behaviour were not affecting the metrics from the research system.

This recommendation could have been met through capturing general web site activity outside and including the research system, or by extending the research system to cover the whole intranet. The recommendations also covered more specific metric gathering which, in the Research Pilot, had not been captured. While metrics were gathered on 'returned and followed' annotations (see section 4.9.4) through the site search engine there were no metrics to identify how many times the search engine was being used in the wider intranet.

It had also been identified that annotation links were being stored in users' favourites and perhaps other desktop applications. It was unknown how widespread this was as no metrics were in place to capture these activities. As such, it was recommended that a mechanism for capturing these metrics be created, as the outcomes of these activities may be important to the wider impacts of the Collaborative Index.

The only approach to addressing the need for specific search and 'returned and followed' metrics is to collect the relevant data, so monitoring mechanisms to capture the data were created. In the case of returned annotations (links) being copied and emailed to colleagues or stored in favourites, the metrics were gathered from the web server access logs. This was done by identifying the unique identity of a link from the Collaborative Index and counting activity from other places as a separate total.

The requirement identifying the possible shortcomings of monitoring the research part of an intranet is only valid if the research is carried out in one section of an intranet. Therefore, the strategy to meet this recommendation took two approaches. The first was to widen the research pilot across a complete intranet and continue with the established metric data capture. The second was to also gather metrics for general intranet activity and search engine usage.

Reason to Gather Metrics	Metrics to Gather
Action: Rating on Quality	Vote Values and Counts
Action: Annotating on Context	Accumulation of Annotations and Counts
Result: Local Language Alignment	Original and Modified Annotations
Result: Alternative Navigation	Annotations Returned and Followed
	Successful Searches
General Metric	Search Engine Activity
	Intranet Traffic Trends

Table 5.1 Metrics Captured by the Collaborative Index

In conclusion, the metrics to be captured were aligned to the actions and predicted results as defined in section 4.3. In addition, the metrics captured were extended to include general web site activity and general search engine usage. This is summarised in table 5.1.

5.2.5 Methodology (Research Pilot)

During the Research Pilot study, an informal methodology for the extraction of metrics and modification of annotations was established (see section 4.4.3). This was an important part of the research process to ensure that consistent comparable results were obtained and appropriate annotation modifications were made. The recommendation from the Research Pilot also included the observation that the Research Pilot had set a restriction on content changes of the target intranet to allow the metrics to be gathered across a 'stable' information store. This was acknowledged as an unrealistic expectation for a 'real world' scenario and it was suggested that any new formal methodology should include, within its process, steps that allowed changes to be made. It was found that the Research Pilot process provided information that became of interest to the system designers and other interested groups. It was recommended that a formal methodology should be developed (see section 4.9.5). This would, through distribution of the findings to appropriate groups, provide an educational effect and may impact the thinking on the creation of the rest of the intranet, and not just the area under research.

This was a complex recommendation which could be separated into four process areas to assist with the identification of possible strategies for implementation.

(i) A process to extract metrics

This process area had only one suggested strategy, which was to extract the gathered data from the reports and information store. However, there were many variations that could be considered for the timings and frequency of the extractions.

(ii) A process to allow controlled modification of annotations

The rules regarding the changes made to annotations were established for the Research Pilot (see section 4.4.3) and the strategy in this case could be to

continue as before. As with other areas, alterations to the frequency and timings of the annotations could provide variations on this strategy.

(iii) A process to allow content and structure changes to occur

One strategy for this process area would have been to only allow changes to be made by the researcher. Another strategy would have been to allow changes to be made by the system designers but only after they had indicated that the changes were suggested by the metrics that were being extracted. A further consideration for both strategies was that of frequency of change.

(iv) A process to facilitate distribution of findings to identified groups

This area could provide a strategy for each identified group, and variations on that strategy for frequency of reporting. The recommendations from the Research Pilot study indicated that there was a wider educational value in distributing the findings. However, while distributing the findings may prove of benefit to the identified groups they would only be of value to this research if each of the groups provided feedback on how they used the findings. As a result of this, the strategy of distribution would also need a supporting strategy for returning feedback from the identified groups.

5.2.6 Methodology (Collaborative Index)

The methodology was constructed to be a cyclic process of review and controlled modification. Within each cycle, a set of tasks would be carried out. The tasks were in a sequence and the cycle was processed at a set, timed frequency. It was decided that three months would be the target duration for the Collaborative Index research as this would provide a lengthy and potentially stable platform for the research. It was therefore decided that the frequency of the methodology's cycle of review would be weekly, as a monthly frequency allowed the research to continue for too long without detailed monitoring. With the frequency of review established as a weekly cycle, the four process areas identified by the Research

Pilot were addressed (see section 5.2.5). The enhancements to the identified process areas, where any were made, are now detailed.

(i) The process area of metric extraction had only one strategy, which was established during the Research Pilot, and this extraction process was continued for the Collaborative Index. The process was extended to cover the newly identified metric gathering, as indicated in table 5.1. The only variation on this strategy was the possibility of varying timing and frequency, but as already explained a decision was taken for the review cycles to be undertaken on a weekly basis.

(ii) The second area of the recommendation, controlled modification of the annotations, also had only one strategy which had been established during the Research Pilot. One change was made for the Collaborative Index, as it had been found during the Research Pilot that the need to turn all annotations into questions did not appear to be beneficial and in some cases forced the modifier to add many words to the annotation. From this it was decided that the need for annotations to be questions could be relaxed, providing all the other rules on annotation modification remained in force.

(iii) The third area of the Research Pilot's recommendation on Methodology was that content and structure changes should be allowed to occur. In the Research Pilot, content changes had been stopped and there was a concern that if control of this area was completely handed back to the content managers, it would be too radical a change between the Research Pilot and the Collaborative Index, and may reduce the value of the comparative metrics. However, change was essential and the strategy suggested of allowing the researcher to make all changes would not stop the action of change; it would merely move it in to another's hands. It was decided that content and structure changes would be allowed to be made by the content managers, but only if the content changes were either new content within an existing structure or content identified by the annotations as requiring

change. Structure changes would only be allowed if indicated by the outputs from the Collaborative Index.

As an example, if part of the intranet was given the title of 'Careers' and the Collaborative Index identified that people were searching for 'Jobs' or 'Positions' then the content could be changed to include these alternative words or the structure could be changed if this was more appropriate. Additionally, it was decided that the changes would only be made on a weekly frequency, to allow changes to occur in a controlled manner.

(iv) The final area of the Research Pilot's recommendation on methodology was that the information produced by the Collaborative Index should be distributed to interested groups as it would have an educational effect on those groups. The strategy for distribution would have been very simple, but the supporting feedback strategy to identify if the interested groups were being 'educated' was likely to be time consuming and draw research attention away from the other elements of the Collaborative Index. A compromise was decided upon where interested groups would be provided with the information that was being produced from the Collaborative Index in weekly meetings rather than through formal reports.

After considering all the areas of the methodology recommendation from the Research Pilot, and the variations on strategies, a formal methodology was established. The methodology that was implemented for the Collaborative Index had a strict week-to-week cycle and followed defined process steps (see table 5.2).

	Review Cycle Stages		
Step	**Extract**	**Review**	**Modify**
1	Vote Values and Counts		
2	Original Annotation Content and Counts		
3	Search Keywords Content		
4	Modified Annotation Returned and Followed Metrics		
5	Search Metrics		
6	Intranet-wide Traffic Trends		
7		Original Annotation Content	
8		Search Keywords Content	
9		Modified Annotation Returned and Followed Metrics	
10			Annotations
11			Intranet Content
12			Reset Counts
13	At the end of the research period review all metrics		

Table 5.2 Methodology Review Cycle

At the end of each week the review cycle defined by the methodology was carried out in thirteen steps across three stages

The first stage of the cycle, the Extract Stage, carried out the extraction of the metrics that would be required for later review. The vote values (ratings) and total voting counts were extracted and saved for later analysis (see chapter 6). The annotations that had been entered that week (see chapter 6) were extracted and presented ready for review. The search keywords used by information-seekers were extracted and presented ready for review. The metrics associated with modified annotations that had been returned by the search engine and then followed by a subsequent user were also extracted (see appendices J and K). They were prepared for review together with the independent metrics on

annotations that had been followed without reference to the search engine (e.g., using email or favourite links). The counts for the total number of intranet-wide searches, for that week, were extracted and prepared for review with the wider intranet traffic trends (see chapter 6).

The second stage of the cycle, the Review Stage, gathered the interested groups together (researcher, system designers and information-managers) to carry out a review of the findings. The original annotations were reviewed to identify what language was being used by information-seekers and to reflect on the structure of the information store in relation to the language. The annotations were checked for appropriate language and recommendations were discussed on how, if at all, the annotation content should be changed to be suitable for inclusion in the annotation index. If the annotation was negative, the same process happened but the annotation was not prepared for addition to the annotation index.

The extracted search keywords were then reviewed. Patterns in behaviour were attempted to be drawn from the words, and 'hot topics' for that week were identified. Where in previous weeks structures had been changed as a result of the keyword review, a second review took place to identify if those changes had been successful. A similar, second review was carried out on the returned and followed metrics for previously modified annotations.

Finally, during the Modify Stage, the original annotations were modified, in line with the housekeeping and monitoring policy (see section 4.4.3) and the group review. The modified annotations were then added to the annotation index, within the Collaborative Index, and made available for information-seekers. If the reviews had highlighted any changes that were required to the structure or the content of the intranet, then these changes were made. The process cycle ended by resetting all the weekly metric counts and clearing down the original annotation holding area.

5.3 Integrating the Collaborative Index

Section 5.2 reviewed the recommendations from the Research Pilot and identified the preferred strategies that were used to enhance the Research Pilot in order to create the Collaborative Index. This section describes the process of implementing the enhancements and identifying a new information store to allow the implementation of the Collaborative Index.

5.3.1 The Target Information Store

The target information store for the Collaborative Index was the AXA UK Information Technology intranet, which had an audience of AXA employees who worked within the area of Information Technology (IT). IT had merged with three other IT groups from AXA's amalgamated companies and although the amount of content on this intranet was smaller than the content of the whole intranet used for the Research Pilot (see section 4.4.1), it was believed that the diversity of historic organisational practice and language would offer a good research ground for the use of the 'local language' alignment (see section 4.3.2). The approximate audience for the intranet was 600 people with a gender split of around 75% male to 25% female, with a mix of ages and geographic locations.

5.3.2 Technology Choices

The technology choices for the Collaborative Index were dictated by the existing system within the host organisation. As the Collaborative Index was an enhancement of the Research Pilot, all the technology choices remained the same and the interface was delivered in web page format XHTML and complied with the look and feel of the company intranet. Below the presentation layers, the existing intranet processes were XML, XSL and JAVA transformations with a data store based on an XML object store and so the Collaborative Index did not deviate from these technologies.

5.3.3 Integration within the Intranet

As with the technology choices (see section 5.3.2), because the Collaborative Index was an enhancement of the Research Pilot there were no changes to the manner in which the pages of the interface were integrated into the host intranet. There were also no changes to the Search screens, the Online Help and Contact Information or the Voting and Confirmation screens. However, a facility for negative comments had been added during the Research Pilot and this was retained for the Collaborative Index study. The Collaborative Index looked like, and behaved in the same manner as, the Research Pilot (sections 4.6.1 to 4.6.6).

5.4 Delivering the Collaborative Index

The Collaborative Index was delivered in May 2005 and was active through May, June and July. There was one day when a hardware failure caused the intranet to be unavailable and consequently the Collaborative Index was unavailable, but other than this the intranet was available for the full three-month period.

When the Collaborative Index was launched on the intranet there was an initial announcement, but following this there were no further communications to users. This supported the strategy adopted following the recommendation of 'Smoothing the Results' (see section 5.2.1).

Throughout the three-month research period, the processes defined for the methodology (see section 5.2.5) were followed and a weekly review cycle was established. Each week, the metrics generated from the Collaborative Index and the metrics from the generic intranet web statistics and search engine software were gathered and reviewed.

At the end of the research period the Collaborative Index was left in place within the intranet, but the research metric gathering processes stopped.

5.5 Gathered Metrics

The Collaborative Index was designed to provide usage information to inform and support this research. In addition to these bespoke metrics, the intranet, which was host to the Collaborative Index, also supplied more generic metrics on site usage. The required outputs from these metric-producing applications were defined in table 5.1.

Metrics were collected in three categories:

(i) Metrics to expose the usage of 'Identified Actions' (see section 4.3.1)

(ii) Metrics to help identify 'Predicted Results' (see section 4.3.2)

(iii) Metrics to ground the research in the wider activity of the intranet

5.5.1 Rating on Quality

To expose the usage of the 'Identified Action' of 'Rating on Quality' (see section 4.3.1), the number of votes (ratings) made and the value of each vote were recorded. These metrics represented which pages were valued by the site visitors and, following the changes made in the Research Pilot, the pages that visitors found of least value. The figures also indicated how many votes were made and how many times users had the chance to vote but chose not to.

In order to annotate a page of information, a user had to vote with a high or low enough value to allow annotation. Owing to this, the metrics captured how many times users had the chance to annotate, by voting in one of the extremes, but chose not to annotate. The voting counts and values were captured independently of the actual annotations.

5.5.2 Annotating on Context

To expose the usage of the 'Identified Action' of 'Annotating on Context' (see section 4.3.1), each annotation added using the Collaborative Index was

collected. Each consisted of the words used, a key to identify the page to which the annotation related and an optional user identifier of email address. Each week the counts of annotations were reviewed as defined by the methodology. The review identified the accumulation of annotations and the trend of annotations input across the research period.

5.5.3 Local Language Alignment - Original and Modified Annotations

To help identify the 'Predicted Result' of 'Local Language Alignment' (see section 4.3.2) each of the annotations collected was reviewed and modified as defined by the methodology and in line with the developed housekeeping and monitoring policy (see section 4.4.3). As well as the modified annotation being added back into the Collaborative Index, the original annotations were used to inform interested groups about the language that was being used when annotations were made and they could compare this with their own use of language.

5.5.4 Alternative Navigation - Returned and Followed Usage

To help identify the 'Predicted Result' of 'Alternative Navigation' (see section 4.3.2) the Collaborative Index provided metrics on the use of annotations as navigation. When a search was made within the intranet, the search engine first searched through the Collaborative Index and generated a list of entries that matched the search criteria. Then the search carried out a content search, appending the results of this search to the bottom of the previous search results. If an entry within the Collaborative Index was returned as part of a result set, then the 'returned' count was incremented. If the user requesting the search then clicked on the returned annotation and followed it to the recommended page then the 'followed' count was incremented.

An important consideration when reviewing the returned and followed counts was that if more than one annotation was returned and the user followed the link

of one of those annotations, then the metrics would show that the other annotations were not followed. This is an accurate recording of the activities but, overall, indicates that in some cases the Collaborative Index annotations were not chosen in preference to other links. However, the other links may have also been Collaborative Index annotations, so the overall 'followed' count may be reduced. As an example of this if a user was searching for 'SSS' then both annotations "How do you delegate authority on SSS" and "SSS Information" would be displayed as links. However, only one can be chosen, so the link that is not followed indicates that it was presented to the user but they preferred a different route.

5.5.5 Wider Metrics - Search Engine Activity

To help ground the research in the wider activities of the intranet, data on Search Engine activity were gathered. The metrics counted every use of the Search Engine and collected all the key words that were used when searching.

5.5.6 Wider Metrics - General Site Activity

In addition to the wider metrics of the Search Engine, the general web statistics related to intranet use were collected. This metric gathering was external to the metrics provided by the Collaborative Index and provided details of all browsing activities, not just those involving the Collaborative Index. The data collected included the number of pages viewed, the number of user sessions and the duration of visits.

5.6 The Methodology in Practice

The methodology proved to be a well-governed approach to changes and metrics gathering. The structured process of week-by-week gathering and review generated discussions between the interested groups and the researcher and provided clear break points for content change. Due to the conventional pressures

of their daily work activities, the information-managers were not always able to attend the reviews but their interest in the review cycles was sustained. It was not thought that their absence was of significant impact as the results found by the researcher and the system designers were reported back in a management summary process.

5.7 Conclusions

This chapter has reviewed the recommendations made as a result of the Research Pilot and considered alternative strategies for implementing those recommendations. Following this, a new research system was created and described in this chapter as the Collaborative Index. Additionally, this chapter has defined a formal methodology to support the Collaborative Index in use and identified a set of specific metrics to be captured. The metrics gathered from the Collaborative Index and the comparable metrics from the Research Pilot will be reviewed in chapter 6.

In this chapter, the Research Pilot and Collaborative Index results will be reviewed and compared, to identify if the aims and objectives of this research have been met.

Research Systems Review 6

6.1 Introduction

Chapter 5 described the creation of a new electronic system called the Collaborative Index. The Collaborative Index was an enhanced version of the Research Pilot system described in chapter 4. The enhancements made to produce the Collaborative index were identified as a result of the recommendations made from the Research Pilot. Chapter 5 also defined the formal methodology that should be used to support the operation of the Collaborative Index (see section 5.2.6). The aims of the methodology were to provide defined points of review for those groups involved in the creation and running of the host information store and to establish a framework within which content update and metric gathering could be carried out at defined points.

In addition to the creation of the Collaborative Index and the definition of a supporting methodology, chapter 5 also detailed the metrics that should be gathered from the Collaborative Index. The metrics defined (see table 5.1) included those captured for the Research Pilot and extended to include activities outside of the Collaborative Index. These new metrics were identified to provide data on the wider information store activity that may affect the use of, or be influenced by, the Collaborative Index.

Finally, chapter 5 described the implementation of the Collaborative Index, the use of the methodology during the research period and the metrics that were gathered.

This chapter brings together and compares the metrics from the Collaborative Index and the Research Pilot. The differences between the two systems are

highlighted and discussed and the formal methodology established in chapter 5 is also reviewed.

The structure of this chapter begins with section 6.2 outlining the metrics gathered with respect to the Identified Actions, Predicted Results and the wider metric gathering. Sections 6.3 and 6.4 analyse the results for the Identified Actions. Sections 6.5 and 6.6 analyse the results for the Predicted Results and sections 6.7 and 6.8 analyse the results from the wider metric gathering. The formal methodology, which was used with the Collaborative Index, is reviewed in section 6.9.

The Identified Actions and Predicted Results were a product of six design considerations defined in chapter 4. Section 6.10 reviews the overall results against these design considerations to identify if they have been well represented by the Research Pilot and the Collaborative Index.

This chapter concludes in section 6.11 that the Collaborative Index has provided an alternative and preferred navigational route to information using the local languages of the information-seeker. This has been achieved by allowing information-seekers to use the context of previous users' retrievals rather than the context of the information's storage. Further to this, the methodology that supports the Collaborative Index has allowed system designers to better understand the needs and behaviours of their information-seeking audience. This in turn has provided the opportunity for wider improvements to the structures of information stores outside the immediate use of the Collaborative Index.

The overall aims and objectives of this work, described in chapter 1, will be reviewed in chapter 7 along with the overall contribution of this research, its limitations and opportunities for further research.

6.2 Outcomes – The Interface

The Research Pilot and the Collaborative Index both produced metrics during their implemented research periods. The metrics from the Research Pilot have, up until this chapter, not been exposed in detail. However, the outcomes of those metrics guided the recommendations that were used to enhance the Research Pilot to become the Collaborative Index. Because the Collaborative Index was an enhanced version of the Research Pilot there are many similarities between the two systems. This chapter will review both sets of metrics and where possible compare the Research Pilot and the Collaborative Index results.

6.3 Action 1: Rating on Quality

The Research Pilot and the Collaborative index both provided the facility for a user to 'rate' the content of a web page based on the user's perception of its value. Allowing human rating on the quality of the information was a recurring requirement in systems such as Tapestry (Goldberg *et al.* 1992) and Group Lens (Resnick *et al.* 1994) and facilitating the action of rating allowed the Research Pilot and the Collaborative Index to realise the benefits described by these systems.

For this work, although the data captured was used to inform the system designers of the perceived value of their content, the main purpose for facilitating this action was to allow the identification of a user's 'good experience'. By identifying this sort of experience the system could then offer the chance for the user to annotate why they believed it was a good experience, and this in turn would build an annotation index for use within the Research Pilot or the Collaborative Index.

Rating activities have been split into two sections. The first presents a count of the votes that were made across the available rating values and illustrates the spread of voting that was recorded. The second presents counts of actual voting

activities over the research period and illustrates the sustained nature of voting behaviour.

6.3.1 Rating Vote Values

The number of votes cast and the value of those votes were captured independently of the annotations. As figure 6.1 shows, the number of extreme positive votes (i.e., +4) for the information on the intranet was around a third of all votes, the number of extreme negative votes (i.e., -4) was around a third and the combined total of all other votes was around a third.

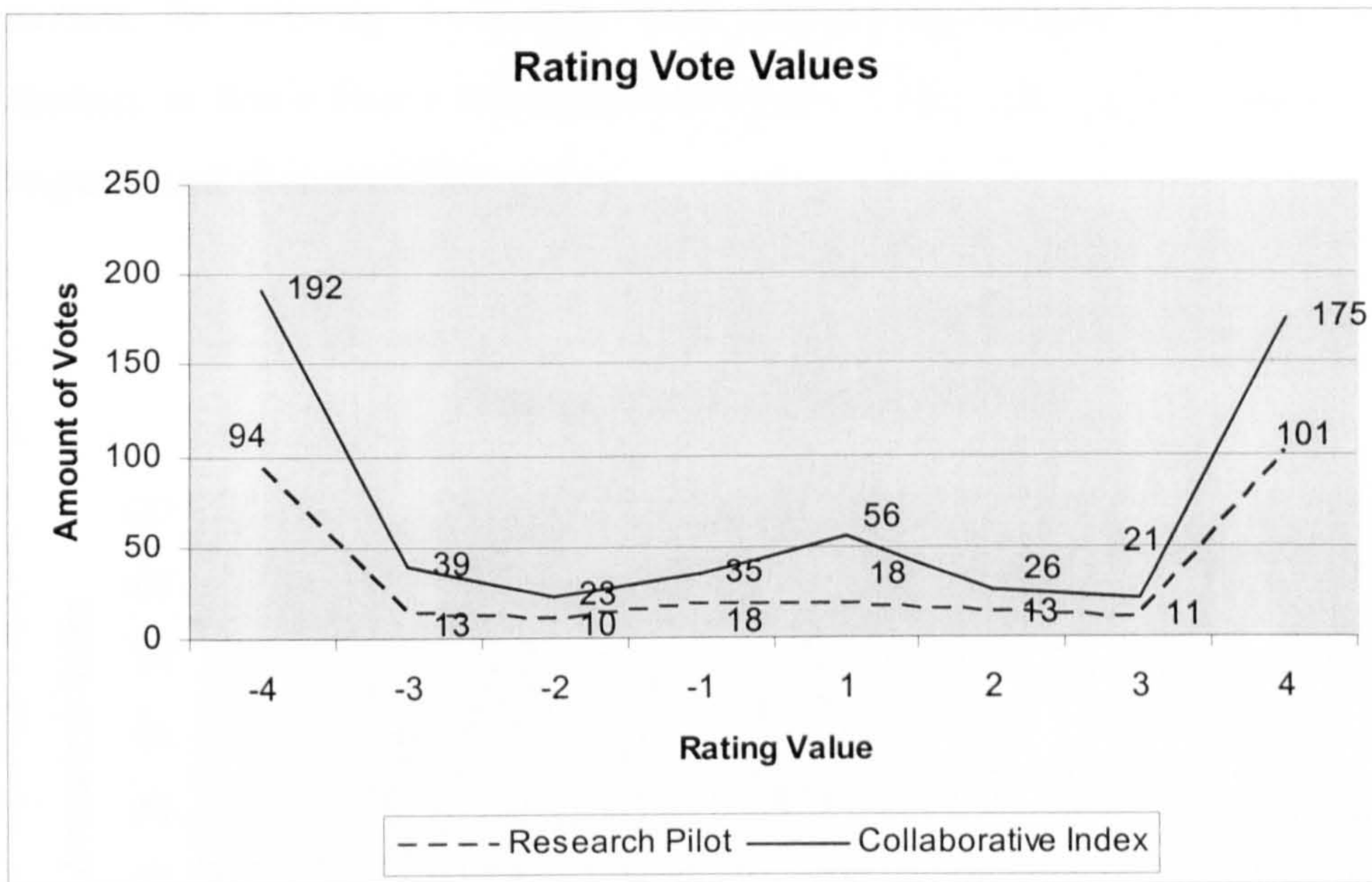

Figure 6.1 Rating Vote Values over Time

This pattern was similar in both the Research Pilot and the Collaborative Index. This could be a result of the annotation input box only being displayed on the extreme voting values. As a result of this users who had taken the time to vote may have also wanted to comment and so voted for the extreme result to allow them to do so. Alternatively, it could have been a result of the users having strong views most of the time.

There were no references to this phenomenon within the existing literature review (see chapter 2) and post-research user interviews were not possible in either of the research systems. However, from this we would suggest that this spread does indicate that the multiple-choice voting mechanism deployed in both research periods is unnecessarily complicated and could be replaced with a simpler three point system rather than the eight points provided.

6.3.2 Rating Vote Counts

The Research Pilot metrics for counts of rating votes, shown in figure 6.2, indicate that after a peak of activity during the first two weeks of the research period, the activity dwindled. Then, following changes to the Research Pilot system, in week four a second announcement was sent out and the activity began to peak and then dwindle again.

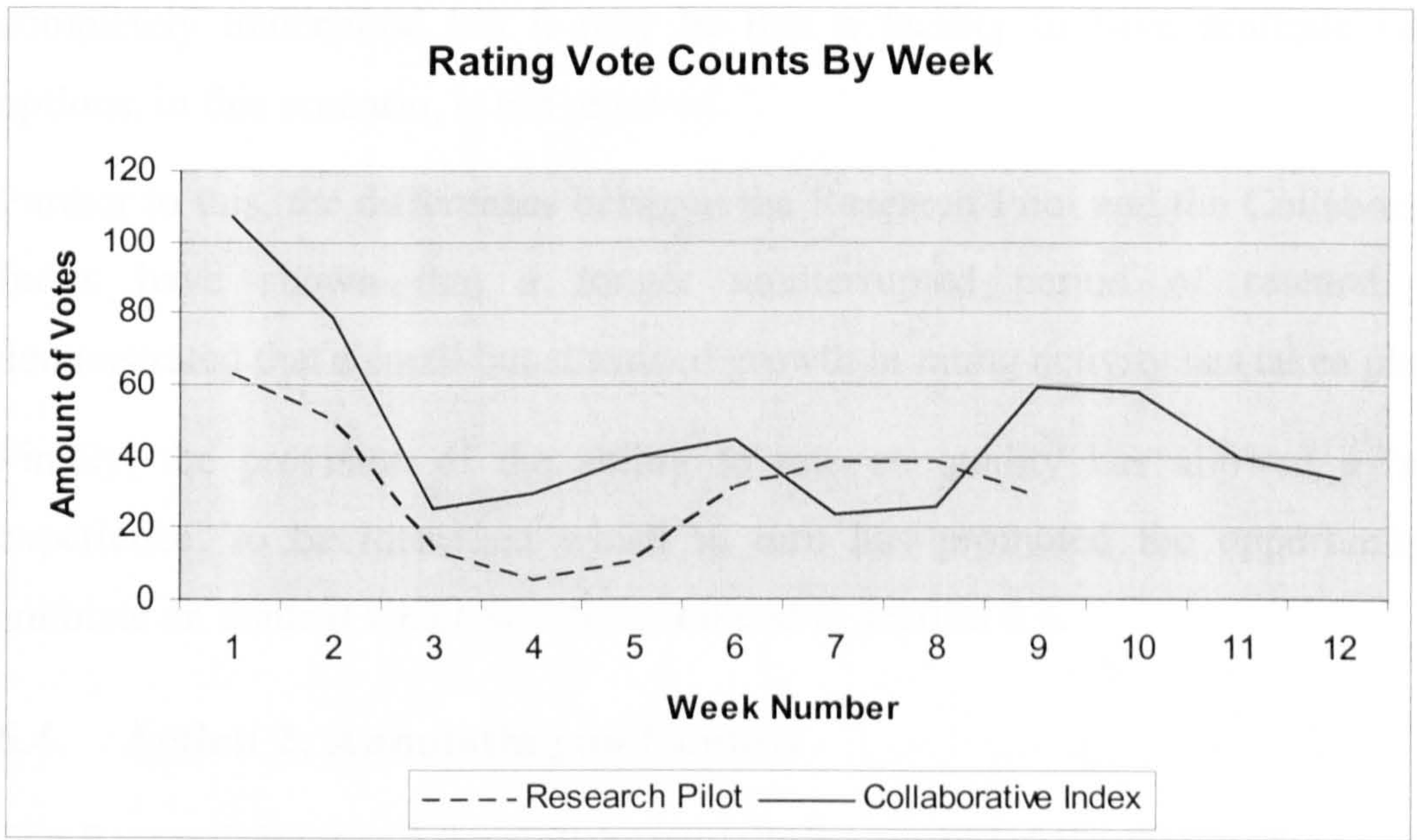

Figure 6.2 Rating Vote Counts over Time

It was recommended, following the Research Pilot, that a longer period of stable research should take place and this would provide a more reliable indicator of voting activity.

Figure 6.2 shows the rating vote count over the longer period of research was undertaken for the Collaborative Index. It can be seen that, again, there was a high curiosity peak at the start of the research period when the initial announcement was sent out. However, unlike the Research Pilot, no further communications were sent out and no system changes were made. Therefore, the peaks and troughs are not induced by announcements or technical changes. These activities appear to indicate a pattern of voting of approximately 40 votes a week.

6.3.3 Conclusions – Action 1: Rating on Quality

The action of rating content on quality has been facilitated by the Research Pilot and the Collaborative Index. Information-seekers' voting behaviours are not completely understood but it may be that a facility to have multiple voting options, in this scenario, is not required.

Further to this, the differences between the Research Pilot and the Collaborative Index have shown that a longer uninterrupted period of research has demonstrated that a small but sustained growth in rating activity has taken place.

Finally, the provision of the ability to rate on quality has allowed a 'good experience' to be identified which in turn has promoted the opportunity to annotate on context which will be examined in section 6.4.

6.4 Action 2: Annotating on Context

The Research Pilot and the Collaborative Index provided the facility for a user to annotate on the context within which they found the content of the page useful. They were given the opportunity to annotate information (content) only when they had voted high enough for the experience to be considered a 'good

experience'. It could be argued that one person's 'good' is not the same as another person's 'good'. However, it was felt that if a user chose the highest possible value then the experience was good enough for the context of their information-seeking and so worth capturing.

The annotation made was added to an annotation index. Both the Research Pilot and the Collaborative Index had an annotation index, which was a central store of annotations indexed for searching activities. This use of human context annotation was facilitated so that users could benefit from a previous user's experience (Dourish and Chalmers 1994, Dourish 1999) using the identified advantage that humans are better placed to judge context than automated systems (Resnick *et al.* 1994, Borchers *et al.* 1998, DMOZ 2005). The use of human context of the information also provided an alternative view of the information formed from the context of retrieval rather than the context of the original storage which had been seen as problematic (see section 1.1).

This section presents two views of the metrics gathered as a result of facilitating the action of annotating on context. The first, the metrics for which are presented in figure 6.3, illustrates the growth of the annotation index over the research periods and the second, the metrics for which are presented in figure 6.4, shows the count of annotations made on a week-by-week basis.

6.4.1 Accumulation of Annotations

The Research Pilot was split across two four week periods and during the first period the Research Pilot only had the ability to accept positive annotations. The reason it only accepted positive annotations was that this work aimed to capture user's good experiences and not bad. While it was acknowledged that bad experiences may also be of value by providing 'do not enter here' warnings, these negative annotations were chosen to be ignored. Within the first few weeks of the Research Pilot it was found that users of the system were using the positive

area for annotations to enter negative annotations and the system had to be modified to allow a separate area for these negative comments. The captured negative annotations were not used in the annotation index of either the Research Pilot or the Collaborative Index but they did provide a feedback loop for the users of the system and they were passed onto the system designers during the weekly reviews established through the methodology for the Collaborative Index study.

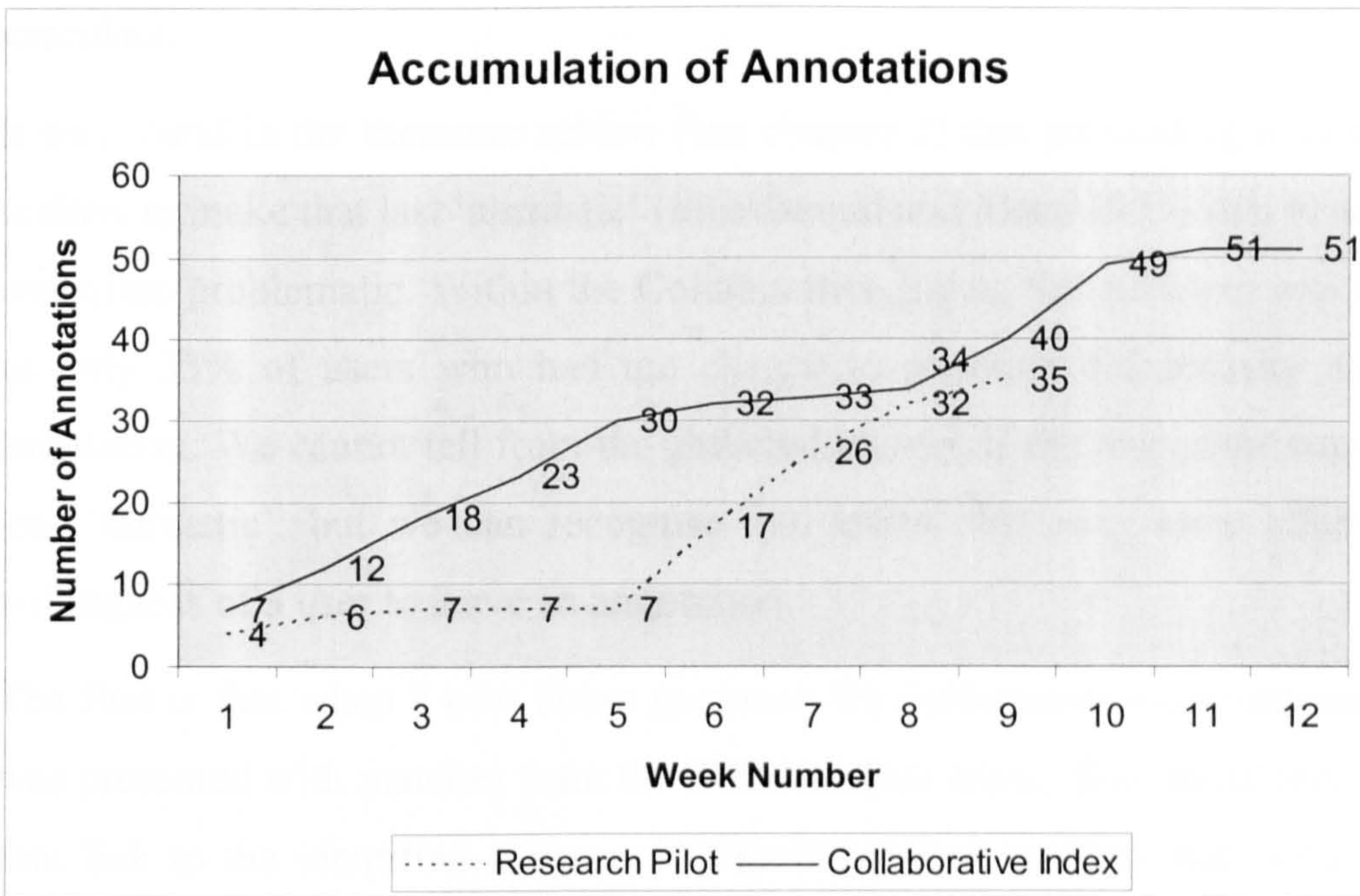

Figure 6.3 Accumulation of Annotations over Time

It is believed that the Research Pilot system changes that led to the inclusion of the facility to add negative annotations caused the plateau that can be seen through week four and five (see figure 6.3). Once corrected, real positive annotations could be recorded accurately and this then resulted in the growth of annotations shown.

The Research Pilot ended with the growth appearing to start to level out. The combination of the early disruption, as a result of the system change, and the

final open-ended levelling out of annotations do not provide reliable evidence on how an annotation index may continue to grow. However, it can be seen that annotations were being added and that the annotation feedback process was being used throughout the implementation of the Research Pilot.

In support of the findings of the Research Pilot, figure 6.3 shows that the uninterrupted period of the Collaborative Index research indicates that the growth of stored annotations continued at a relatively steady rate, but once again tantalises us with a levelling off at the end of the period, on which we can only speculate.

It was found in the literature review (see chapter 2) that persuading information-seekers to make that last 'altruistic' (Shardanand and Maes 1995) step to annotate was often problematic. Within the Collaborative Index, this problem was evident as only 33% of users who had the chance to annotate did actually make an annotation. We cannot tell from the gathered metrics if the rest of the users were less 'altruistic', but we can recognise two issues that may have affected the willingness of a user to leave an annotation.

The first is that when a user chose to search the information-store (intranet) and was presented with matches from the Collaborative Index, they could then follow that link to the identified content. If they did follow the link and voted highly they would be given the chance to annotate again. However, there would be no need to annotate as an annotation, in the user's local language, already existed (the one they followed). So in these cases it is unlikely that a further annotation would be made.

A second possible reason for not annotating after voting highly is the common problem of people not having the time to annotate. It was found, during the review cycles of the methodology, that many of the annotations added to the Collaborative Index were 'rushed' entries (see section 6.5.1). These rushed annotations had multiple typographical errors, spelling mistakes and incorrect

mixed cases, all potentially indicating that the person making the annotation was trying to do so as fast as possible, potentially under time pressures.

To improve the process of collecting user's good experiences, the literature review identified that passive tracking of user activity (Hill *et al.* 1992, Wexelblat 1998) was possible and this would have relieved the issues of time pressure as the user would not have been required to carry out any other action. However, if this form of tracking had been implemented then the context of why the user was seeking the information would never have been known. Therefore, we believe that the 'cost' of a low return of context annotations is worth 'paying' when the annotations that are made provide a 'value' that could not be obtained through passive tracking and are in the control of the human using the system rather than an automated process.

To support this belief further, one observation, which will be dealt with later in the search and results analysis (see section 6.7.1), is that even a small number of annotations, representing the good experiences of previous users, was shown to answer a high percentage of subsequent users' searching needs. This indicates the overall benefit of the user-controlled context annotations.

6.4.2 Sustained Annotation Input

Figure 6.4 shows the weekly count of annotations made throughout the research periods. It can be seen that the Research Pilot weekly counts were erratic and this may have been due to the disruption of the Research Pilot in the first half of the research period. However, the Collaborative Index, with its longer and more stable research period, demonstrated a different pattern of activity.

We can see that the first five weeks are relatively steady and consistent with a reduction in annotations across weeks six, seven and eight. This could suggest that the interest in the Collaborative Index had waned and that the longer research period had allowed the system to lose its 'novelty value'. However, it

could also suggest that, over time, annotation entry would reduce as there were already annotations in place, left by previous users, which could be followed making additional annotation unnecessary. If interest in the annotation had waned then the peak of activity across weeks nine and ten would be difficult to understand, but an inspection of the annotations made during this peak activity provided an alternative insight into this second peak.

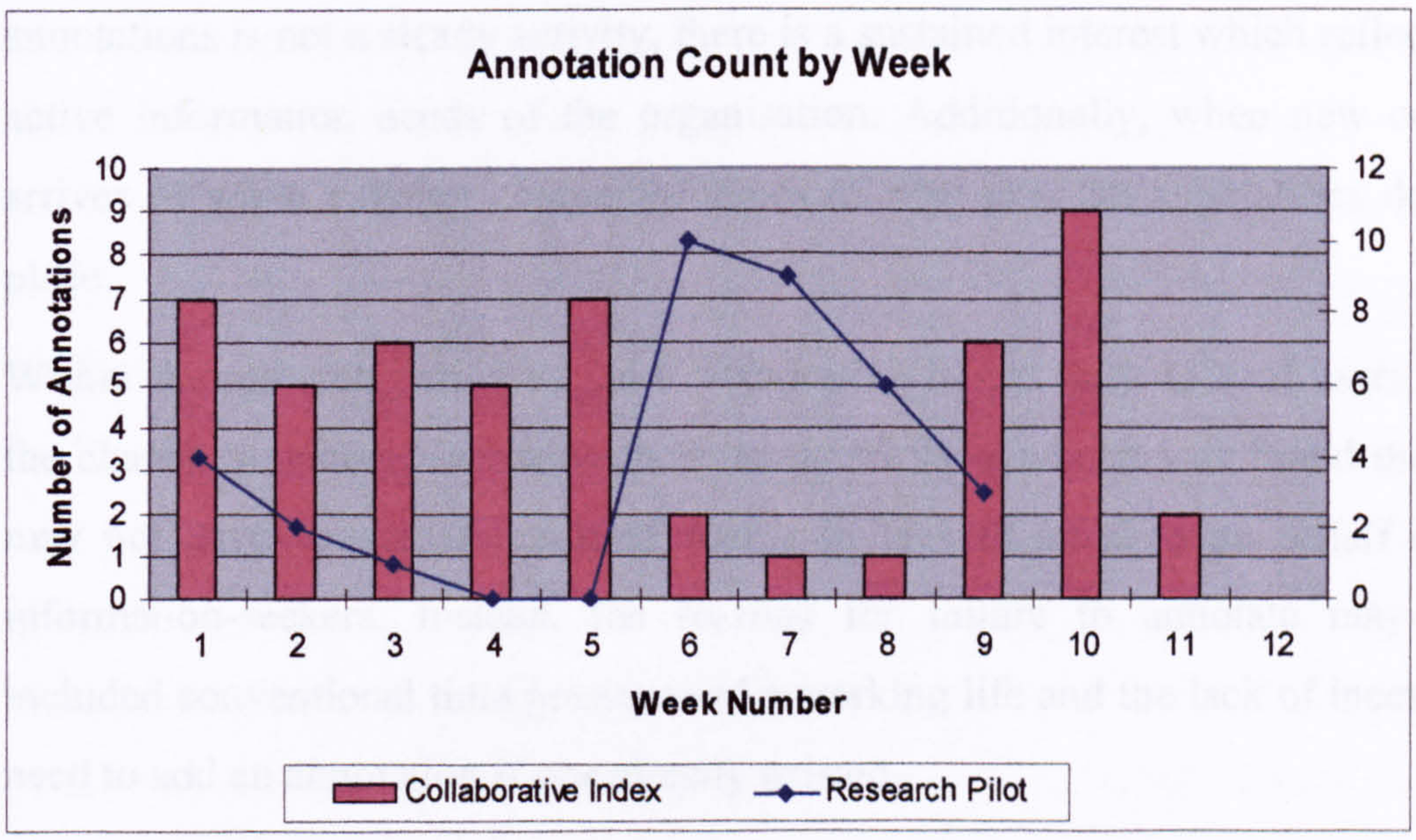

Figure 6.4 Annotation Count by Week

It was found that, in general, the annotations made during this period were related to information areas that had not previously been annotated and had become important to the organisation during the research period. For example, the organisation was moving towards compliance to the standards defined by Sarbanes Oxley and also during this period there was a drive towards standards of service and system availability. In each case, the annotations reflected this new need for information and this resulted in the increased annotations and recorded peak activity. It may well have been that after this peak there would have been

another reduction in annotations being added to the Collaborative Index while awaiting the next 'current' topic to enter into the corporate consciousness.

6.4.3 Conclusions – Action 2: Annotating on Context

The action of annotating on context has been seen to be facilitated by both the Research Pilot and the Collaborative Index.

One finding from facilitating context annotation is that although adding annotations is not a steady activity, there is a sustained interest which reflects the active information needs of the organisation. Additionally, when new content arrives or when existing content becomes of new interest, annotations do take place.

Within the research period of the Collaborative Index, only 33% of users given the chance to annotate actually chose to do so. However, it was found that this may not have been as a result of apathy or lack of altruism on behalf of the information-seekers. Instead, the reasons for failure to annotate may have included conventional time pressures of a working life and the lack of incentive / need to add an annotation if one already existed.

Finally, it was also found that a small number of context annotations provided significant benefit to subsequent information-seekers, and so even a low number does not reduce the effectiveness of the Collaborative Index. This issue will be clarified further in section 6.7.1.

6.5 Predicted Result 1: Local Language Alignment

It was found during the physical world observational study (see chapter 3) that when humans seek information from each other they prefer to do so using their local language and local experts. Only when this fails will they enter into a language and question reformulating session with another human information source. To support this human activity the context annotations, described in

section 6.4, captured the local language of the user making the annotation. This allowed subsequent information-seekers, when reading search results, to align their local language seeking needs against the context annotations of others.

It was hoped that by doing this information-seekers could recognise the similar language being used in the annotation and the context of why the associated content was considered 'good'. Following this, the information-seeker could proceed knowing that the language and the context of the rating aligned with their own seeking needs. If the language was not similar to their own, or the context did not align with their own seeking context, then they could revert to the conventional search engine or hierarchic navigational structures. If they did revert, then they would still be following the observed human behaviours, which the Collaborative Index was facilitating, by seeking in a local language before having to use non-local language.

It was predicted that one of the expected results of the use of the Research Pilot or the Collaborative Index would be that users would align their own local language with the language used by others (see section 4.3.2). Section 6.5.1 details the process by which original annotations were, if necessary, carefully modified without altering the local language of the annotation. Section 6.5.2 details the opportunities provided for a user to carry out Local Language Alignment. Finally, section 6.5.3 concludes on the success of the predicted result of Local Language Alignment.

6.5.1 Original and Modified Annotations

It was initially hoped that the actual annotations entered by the users would be used in the annotation indexes of the Research Pilot and the Collaborative Index. However, there was a concern that an open publishing mechanism may have given rise to problems around appropriate language and acceptable comments

(see section 4.4.3). This resulted in the comments being validated and modified by the researcher to ensure that they were suitable for publication.

Tables 6.1 and 6.2 show a subset of the gathered annotations and the modified versions that were used in the Research Pilot and the Collaborative Index (see appendices H and I for complete tables). Once this data had been collected it was clear that direct publishing would have been unsuitable, as the annotations were often not well formatted, spelt incorrectly or contained a mix of lower and upper case letters in inappropriate places. However, there were no instances where the language or purpose of the annotation used was unprofessional. This continued professional approach, even though the annotations remained anonymous, is representative of the 'Appropriate Behavioural Framing' identified by Harrison and Dourish (1996). They reported that the 'space' that a system provides becomes a 'place' through usage and with this place are created unwritten rules that are adopted by users of the place. It could be that this continued professionalism is an indicator that the Collaborative Index was transforming the host intranet into a 'place' and behavioural rules were being adhered to. However, it could also be a result of the users of the system being present in a 'real' place, the office environment, within which they had physical world behavioural rules that they transferred to the use of their intranet.

The spelling mistakes raised concerns that the misspelling may actually be the way users would search for the data and questions were raised on whether the annotations should be stored with spelling mistakes. It was agreed that spelling mistakes would be corrected and perhaps a future implementation may wish to include an automatic spellchecker on the annotation input screen.

Original Annotation	Modified Annotation
Who's responsible for looking after the health and safety of non axa employees when they visit us	Health and Safety of non AXA employees during a visit

Table 6.1 Research Pilot – Sample Modified Annotations

Table 6.1 shows an example from the Research Pilot which was implemented over a Human Resource intranet site. The original annotation shows the language of the user seeking information. The modified annotation shows all the significant words that a subsequent user may seek. To expand on this example, and to expose the difficulties of information-seeking in a language other than a local language, the positions of the information in the site's original hierarchy will now be described. The first information-seeking question could have been answered by visiting the 'Resourcing' site, then from there to a secondary navigation item of 'Third Party Contracts' and then a third level on 'Liability'. All of these information architecture labels make good organisational steps for the structure of information, but are alien to the language of the users seeking the information. These local language experiences from the Research Pilot were also evident in the Collaborative Index.

Original Annotation	Modified Annotation
I thought they were called Help Desk not Service Desk and this page had the details I wanted	Help Desk Information

Table 6.2 Collaborative Index – Sample Modified Annotations

Table 6.2 illustrates an example from the Collaborative Index research. This intranet was for the IT staff within the organisation. It was thought that as the

audience for this site had gone through a recent multi-organisation merger, the use of local language may be more problematic for members of the group and that this would be shown in the annotations. The example annotation does indicate this.

One organisation's help desk, for support of system problems, was called 'The Service Desk' and another 'The Help Desk'. Although the services had been harmonised to become a single help desk, and a brochure had communicated the new name and details of contacts, the old language name still prevailed. Within the new organisation the name had been changed but within the mind set and local language of the users it had not. In this case, the corporate communications had failed to modify the local language within the culture of the IT staff.

Very few other annotations were as obvious as this example and a possible reason for this, which will be described in section 6.7.2, was that it was found through the metrics provided by the Collaborative Index that this 'IT' intranet was actually being used for Human Resource and Administration information seeking. This disparity between the proposed usage and the actual usage did not display the diversity in local languages expected from recently merged technical communities.

6.5.2 Identifying Local Language Alignment

The Research Pilot and the Collaborative Index provided a search mechanism that could be used by information-seekers. The full details of the search process and wider metrics associated with searching are detailed in section 6.7. This section will only describe the elements of the search that are relevant to Local Language Alignment.

When an information-seeker used the Collaborative Index they entered keywords in to the search engine to search the context annotations made by previous users. The return from the search was a list of links matched on the keywords entered.

By carrying out this process, the information-seeker had used their own language to match the language used by a previous user and so if results were returned they could then carry out further Local Language Alignment by comparing their needs to the annotated good experience of previous users. If the Collaborative Index provided nil returns or if the returned details were never used by the information-seeker, then Local Language Alignment would be considered to have failed. However appendices J and K illustrate that context annotations were consistently followed by subsequent information-seekers and this will be reinforced in section 6.7 through the analysis of the wider metric gathering.

6.5.3 Conclusions – Predicted Result 1: Local Language Alignment

The predicted result of Local Language Alignment was observed within the research periods for the Research Pilot and the Collaborative Index. It was also found that there were significant differences in the languages used by designers of the information store and the information-seekers.

The Collaborative Index demonstrated through local language alignment that the connection from local to organisational language could occur without altering the original stored information. This led to the creation of an alternative navigational route for information-seekers that was in the control of the information-seekers and not the system designers.

Finally, allowing information-seekers to use their own local language highlighted that the IT intranet was not always being used for IT information-seeking. However, despite this mismatch between the designers' information provision and the intended audience, the Collaborative Index provided the functionality for users to build an alternative navigational structure that met their information-seeking needs.

6.6 Predicted Result 2: Alternative Navigation

The second predicted result was that an alternative navigational structure, based on other users' annotations, would develop (see section 4.3.2). It has already been indicated in section 6.5.3 that an alternative navigation was being created by user activity, and this section will detail how the alternative navigation was used.

Section 6.6.1 presents the data gathered that identifies that previous users' annotations were reused as an alternative navigation route. It also illustrates the amount of times that an annotation was presented to be reused and how many times it was actually used in preference to other navigational choices. Section 6.6.2 concludes on the success of the predicted result of Alternative Navigation

6.6.1 Identifying Alternative Navigation

When a search was made within the intranet, the search engine first searched through the annotation index for the research system and generated a list of entries that matched the searching criteria based on the context of previous users' good experiences. This approach followed the findings of the observational study (see chapter 3) where it was identified that when humans seek information they choose to seek it from their immediate colleagues in a local language before carrying out a wider search.

The search then carried out a content search across the intranet, appending the results of this search to the bottom of the previous search results. By doing this the search process was made very simple and avoided the unused complex functionality warned against in section 2.3 (and noted by Jansen *et al.* 1998). The approach of combining both the conventional intranet content search and the annotation index context search was taken, as it had been found that when humans use electronic systems they prefer to make one search attempt and then filter through the returned results (Selberg and Etzioni 1997).

If an entry within the annotation index was displayed as part of a result set, then the count was incremented, and this figure can be seen in the 'Returned' column of tables 6.3 and 6.4. The full tables of results can be found in appendix J for the Research Pilot and appendix K for the Collaborative Index. If the user requesting the search then clicked on the presented link and followed it to the recommended page, then a second count was incremented and this can be seen in the 'Followed' column.

Annotation Id	Returned	Followed
rps2	11	11
rps11	0	0
rps21	8	5
rps30	18	10

Table 6.3 Research Pilot – Sample Annotations Returned and Followed

Table 6.3 is from the Research Pilot and should be read as follows. During all of the searches made during the research period, annotation 'rps2' matched the criterion requested and was returned on 11 separate occasions. Out of those occasions, the alternative navigation link that this annotation created was followed (clicked) by information-seekers 11 times. So, in the case of this annotation, every time it was returned it became the preferred method of navigation over the three other options.

The three other options of navigation were: any other links that may have been returned by the Research Pilot; any other links that were returned by the text searching capabilities of the search engine; and any other links that were visible on the conventional hierarchic navigational structure. This particular annotation was very popular, but others were not. Annotation 'rps11' was entered into the Research Pilot by one user and never met anyone's criteria on any other search.

As a result it could not be followed to the source of information that the original user found so worthwhile.

Similar results were found from the metrics of the Collaborative Index. Table 6.4 is a subset of the Annotations Returned and Followed table for the Collaborative Index (see appendix K for the full table) but differs from the Research Pilot in that it has a fourth column of metrics which were only gathered as a result of the recommendations from chapter 4.

It had been found that during the Research Pilot users were following a link that was offered to them by the Research Pilot and then storing the link in their browser favourites, or emailing the link to another colleague. By taking these actions, if the saved or emailed link was clicked and followed, the Research Pilot could not identify that the request had originally come from search results and did not count it. The recommendations from chapter 4 pointed out that these uncounted 'followed' links may or may not be significant but no metrics existed as evidence, so the Collaborative Index was enhanced to collect these metrics.

Annotation Id	Returned	Followed	External Link
tci1116668336396	35	22	
tci1116668392245	15	16	Yes
tci1116668590958	4	4	
tci1117713738312	8	92	Yes
tci1117644286439	23	37	Yes

Table 6.4 Collaborative Index – Sample Annotations Returned and Followed

The External Link column displays a 'Yes' if the Collaborative Index entry was followed as the result of a mechanism that had saved the address from a search engine result. Extreme cases (e.g., the last two table entries) show significant counts for times that the Collaborative Index entry was being reused without

going through the search engine. This count would have been missed in the Research Pilot, but it can be seen that it is of significant value.

In both the Research Pilot and the Collaborative Index, an important consideration when reviewing these tables is that if more than one link was returned and the user followed the link of one of those entries, then the metrics would show that the other links were not followed. This is an accurate recording of the activities but, overall, indicates that in some cases the Research Pilot or Collaborative Index links were not chosen in preference to other links. However, the other link that was chosen may have also been a Research Pilot or Collaborative Index link in itself.

In both the Research Pilot and the Collaborative Index the metrics do not provide the level of granularity needed to identify if an annotation link was taken in preference to another annotation link, so we can only say that the metrics gathered indicate the minimum number of times the Research Pilot and the Collaborative Index provided preferred results.

6.6.2 Conclusions – Predicted Result 2: Alternative Navigation

There is clear evidence that an alternative navigation was created a result of using the Research Pilot and the Collaborative Index. The alternative navigation was a product of previous users' good experiences and allowed users to match their seeking needs with the context of others' information-seeking successes.

Unlike the other forms of navigation available to an information-seeker within the intranet, this alternative navigation was controlled by the information-seekers and not the system designers. As a result, access to the information was facilitated through 'context adaptation', avoiding the issues associated with adaptive interfaces (Höök and Svensson 1999). This provided multiple routes to the same information without altering the stored information.

Finally, an alternative navigation route was also generated outside the immediate information store as users stored and shared links, within other desktop applications, to the information that had been provided by the Collaborative Index.

6.7 Wider Metrics: Search Engine Activity

The Research Pilot and the Collaborative Index relied on the search engine to deliver the annotations to an information-seeker. In the Research Pilot, metrics were not gathered on the total number of searches being made and one of the recommendations made for the Collaborative Index was to provide detail of the quantity and type of searches made. This section describes the results of implementing the recommendation for the Collaborative Index and discusses the impacts of the findings.

6.7.1 Counting the Number of Searches and the Use of Annotations

Each time the search engine was used by an information-seeker, the search engine recorded the activity. Figure 6.5 shows the number of times that the search engine was used. These results are of little value on their own; they simply show that, as a generalisation, the use of the intranet search engine did not alter significantly during the Collaborative Index research period.

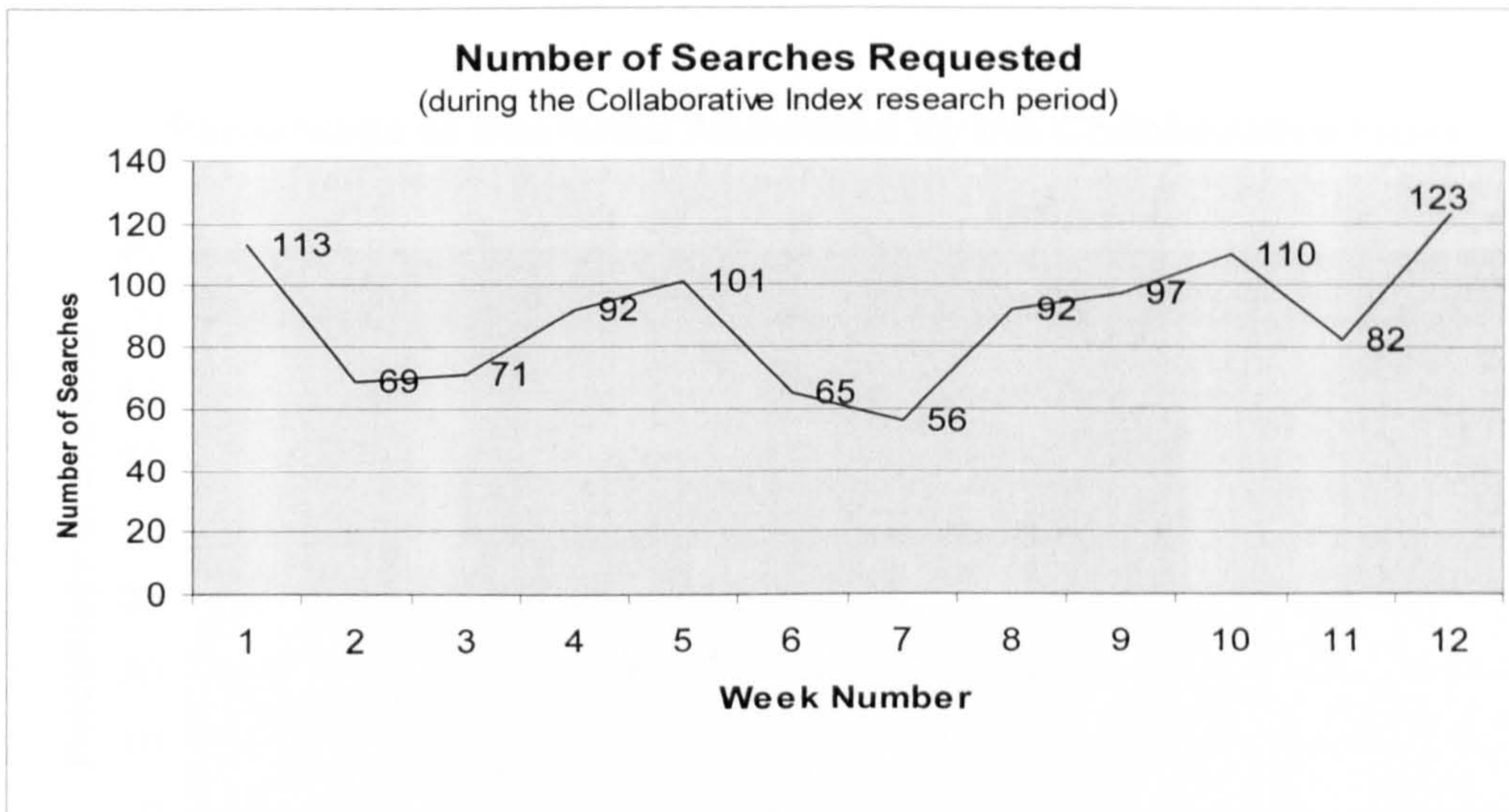

Figure 6.5 Count of Searches over Time

However, figure 6.6 is significant as it combines the metrics from the total number of searches with the metrics that indicate how many times an annotation was 'returned' and 'followed' (see appendix K) to illustrate the impact that the Collaborative Index was having on the effectiveness of search engine results.

Figure 6.6 shows that by the end of the research period, the Collaborative Index was supplying at least one response to 71% of the search engine enquiries. This is important because by the end of the research period there were only around 50 unique annotation index entries but they were still satisfying 71% of the search engine enquiries.

This suggests that the overall number of annotation index entries, which was originally presumed to be potentially large, may actually only need to be quite small, as the use of annotations stored in a local language promoting an alternative navigational approach was proving to be effective.

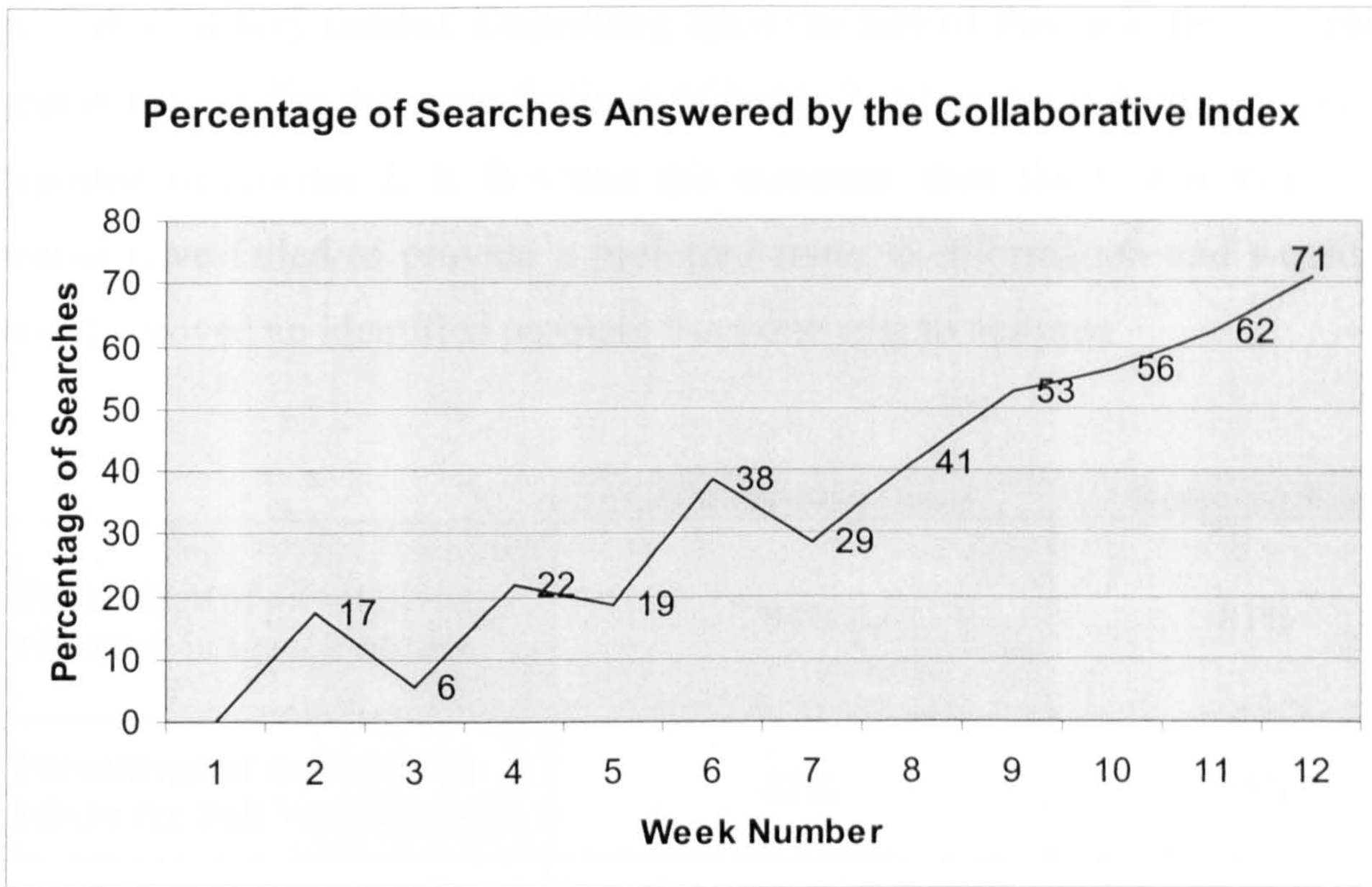

Figure 6.6 Percentage of Answered Searches over Time

However, it may be possible to reduce the number of annotations even further. Table 6.5 shows that in the Research Pilot 81% of the available annotations were returned in search results at some time. This percentage was marginally improved to 84% for the Collaborative Index research period. This demonstrates that around 20% of annotations, once entered into the annotation index of the Research Pilot or Collaborative Index, were never used again. As a result of this, in the case of the Collaborative Index, the number of annotations required to provide a significant improvement in information-seeking could be reduced from 50 to around 40.

The issue with the accumulation of annotations is that if the annotation index within the Research Pilot or Collaborative index had to be very large then this may present a problem to an information-seeker. If the information-seeker carried out their searches over a large annotation index, then they would probably receive back a large number of results. If this was the case, then the information seeker would have to spend time and mental energy working through the results

to find what they needed. Depending upon the size of this task, the information-seeker may suffer the same feelings of being 'lost' in the information that were reported in chapter 1. If this was the outcome, then the Collaborative Index would have failed to provide a preferred route to information and would have merely moved an identified problem from one area to another.

	Collaborative Index	Research Pilot
Percentage of annotations returned in search results	84%	81%
Percentage of annotations where the link was followed	82%	55%

Table 6.5 Percentage of Annotations Returned and Followed Comparison

It was shown that over time the number of annotations increased and that the interest in making annotations was maintained, although with a wave-like pattern. It seems inevitable that over a substantial period of time, perhaps one or two years, certain 'housekeeping' activities would need to take place to keep the number of annotations down to a minimum.

A paring down of annotations offers the opportunity for system designers to have an influence, perhaps a bad influence, on the alternative navigation. We see this opportunity as one that needs careful monitoring. This monitoring is similar to the 'housekeeping' activities defined in section 4.4.3 and positioned within the methodology for modifying the original annotations. If a system designer chose to remove an annotation, we suspect but have no evidence, that a new annotation would be added by the information-seekers, providing that an information need was still active. However, if the annotation's information target was changed, then this would distort the alternative index as the language of the original annotator would be left the same but it would not 'point' to the information that

was found useful in the context of the original search. We believe this type of modification would be against the design principle that aims to foster an Environment of Trust (see section 4.2) and would subsequently damage the use of the Collaborative Index.

6.7.2 Search Keywords as an Indirect Feedback Loop

In addition to counting the searches made and identifying the effectiveness of the returned results, the keywords used to search the intranet were also captured. These proved to be a very important indirect feedback loop for the system designers. The keywords were studied extensively during the review cycles that the methodology put in place.

Within the Collaborative Index research, it was found that the Information Technology (IT) Department intranet was not used for technical IT information-seeking, but instead had a high percentage of searches made for human resource and administration information. This indicated to the system designers that, firstly, the intranet had the wrong focus for the needs of the information-seeking audience and, secondly, a related intranet that had the information required was not being used by the IT audience. This demonstrates that the methodology supporting the Collaborative Index was providing a review cycle that not only supplied information to the system designers of one information store, but also highlighted information-seeking habits that could impact other, out of scope, information stores.

It has been reported that users of electronic systems feel outside the machine (Dourish 1999) and that approaches such as Social Navigation allow the user to enter into the machine and use the tracks or behaviours of others to make their information-seeking more effective. We have shown that by facilitating user annotation and the subsequent creation of an alternative navigation created by the users, the Collaborative Index has allowed the user to be 'inside the machine'. In

addition to this, we have shown that it is not only the users of the system that were 'outside the machine'. We have found that the system designers are equally removed from the information once the system has been created and the methodology has allowed the designers to also take steps 'into the machine'. This, in turn, allows them to understand the use of the information store and be better educated on the wider behaviours of their information-seeking audience.

6.7.3 Conclusions Wider Metrics: Search Engine Activity

The recommendation from the Research Pilot to capture metrics around search activity was implemented in the Collaborative Index and provided a beneficial insight into user-behaviour within the intranet. The Collaborative Index did not display a marked difference in actual search engine activity when compared with a previous period of intranet activity, but the use of the search engine within the Collaborative Index demonstrated an effective servicing of a high percentage of information-seeking activities, providing a rapid and preferred route to existing information.

It was found that only a small number of annotations were required to service a high percentage of searches and although the facility for a user to provide an annotation had provided a direct feedback to the system designers, the capture of the keywords used when searching the Collaborative Index was also providing an indirect feedback. This indirect feedback mechanism provided the system designers with a view of user activity and habits that allowed them to step inside the machine and better understand the behaviours of the information seekers and the use of the information.

Finally, the capture of search engine activity metrics through the Collaborative Index, in conjunction with the supporting methodology, provided the system designers with information that had impacts outside the immediate intranet and highlighted issues with other related information stores.

6.8 Wider Metrics: General Site Activity

The Research Pilot suggested that capturing additional metrics on conventional intranet activity, rather than just those produced through interaction with the Collaborative Index, might provide an understanding of how the Collaborative Index was impacting the wider intranet. This section details the findings of the metrics captured on general site activity.

6.8.1 Intranet Activity

Figure 6.7 shows the three months activity prior to the Collaborative Index and the three months activity following its introduction. The dotted vertical line separates the two periods. The trough in week 16 is the result of an intranet hardware failure and the white line between weeks 15 and 17 is a guide to suggest where the actual trend may have been. The observation from this graph is that, in general, intranet activity was on a slow rise and the Collaborative Index did not have any visible impact on the number of pages of information being returned.

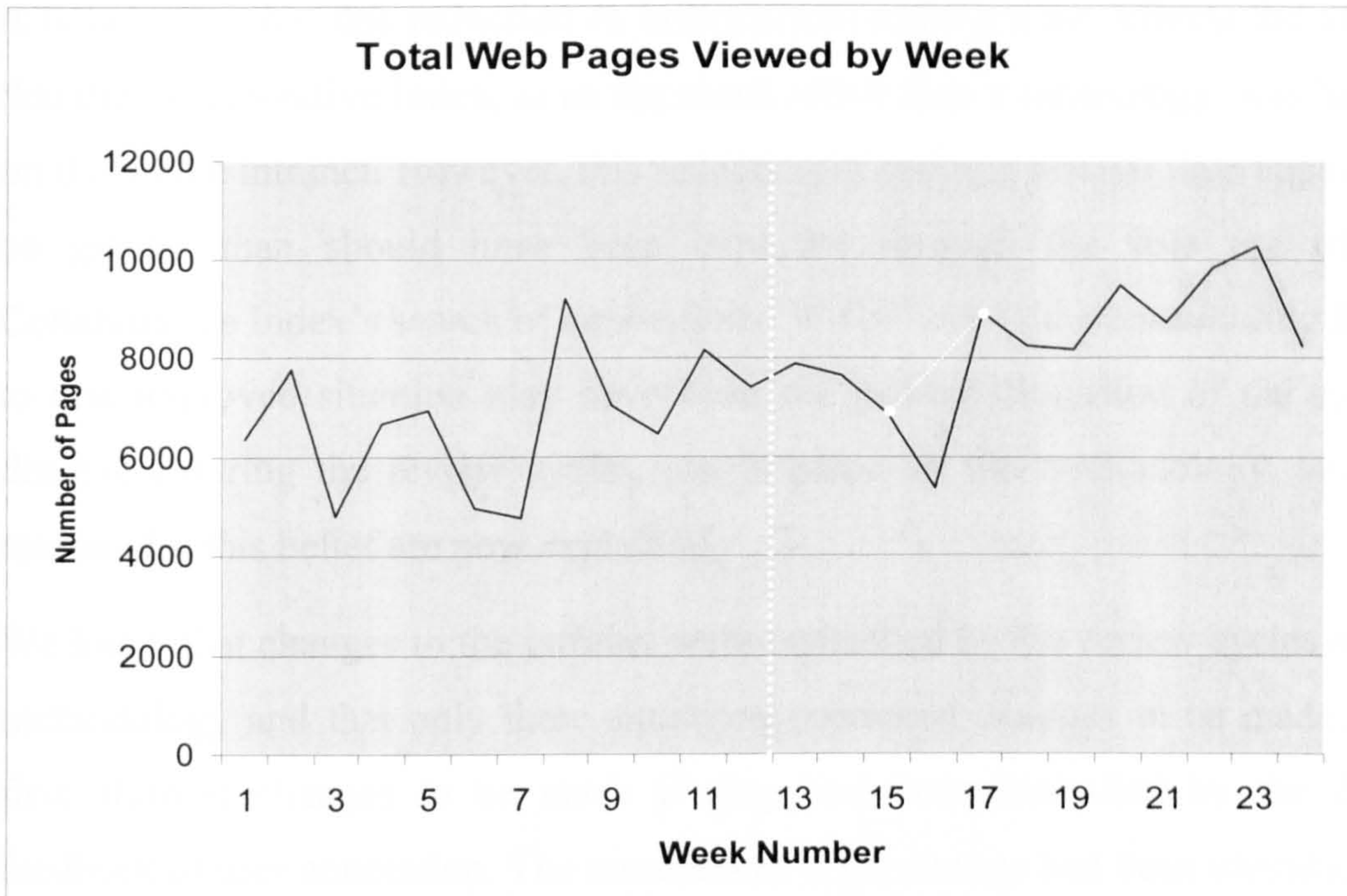

Figure 6.7 Total Web Pages Viewed by Week

Appendix L shows the full figures that have been used for the production of figure 6.7 and also holds the data that support the following observation on the changes in the time period that users spent seeking information.

Although the Collaborative Index had no discernable effect on the number of pages being viewed on the intranet, or the trend for increasing information retrieval, the metrics gathered identified that there was a difference in the length of a user's 'session' when information-seeking. When a user requested their first intranet page, the activity monitoring registered a session start time. While a user was navigating or reading information, then the session time was recorded. If the user did not carry out any activity over 30 minutes then the session was closed and the total time reduced by 30 minutes. Before the Collaborative Index was implemented, an average user's session would last seven minutes and 30 seconds. By the end of the Collaborative Index research period, the average user's session had been reduced to six minutes and 35 seconds.

It is believed that this reduction in information-seeking time reflects the effects that the Collaborative Index, as an approach rather than a technology, was having on the whole intranet. However, this reduction in average session time appears to be greater than should have been expected through the sole use of the Collaborative Index's search of annotations. We believe that a contributing factor to this improved situation may have been the general education of the system designers during the review cycles, put in place by the methodology, and the reasons for this belief are now explained.

We know that changes to the intranet were controlled by the review cycles of the methodology and that only three situations prompted changes to be made. The first allowed changes to be made if they had been identified by the direct feedback of user annotation. The second was if the change had been identified by the search keyword review. The final way allowed the addition of new content in existing structures. We know that general activity metrics appeared to be unaffected and remained on a steady rise through the research period (see figure 6.7). We also know that despite a high percentage of search returns now being delivered from the Collaborative Index (see figure 6.6 and table 6.5), they still represented only one part of the total activity on the intranet and so it is suspected that these alone would not be enough to generate the average difference across all visitor session times.

Therefore, as the search alone could not be fully responsible for the reduction in average session times and the patterns of user activity appeared to be unaltered, then the mechanisms for users to find what they needed might have become more efficient. From this, we conclude that session time reduction appears to be a result of the changes to the intranet being carried out by system designers who, through direct annotation and search keyword review, had been allowed to better understand the searching behaviours and needs of their information audiences

and had provided content changes, within the constraints of the methodology, that were aligned with the audience's seeking behaviours.

6.9 Outcomes – The Methodology

The Research Pilot indicated that the methodology adopted during the research period was beneficial and a recommendation was made to formalise the methodology for use within the Collaborative Index (see section 4.9.5). The methodology was formalised (see section 5.2.6 and table 5.2) and the identified outcomes are now reviewed.

6.9.1 The Methodology in Practise

The methodology proved to be a well-governed approach to changes and metrics gathering. The structured process of week-by-week gathering and review generated discussions between the system designers and the researcher and provided clear break points for content change.

Each week, the web site activity metrics and the metrics from the Collaborative Index were gathered from the intranet. In addition to these metrics, the annotations that had been entered into the annotation index of the Collaborative Index were collected and reviewed. The keywords that had been entered when information-seekers used the search engine were also collected and discussed.

The first weeks of using the methodology proved to be time-consuming as, firstly, this was the peak of activity and, secondly, considerable debate over the modification of annotations and the meaning of the search keywords took place. In later weeks, with the reduction in annotations and also the familiarity of process, the review cycles were less time-consuming but still an identifiable overhead.

Throughout the research periods there was a sustained interest in the findings and at first a strong desire to make instant changes to the intranet. The defined and

agreed methodology process to allow content and structure change to occur acted as a timely restraint from random changes and it is believed that this restraint was very important to the overall research findings. Without it, change could have been random and, although well-meaning, may have adversely affected the research and the identified value of the Collaborative Index.

The final stages of the methodology were to carry out any annotation modifications that were required, add the annotations to the annotation index and finally carry out any content changes that were decided upon as a result of the direct feedback from the annotations or the indirect feedback from the search keywords. One incident led to a modification to the content change process during the Collaborative Index research and will now be described in detail.

The Collaborative Index search engine results, which were collected each week, detailed all the keywords that users of the intranet were entering when searching for information. The system designers identified that some keywords were being repeatedly entered and the searches failing to provide any answers. This meant that none of the users found what they needed and consequently could not rate and annotate the information for others. The fundamental cause of this failure was that the structural labels of the area containing the information used a language that the information-seeker could not associate with their search. However, these areas of the site were still being visited by other users so it was thought inappropriate to change the structure of the labelling of the site.

The designers requested that they enter an annotation, through the normal annotation route, using the keywords that were being searched for, but pointed to the area where the information was stored. This request raised concern that the process was being distorted by the system designers but the action was agreed as the change was a direct result of the information provided by the Collaborative Index. Further to this, the system designers were providing information in the language that users were seeking, despite their being unsuccessful in their

seeking activities. The annotation was added and the following week the failing searches ceased to be a recurring problem.

6.9.2 Conclusions - The Methodology

It was found that the methodology was an important part of the Collaborative Index. This supported the observations of Bostron *et al.* (1992) when they identified that the process a technology generates is more important than the features of the technology. As the constraining framework, the methodology enforced ensured a consistent approach to metric collection and content change and helped the research by providing a formal behavioural reference for all those involved.

The methodology, through the defined review cycles, allowed the system designers to gain a better understanding of the needs of their information-seeking audience.

6.10 Design Considerations Review

In chapter 2, four design considerations were identified from a review of electronic world information systems: Appropriate Integration; Anonymous Presence; Environment of Trust; and Feedback Loops. In chapter 3, two more design considerations were identified from a physical world observations study: Alternative Routes to Information and Local Language Information Seeking. In chapter 4, both sets of design consideration were combined. The combined design considerations were then discussed and a set of Identified Actions and a set of Predicted Results were identified. The incorporation of the Identified Actions into an electronic interface to information should have provided an improved information-seeking experience and the Predicted Results were to be monitored to identify if the Identified Actions were effective.

It has been shown in sections 6.2 to 6.8 that the Identified Actions have been facilitated and the Predicted Results have been observed to occur and it has been

argued that the Identified Actions have been effective. In this section we 'step back' to examine the choice of the six combined design considerations that were the foundation to the Identified Actions and Predicted Results, to assess what impact they have had on the Research Pilot and the Collaborative Index.

6.10.1 Appropriate Integration

The design consideration of Appropriate Integration combined the Social Navigation design principles (Forsberg *et al.* 1998) of Appropriateness and Integration. It was proposed that for this research a system should be created and integrated into an environment with a specific appeal and an active (not passive) recommendation process (see section 2.6.5). The reasons for an active and not passive recommendation process were defined in section 2.5. It was further suggested that appropriate integration would include the factors of: intended audience; choice of information store; and the integration of an interface between the intended audience and the information store (see section 4.2).

The Research Pilot environment was of a specific appeal as it contained the Human Resource's information store that was relevant for the audience (see section 4.4.1). The Collaborative Index environment was also of specific appeal, containing technical information to meet the needs of a specific technical audience (see section 5.3.1).

The common interface used for the Research Pilot and the Collaborative Index was appropriately integrated using the resident technologies (see section 4.4.5) and was visually integrated using the style and design of the established information store. The use of the interface by the audience to retrieve information was integrated using established processes for help screens (see section 4.6.2) and reuse of the established search engine interface (see section 4.6.4). The process of rating on quality was not a passive process and so could not be integrated invisibly, so this process was integrated through the use of a voting bar

that fitted within a page of information with minimal impact (see figure 4.1). The process of annotating on context was also not passive, and so was the least 'integrated' of the research artefacts (see section 4.6.3 and figure 4.4), but it proved to be an appropriate method for annotation collection. Overall, both research systems fitted into the existing technology, the visual presentation and the established processes of the information store (intranet).

6.10.2 Anonymous Presence

The design consideration for Anonymous Presence includes the elements of Presence, Privacy and Trust from the Social Navigation design principles (Forsberg *et al.* 1998). It was proposed that anonymous access to a system's information should be supported, and the use of others' annotations should provide a suitable feeling of 'others having been there before' which should reinforce social presence (Riedl 2001) (see section 2.6.5). The design consideration advised that privacy of anonymous users should be maintained promoting an environment of trust.

The information stores used by the Research Pilot and the Collaborative Index were both anonymous access systems, and so anonymous access was maintained. This was in line with the design consideration and also with the expressed requirements of the host organisation. One difficulty with complete anonymity was that post-research interviews were not possible. As a result of this, we cannot say if users of others' annotations felt that 'someone had been there before'. However, there is considerable evidence from the metrics to suggest that the annotations of others were being reused by subsequent information-seekers, and by association those information-seekers knew that the 'recommendation' in the annotation had been made by someone who had 'been there before'. Therefore, we believe that there is strong evidence to suggest that this element of the design consideration had been achieved.

6.10.3 Environment of Trust

Environment of Trust overlaps with the Anonymous Presence design consideration by including the Social Navigation design principle of Trust (see section 6.10.2). However, Environment of Trust also includes Personalisation (Forsberg *et al.* 1998). The aim of this design consideration is to ensure that the system created encourages and promotes an Environment of Trust both in information and received advice, and that the information provided by a system should not be changeable by an unauthorised source.

During the Research Pilot it was found that users needed a mechanism to provide negative annotations and the results of this provided the researcher and the system designers with an opportunity to review why the negative comments were made. In the majority of cases where annotations had been made, the negative feedback was related to wanting more information rather than indicating that it was untrustworthy. The processes of rating content and leaving annotations suggest that they were trusted to either be an agent for change or mechanism of recommendation for others. It was found that the annotations were trusted as they were often chosen as a preferred route to information and it was believed that they would not have been if they were not trusted. Finally, the intranet that was host to the Collaborative Index demonstrated an unchanged pattern of activity after the introduction of the research system and it was believed that if the system had become untrustworthy, a reduction in activity would have been expected. However, none of these factors definitively prove that an Environment of Trust had been established. Without post-research interviews for this design consideration it can only be said that throughout both research periods, and within the combined metrics and reviews, there was no evidence that suggested that an Environment of Trust had not been established.

6.10.4 Feedback Loops

The design consideration of Feedback Loops was identified within the design principles for online community building (Kim 2000). It is linked to the consideration of Environment of Trust (see section 6.10.3) and combined with the element of Trust from the Social Navigation design principles (Forsberg *et al.* 1998). The aim of the design consideration was to provide mechanisms that would allow feedback from, and to, the user and system designers. It was hoped that by facilitating this two-way process an Environment of Trust between the two groups would become established and the open annotations, made through the feedback interaction, would be visible to all. The annotations could then further provide evidence, through social presence (Riedl 2001), of other users in the system.

This design consideration was met by both of the research systems implementing direct and indirect feedback loops. A user had two direct and two indirect mechanisms for providing feedback. The first direct mechanism was to rate the quality of a page of information across an eight point scale (see figure 4.1). The second direct mechanism was the opportunity to provide an annotation detailing the context within which the information was found to be of value (see section 4.6.3). Of the two indirect methods, the first was the capture of keywords used when an information-seeker was using the search engine (see section 6.7.2) and the second was the 'returned and followed' activity around the links provided by the research systems in reply to a search request (see section 6.6.1).

The feedback outputs provided system designers with an indication of the value that the information had to the user audience. They provided information-seekers with an alternative navigational route to information. They promoted the recognition that one of the host intranets had the wrong focus for its intended audience and that another intranet (not part of this study) was failing to provide the information that was required (see section 6.7.2). Finally, they provided an

opportunity for the system designers to observe information-seeking behaviour and language within an information store and modify navigation mechanism and content to meet the needs of the information-seeking audience.

6.10.5 Alternative Routes to Information

The importance of alternative routes to information was identified in the electronic world when reviewing the functionality of search engines (see section 2.3). The importance was reinforced following the physical world observational study, which identified that when humans seek information from each other they use a variety of (human) routes to the same information (see section 3.8.2). Within the Research Pilot and the Collaborative Index there is considerable evidence that demonstrates that this design consideration has been met.

The construction of alternative navigational routes to information provided the information-seeker with the opportunity to link information within an existing information store without the need to modify the core information. They could do this through the use of annotations that were then used by others as a form of alternative navigation. This mechanism of annotation, followed by the creation of an alternative navigation route, was shown to be successful (see section 6.7.1) and provided a faster (see section 6.8.1) and preferred access route to information (see table 6.5).

6.10.6 Local Language Information Seeking

The design consideration of Local Language Information Seeking was closely connected to the consideration of Alternative Routes to Information. The aim of the design consideration was to provide information-seekers with the opportunity to seek information using their own language and context rather than that of the system designer. This seeking method had been observed in the observational study of human's information-seeking and had demonstrated that it was quicker

than other forms of retrieval (see section 3.8.3) and was a preferred method of information retrieval (see section 3.8.4).

Within the Research Pilot and the Collaborative Index, the functionality to add annotations on the context of information was provided and these annotations were then made available through the search engine. Subsequent information-seekers could review the annotations and match their own seeking needs to the context of similar seeking successes using their preferred local language.

The metrics gathered indicated that this approach promoted a preferred access route to information and the usage activity around local language alignment highlighted to the system designers which language(s) were being used to seek in the information-stores.

6.11 Conclusions

This chapter has detailed the results and reviewed the outcomes of the implementation of the Collaborative Index. In doing this, it has described the actions taken to carry out the recommendations of the Research Pilot and, where possible, contrasted the results of the Research Pilot with those of the Collaborative Index.

It has been shown that the predicted results of Local Language Alignment and Alternative Navigation have been observed as a product of facilitating the identified actions of Rating on Quality and Annotating on Context. These observations were identified as a result of implementing both specific activity and wider information store metric gathering. Both the Collaborative Index and the metric-gathering processes were controlled and supported through an identified methodology.

It has also been observed that the design considerations, which were identified from the electronic world research and the physical world observational study, have been well realised by the Collaborative Index. It is believed that this

observation suggests that the facilitation of the Identified Actions and the metric capturing carried out to measure the Predicted Results were a valid approach for this research.

From this, we conclude that the Collaborative Index has provided an alternative and preferred navigational route to information using the local languages of the information-seeker. This has been achieved by allowing information-seekers to use the context of a previous users' retrieval rather than the context of the information's storage. Further to this, the methodology that supports the Collaborative Index has allowed system designers to better understand the needs and behaviours of their information-seeking audience by allowing them to 'see' the behaviours and languages used within the information store. This in turn has provided the opportunity for wider improvements to the structures of information stores outside the immediate use of the Collaborative Index.

Conclusions 7

7.1 Introduction

This work has identified that information storage and retrieval are important on many levels (see section 1.1). However, the mechanisms to support human-to-computer information seeking generate problems that are often not reported when humans socially interact and collaborate in the physical world (see section 2.1). This situation undermines the trend of increasing electronic information storage, and potentially threatens the value of advances in technology. This work has aimed to identify how humans seek and share information with each other and from this create an electronic interface that combines the benefits of human-to-human behaviour with the benefits of human-to-computer information-seeking (see section 1.4).

To progress these aims, a set of objectives were proposed (see section 1.5) which led to the following activities. The first was to review the existing literature and research on electronic systems that facilitate social and collaborative human behaviour. Following this, an observational study of humans seeking and sharing information was conducted. From the combination of the findings of the review and the observational study, a set of design considerations was proposed to inform the design of a new electronic interface to information. Finally, two electronic interfaces were created and, through metric capture and analysis, the value of the interface design was considered. This chapter reviews each of the previous chapters and is structured to reflect the aims, objectives and activities described. Section 7.2 provides a review of each chapter and section 7.3 details the research contributions and the areas they effect. Section 7.4 reviews the

limitations of this research and, finally, section 7.5 concludes this dissertation by outlining future research opportunities arising from this work.

7.2 Research Review

Chapter 1 identified that information storage and retrieval are important and not new phenomena. However, when using electronic information systems information-seekers often report feelings of being lost and overloaded (Toffler 1971, Wexelblat 1999). These feelings were suspected to be the result of the mechanisms used for accessing stored information. It was argued that humans access many sources of information and that asking others for information is often a preferred mechanism (Tichy and Fombrun 1979). This research termed the use of other people as 'seeking in the physical world', as opposed to the 'electronic world of information'. It was suggested that information-seeking may be improved if the mechanisms provided in the electronic world were more closely aligned with physical world behaviours.

Chapter 2 investigated existing electronic world research that had taken steps to align physical world behaviours and electronic world mechanisms; these included: Adaptive Navigation; Collaborative Filtering; Recommender Systems; Social Navigation; and Online Community Building. From within these areas four design considerations were identified that could be used to inform the creation of a new interface to information (see section 2.6.5). During the investigation, it was found that there was little empirical evidence on how information-seeking took place in the physical world (Reddy and Dourish 2002) and so an observational field study was recommended to supplement the four electronic world design considerations.

Chapter 3 described the creation of an observational study and reported on its findings. Existing research had found that across separate organisations specific task roles shared common information-seeking activities (Poltrock *et al.* 2003).

As such, it was thought that if generic information-seeking behaviours could be found across task role groups within a single organisation, then these behaviours could be used as physical world design considerations. The observation study identified that one generic behaviour across task role groups was the use of two 'subject specialists' when information-seeking. These specialists were separated by the use of their language when resolving information-seeking requests. Both specialists would provide the same information, but they provided alternative routes to the information and the ability for the information-seeker to seek in a local language, which was suggested to be a second generic behaviour. These generic behaviours were identified as two design considerations from the physical world (see section 3.9.1), these could be used to supplement the four from the electronic world identified in chapter 2.

Chapter 4 described the creation, implementation and review of an electronic information-seeking interface called the Research Pilot. The Research Pilot design was created by combining the design considerations found in chapters 2 and 3. From the combined design considerations specific actions and predicted results were identified. The Research Pilot was created to facilitate the specific actions and provide metrics, for later analysis, to identify if the predicted results had occurred (see section 4.3). In addition to the creation of an electronic interface, chapter 4 described an emerging methodology to support the Research Pilot and provide a framework to ensure uniformity of process during the research period. The Research Pilot provided the functionality to accept user annotation on context and quality and allow alternative navigation to information in a local language using the previous good experiences of other information-seekers. It was found that the Research Pilot interface had provided a preferred route to information and that the methodology used to support the Research Pilot had been an important part of the process. It was recommended that a longer period of uninterrupted research would be beneficial to this research (see section 4.9) to build on the findings of the Research Pilot.

Chapter 5 described the implementation and review of the Collaborative Index across a three month research period. The Collaborative Index was described as being created by enhancing the Research Pilot interface with the recommendations made from the results of the Research Pilot study. The chapter also described the enhancement and formalisation of the methodology through the recommendations of the Research Pilot (see section 5.2.6). In addition to the conventional web site navigation mechanisms, the Collaborative Index, like the Research Pilot, allowed a local language annotation search on the context of previous users' good experiences, placing the control of this navigational route in the hands of the information-seekers.

Chapter 6 reviewed the results of the Collaborative Index research period and detailed the local and wider impacts of its use. Additionally, the Collaborative Index and the Research Pilot outcomes were contrasted to understand the consequences of the changes made while developing the Collaborative Index. The overall results indicated that the Collaborative Index had allowed information-seekers to spend less time searching for information and promoted sustained activity throughout the research period. It was found that the methodology provided an important behavioural reference for all those involved (see section 6.9.1) and helped govern decisions on annotation modification, keyword review, rating, voting review, and content changes, as well as acting as an educational process for all those involved. It was found that while the Collaborative Index, as an interface, had provided a 'door' for a user to 'enter into the machine', the methodology had provided a 'door' for system designers.

The collective research contributions, made as a result of this research, will be distilled and described in detail in section 7.3.

7.3 Research Contributions

This research has designed and produced an interface and supporting methodology which has generated alternative and user-preferred routes to information. This has been possible through the combination of an understanding of human information-seeking behaviours and their integration into the design of an electronic system that facilitates those behaviours. The different research contributions, arising from the work, will now be described together with an indication of the areas and groups the contribution is likely to affect.

7.3.1 Identification of Generic Information-seeking Behaviours

The review of existing research in chapter 2 has already identified that specific task groups (e.g., Design Team Member) share specific information-seeking behaviours even though they are in separate organisations and working on different products (Poltrock *et al.* 2003). The observational study from this research, described in chapter 3, uniquely identified that there are also generic information-seeking behaviours demonstrated across varied task groups. This work has found that each task group has more than one subject specialist and that the separation of these specialists can be identified through the use of language and the audience that they service. For example, a specialist who answers enquiries from immediate colleagues in a local language, using the established jargon and locally-understood premise for query resolution, has been defined as an internal subject specialist who can resolve a local enquiry quickly. An external subject specialist, who would deal with enquires in a non-local language and require extensive enquiry reformulation to establish a premise, has been shown to take much longer to resolve an enquiry. From the findings of this work, it has been established that the use of a local language is the preferred mechanism for information-seeking and that there are generic behaviours across task groups within a single organisation as well as across organisations within a single task group, furthering the work of Poltrock *et al.* (2003).

These findings have been used to inform the design of two original research systems and, in both cases, the facilitated mechanism for retrieval, indicated by the findings, was used in preference to conventional content searches. Additionally, the findings have been explained to the people within the task groups and they have confirmed that the observations are representative of their information-seeking behaviours even though, in some cases, they were unaware of their own behaviours.

7.3.2 Information-seeking Interface with Generic Reuse Possibilities

Two electronic interfaces to information have been created for this research (see chapters 4 and 5). The Research Pilot trialled the new functionality and defined which metrics to gather. The Collaborative Index reused the Research Pilot interface functionality, enhanced and widened the metric gathering and defined a formal methodology for analysis of collected data and subsequent system change.

This research has identified functionality that allows users to seek electronic information using behaviours employed in human-to-human interaction. It has demonstrated the value of combining, rather than replacing, human behaviour with the capabilities of a modern search engine. The identification, and implementation, of this functionality, has provided a unique information-seeking interface. In addition to this, the interface has not been created with the focus of one specific content category, such as information on citations (Giles *et al.* 1998) or video cataloguing (Shardanand and Maes 1995). Due to this, unlike specialised electronic interfaces, the Collaborative Index can be used across any content category that is delivered in a web page format. This original design will allow the Collaborative Index to be used to advance internet and extranet information-seeking as well as the intranet information stores used in this research.

Finally, the Collaborative Index provided the unique functionality that facilitated the creation of a navigational route to information that was owned by the information-seekers. The navigational route was a product of their interactions 'within' the information and maintained the integrity of the source information and existing navigational structures.

7.3.3 Supporting Methodology Creation with Partial Reuse Possibilities

This research has defined and demonstrated a formal methodology to support the Collaborative Index (see section 5.2.6). As a result of using the methodology, the users of an information store have been provided with information that meets their seeking needs. In addition to this, the nature of the target information stores and the behaviours of information-seekers within those stores have been better understood by the system designers and information managers. Both of these results reinforce the value of the methodology as a supportive process to the Collaborative Index.

Although within the reviewed literature there are references to the user of a system being outside the machine or information (Dourish 1999), none were found that suggested that the system designers were also outside. However, the methodology identified that the system designers were as equally outside the information, once it was created, as were the information-seekers. Benyon (1998) pointed out that history was littered with examples of systems built from the perspective of the designer and expected to work from the perspective of the user. The methodology provided the system designers with a 'door' back into the information and generated an alternative perspective. The cycles of review, enforced by the methodology, educated system designers and raised their understanding of the behaviours of information-seekers and their local languages; it allowed them to see the users' interactions with the information and informed them of the shortcomings in their own information architecture. In one case, this unique insight provided by the methodology demonstrated that the focus of one

information store was not aligned with the seeking needs of its user audience and another information store (outside the research area) was also failing to provide appropriate information.

The methodology was created to support the Collaborative Index and was not created to be a generic methodology for other web-based information systems. However, the identification of 'local language' from the observation study (see section 3.9) suggests that any web information system could benefit from the methodology review cycles providing that the system captured metrics on user searching activities. While it is recognised that without the Collaborative Index interface no mechanism for collection of annotations would exist, if the system could capture search keyword activities and enforce content reviews then it could still be used as indirect feedback for the system designers' education.

7.3.4 The Scope of the Research Contributions

Different groups have benefited from this research, from the 'grass roots' information-seekers up to the overarching organisation, and this scope of impact demonstrates the breadth of contributions produced from this research.

The information-seeker has been shown to benefit from the contributions of this research through the evidence that a preferred route for accessing information became apparent. The result of this was that the information-seeker spent less time seeking information. In addition to this, the information-seeker was provided with mechanisms for giving direct and indirect feedback to the system designers and to other users. Within the feedback, they could voice their opinion of what was good and bad. Information-seekers could see their input into the information store becoming part of a navigational route that they owned and could also benefit from the experiences of other information-seekers.

For system designers, there were also benefits provided through the contributions of this research. System designers could receive indirect feedback from the

capture of search keywords and direct feedback from the annotation on rating. This provided them with an information-seeker's view of the information store and the established navigational hierarchies. It also provided them with a unique insight into the seeking behaviours and the languages that information-seekers were using. These factors were educational to the system designers and allowed them to use the knowledge gained to address design issues outside the immediate areas of the Collaborative Index. The Collaborative Index provided 'real' Frequently Asked Questions, which could result in the removal of the conventional FAQ (see section 4.5) from a web site and also provide a collection of words and phrases that could be included into an established search synonym process or thesaurus.

For information managers, this research has also provided valuable contributions. It was found, through the use of the Collaborative Index, that in one case an information store had the wrong focus for its immediate audience and another information-store (outside the scope of the Collaborative Index) was failing to provide the information required resulting in the first information store being used incorrectly. At the level of corporate communications, it was found that corporate messages were either not being received by the intended audience or were being ignored. In either case the outputs of the Collaborative Index was providing a mechanism to identify the impact of issued messages.

For the wider internal organisation, the Collaborative Index indicates changes in language within the organisation. It further offers the opportunity to consider the relevance to the organisation of the most frequently followed links and indicates trends in current 'hot topics' within the corporate consciousness.

Finally, although this research used information stores that were internal to an organisation, it may be that if the information stores were outward facing, then the contribution of the methodology would provide an insight into the marketing

effectiveness of the organisation and assist the organisation in aligning its own language with that of its customers.

7.4 Research Limitations

It is common for research studies to be limited or constrained in some manner and, despite its unique contributions; the Collaborative Index is no exception. This section describes the limitations and constraints within this research.

7.4.1 Post-Research Interviews

It is believed that the most significant limitation with the Research Pilot and the Collaborative Index was the lack of opportunity for post-research interviews. The target information stores used in the Research Pilot and the Collaborative Index were fully functional business production environments and the opportunity to use these environments did come with some constraints. Both environments enforced anonymous access and this meant that identifying individuals who used the information stores was not possible or permissible.

An aim of this work was to provide a mechanism to allow users to benefit from the good experiences of other users within an anonymous environment and, as such, the choice of information store was appropriate. An anonymous environment for the research was important because across the Internet and other large generic information stores anonymity is often maintained. As a result of anonymity, users cannot use the positive transference of real world human respect to identify whose annotations to 'trust'. It was hoped that the use of the similarity of local languages, when reviewing others annotations, would provide an alternative guide for whom to trust based on the finding that in the absence of all other information humans make decisions based on similarity (Medin *et al.* 1993). The annotations were trusted and we can say that this trust was definitely not a result of the transference of physical world human respect. This statement

could not have been made, with any certainty, within a non-anonymous environment. So, while the enforced anonymity was essential for the Research Pilot and the Collaborative Index, it is believed that further research contributions may have been achievable if the environment had remained anonymous but information-seekers were given the opportunity to volunteer for post-research interviews.

Overall, we believe the unique opportunity to use an organisation's production intranet for three months, maintain research controls over all aspects of structural and content change, and the appropriateness of the information store for the aims of this research have outweighed this research limitation.

7.4.2 Methodology Commitment

The Collaborative Index as a technology and methodology can provide generic reusability. However, it is acknowledged that the demonstrated benefits of this research must be balanced against the commitment of the individuals in charge of the review cycle of the methodology. We do not know if the observed commitment is representative of other organisation's commitment and without the application of the methodology we believe that the worth of the Collaborative Index could be reduced.

Weekly commitment to annotation and search keyword reviews was time-consuming and, as such, could generate a tangible financial cost within most organisations. There may, therefore, be a need to identify a tangible benefit for the Collaborative Index to allow ongoing review cycles to take place. For example, the identified reduction in session time may be translatable into hard financial costs. In any case, the commitment of human-resource to the methodology should not be overlooked.

Within this research, commitment to the methodology was present and so we do not believe that this research has been affected by this research limitation but in some situations commitment may be a future research limitation.

7.4.3 Failure to Annotate

The process of capturing the annotations of users was successful, but 67% of users who voted high enough to have the opportunity to add their annotations chose not to (see section 6.4.3). However, even though the number of annotations made was relatively small (see section 6.7.1), this research has shown that they satisfied a high percentage of searching needs. Therefore, while this failure to annotate is seen as a research limitation, it is not seen as a significant limitation to the success of the Collaborative Index or the outcomes of this research.

One other factor that could be seen as a limitation within the area of annotation failures is that the Collaborative Index provided the opportunity to rate information on an eight point scale (see figure 6.1). Only where a user gave the highest or lowest rating were they given the opportunity to annotate. It was found that the voting patterns of the information-seekers broadly fell into thirds: one third for the positive extreme; one third for the negative extreme; and one third in the middle. We believe that the experience that has been gained, through this research's use of the larger scale, suggests that a three point scale would have been acceptable. It is believed that if the scale had three points, and two of those points provided the opportunity to annotate, then it is possible that more annotations may have been added. While we have already indicated that more annotations would not necessarily mean a major improvement in the overall value of the Collaborative Index, it would at least provide more opportunities to annotate, thereby potentially providing more feedback for the methodology review cycles.

7.4.4 Future Long Term Use

The longest single sustained period of data collection for this work was three months. This period of time may be viewed as a limitation in the research as a formal production implementation of the Collaborative Index, and its methodology, might be more reasonably measured in years rather than months. The research has not therefore had the opportunity to provide information on the ongoing maintenance of the Collaborative Index and this is an area where there may be emergent issues that would have to be considered, for example the consolidation and removal of annotations. Practically, we believe that having the opportunity to carry out controlled research over an organisation's production intranet for one or two years is unlikely to be possible and is outside the scope of this research. However, if the Collaborative Index was used for an extended period of time, the supporting methodology could be extended to include formal 'housekeeping' activities within its review cycles to deal with any other limitations identified through the experience of use.

7.5 Future Research

It had been suspected that human-to-human information-seeking behaviours in the physical world may have been a community activity. As this research aimed to move human-to-human behaviours into an electronic interface, the creation of online communities was investigated. It was found that online communities are reliant on the identification of individuals. This need not be a physical world identity, but could be replaced with a pseudonym. In either case, an identity is established. It had been reported that without the ability to identify someone, it was not possible to know how they had behaved in the past (Kollock 1998); in short, it was not possible to know if that person could be trusted. Additionally, over time, the identity may establish 'respect' through acknowledgement of historic actions (Dieberger *et al.* 2000). However, within a truly anonymous environment, where identity in any form is not established, it was arguable

whether it would be possible to create trust and respect. Perhaps an anonymous environment would preclude these important human values of trust and respect, or perhaps deciding on whom or what to respect, in an anonymous community, could be established using some other factor.

For the Collaborative Index, the factor was the annotations of previous users. The decision to trust an annotation could only be made by comparing a user's information-seeking context with the annotated context of a previous user. We believe that 'trust and respect' for the annotations were generated through the similarity of our seeking contexts and comparison of shared local language. If this belief is accurate, then the use of 'similarity' may provide an alternative to physical world human respect within the context of collaborative information-seeking. We see this process as a form of 'Congruent Collaboration' and explain the phenomena as the identification of similar needs and shared experiences drawing on the fundamentals of 'similiarity' from within the psychological foundations of human respect. Within this work, these ideas have not been rigourously investigated and this presents one opportunity for further research.

Another opportunity for further research is the identification of the boundaries between socially-enhanced systems and online communities. It has already been established that online communities rely on identification (see section 2.6.3). While accepting this, we have seen that a socially-enhanced system, in the form of the Collaborative Index, provided collaborative benefits without the need for identity. Therefore, this suggests that socially-enhanced systems are fundamentally different from online communities. This appears to be a research opportunity to understand why Social Navigation does not rely on this fundamental community factor. In addition to this there are related research opportunities to identify what other factors are part of the division between community and socially-enhanced systems and what effects the division has on the information-seeker.

Finally, there could be unlimited permutations of further research opportunities for the Collaborative Index and the supporting methodology. Each of the research limitations could offer further opportunities to supplement the finding of this work and the use an outward facing information store could provide an opportunity to understand the impacts on a global audience. Within an organisation the outputs from the Collaborative index could produce a 'cottage industry' of analysis roles, with the aims of understanding the information-seeker, the stored information and bringing the two together to relieve the feelings, described in chapter 1, of being 'lost and overloaded'.

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Appendices

Appendix A

Observational Findings - Telephony and Reception Individual Activity (TRTG)

Appendix B

Observational Findings - Human Resources Individual Activity (HRTG)

Appendix C

Observational Findings - Information Technology Individual Activity (ITTG)

Appendix D

Observational Findings - All Task Group Average Activity

Appendix E

Telephony and Reception Task Group - Internal and External Subject Specialist Identification

Appendix F

Human Resources Task Group - Internal and External Subject Specialist Identification

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Information Technology Task Group - Internal and External Subject Specialist Identification

Appendix H

Research Pilot - Original and Modified Annotations

Appendix I

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Research Pilot - Annotation Returned and Followed Counts

Appendix K

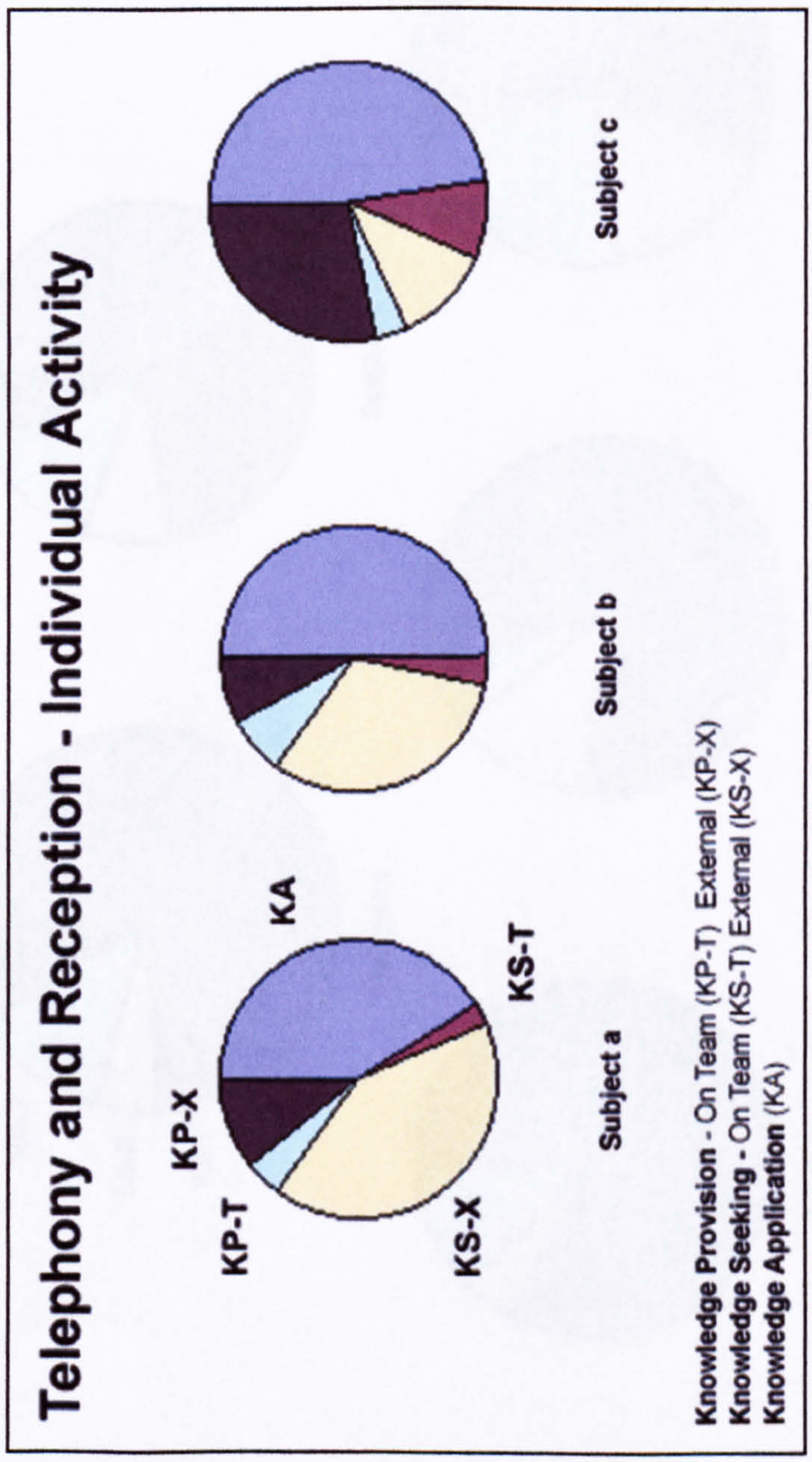
Collaborative Index - Annotation Returned and Followed Counts

Appendix L

Web Site Traffic Metrics – Before and During the Collaborative Index Research

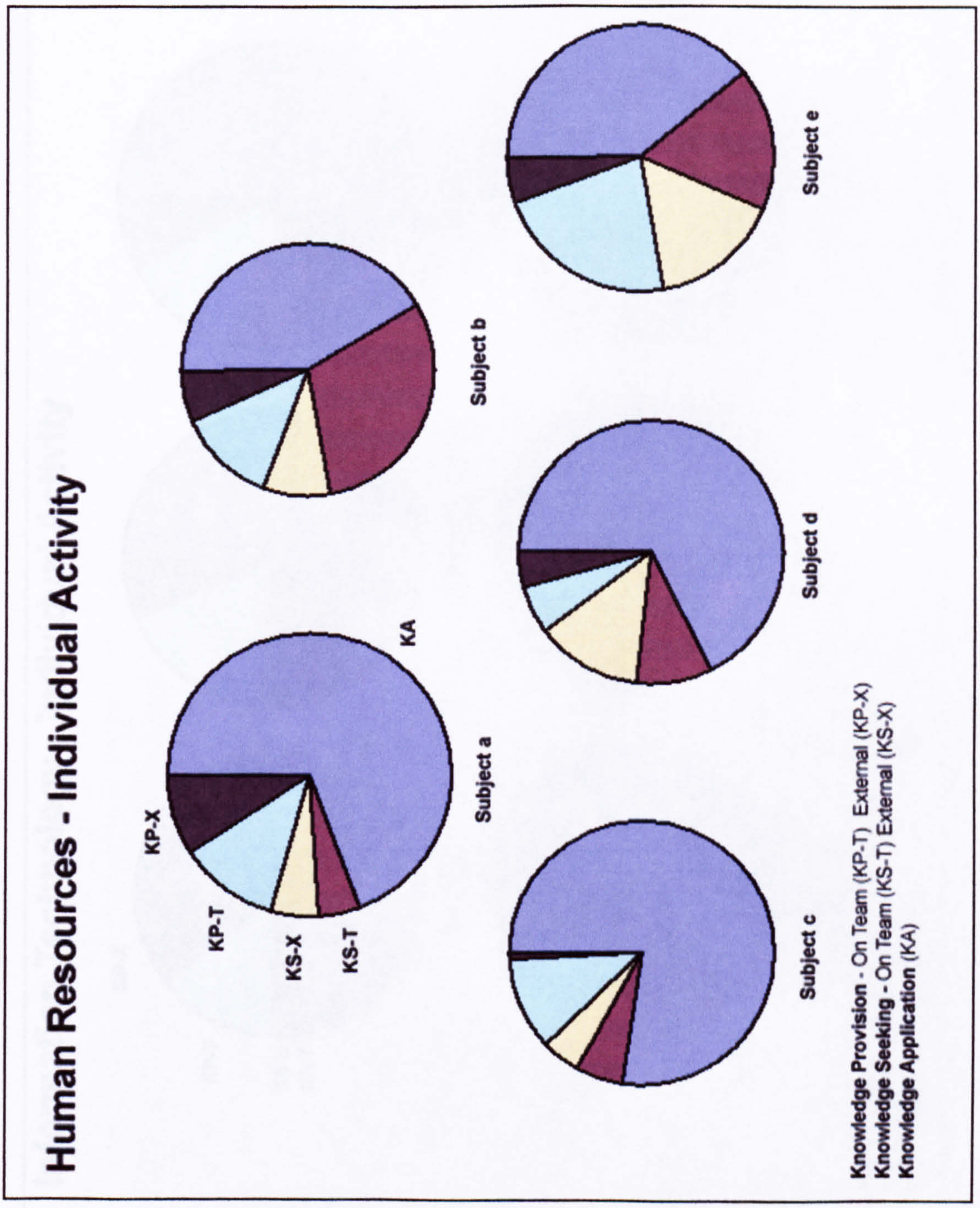
Appendix A

Observational Findings - **Telephony and Reception Individual Activity (TRTG)**



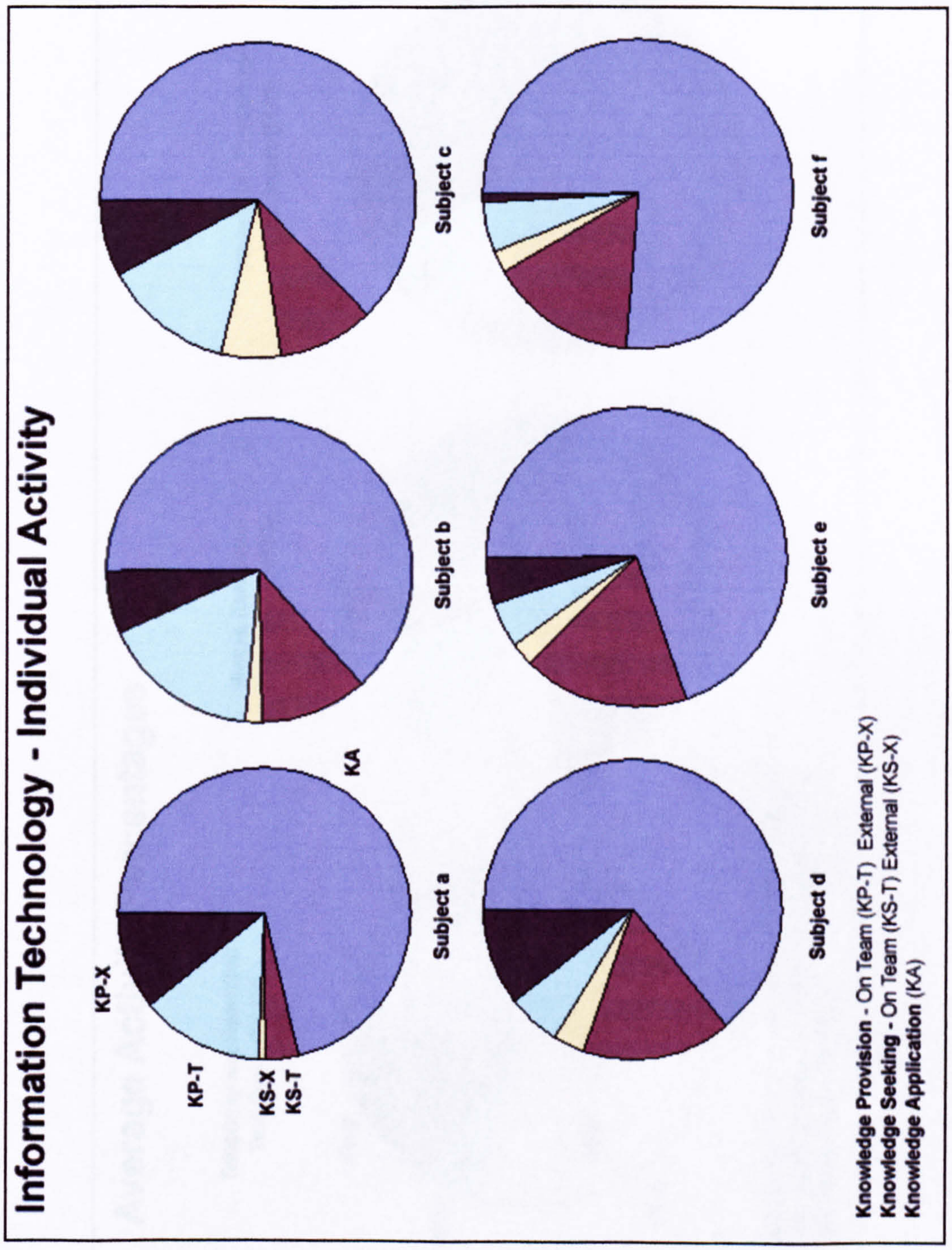
Appendix B

Observational Findings - **Human Resources Individual Activity (HRTG)**



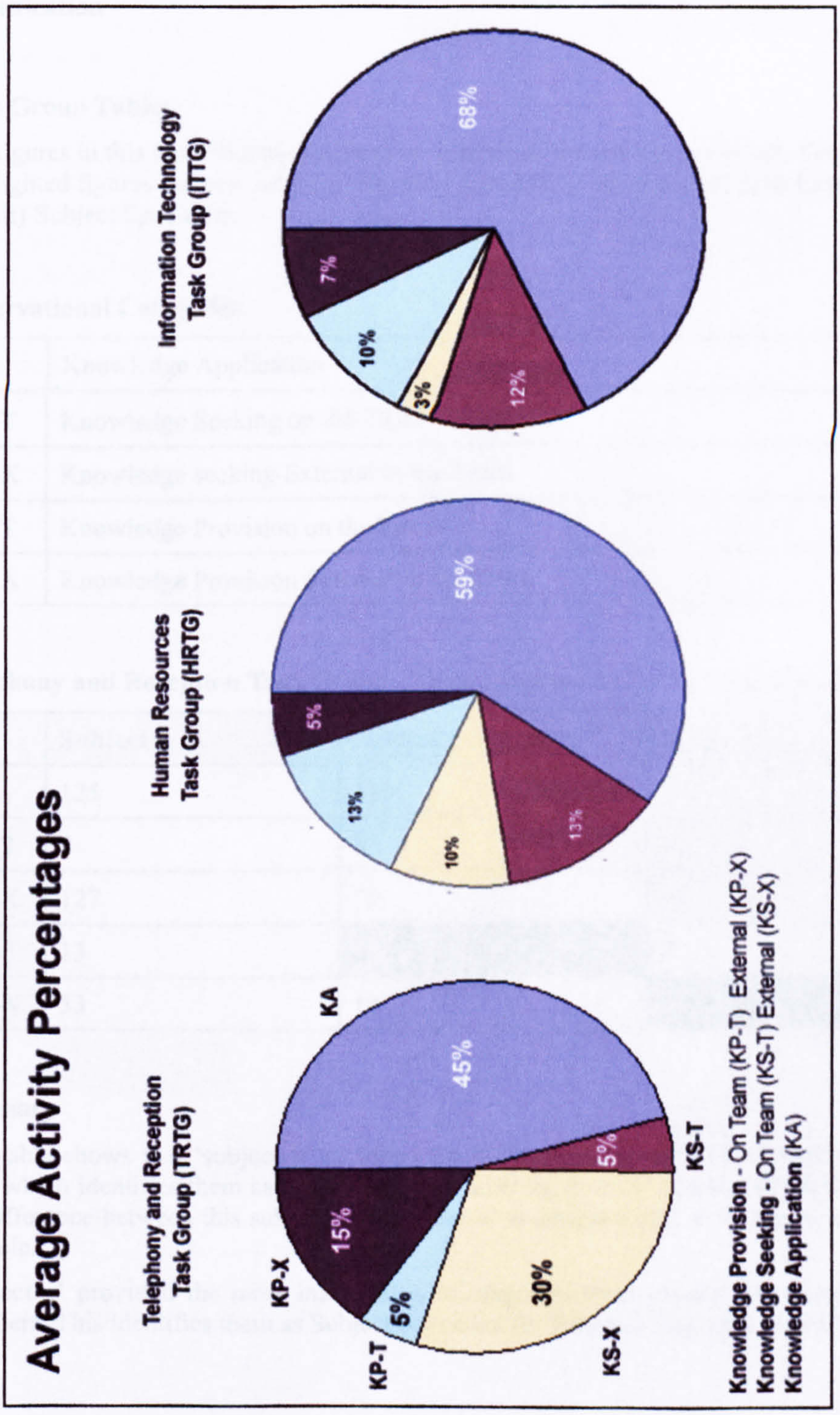
Appendix C

Observational Findings - **Information Technology Individual Activity (ITTG)**



Appendix D

Observational Findings - **All Task Group Average Activity**



Appendix E

Telephony and Reception Task Group (TRTG) - **Internal and External Subject Specialist Identification**

Task Group Tables

The figures in this table illustrate a count of minutes of the activity indicated. The inverse highlighted figures indicate subjects who were found to be Internal (SSIE) or External (SSEE) Subject Specialists.

Observational Categories

KA	Knowledge Application
KS-T	Knowledge Seeking on the Team
KS-X	Knowledge seeking External to the Team
KP-T	Knowledge Provision on the Team
KP-X	Knowledge Provision External to the Team

Telephony and Reception Task Group: Three subjects sampled over eight hours.

	Subject a	**Subject b**	**Subject c**
KA	125	110	110
KS-T	8	8	21
KS-X	127	70	21
KP-T	13	15	8
KP-X	33	18	66

Summary

This table shows that 'subject b' provided the most information to other members of this team which identifies them as the Subject Specialist for Internal Enquiries (SSIE), however the difference between this subject and 'subject a' is marginal and so is a weak example of this role.

'Subject c' provided the most information to enquiries from people who were not team members. This identifies them as Subject Specialist for External Enquiries (SSEE).

Appendix F

Human Resource Task Group (HRTG) - **Internal and External Subject Specialist Identification**

Task Group Tables

The figures in this table illustrate a count of minutes of the activity indicated. The inverse highlighted figures indicate subjects who were found to be Internal (SSIE) or External (SSEE) Subject Specialists.

Observational Categories

KA	Knowledge Application
KS-T	Knowledge Seeking on the Team
KS-X	Knowledge seeking External to the Team
KP-T	Knowledge Provision on the Team
KP-X	Knowledge Provision External to the Team

Human Resource Task Group (HRTG): Three subjects sampled over eight hours.

	Subject a	**Subject b**	**Subject c**	**Subject d**	**Subject e**
KA	288	152	345	275	163
KS-T	20	113	26	37	72
KS-X	23	31	22	53	68
KP-T	48	47	50	24	93
KP-X	38	25	4	18	23

Summary

This table shows that 'subject e' provided the most information to other members of this team which identifies them as the Subject Specialist for Internal Enquiries (SSIE). 'Subject a' provided the most information to enquiries from people who were not team members and this identifies them as Subject Specialist for External Enquiries (SSEE).

Appendix G

Information Technology Task Group (ITTG) - **Internal and External Subject Specialist Identification**

Task Group Tables

The figures in this table illustrate a count of minutes of the activity indicated. The inverse highlighted figures indicate subjects who were found to be Internal (SSIE) or External (SSEE) Subject Specialists.

Observational Categories

KA	Knowledge Application
KS-T	Knowledge Seeking on the Team
KS-X	Knowledge seeking External to the Team
KP-T	Knowledge Provision on the Team
KP-X	Knowledge Provision External to the Team

Information Technology Task Group (ITTG): Three subjects sampled over 12 hours.

	Subject a	**Subject b**	**Subject c**	**Subject d**	**Subject e**	**Subject f**
KA	461	357	368	354	354	408
KS-T	24	64	57	88	92	83
KS-X	5	11	36	19	12	12
KP-T	88	96	81	32	26	28
KP-X	71	38	45	58	25	5

Summary

This table shows that 'subject b' provided the most information to other members of this team which identifies them as the Subject Specialist for Internal Enquiries (SSIE). Subject a provided the most information to enquiries from people who were not team members and this identifies them as Subject Specialist for External Enquiries (SSEE).

Appendix H

Research Pilot – **Original and Modified Annotations**

Original Annotation	**Modified Annotation**
What number to contact for HR help.	HR help telephone number
when we get paid next	When do we get paid next ?
How to delegate authority on SSS	How do you delegate authority on SSS ?
Found SSS	SSS information
how do I take on a new person	How do I take on a new person ?
what do the FSA say about professional requirements	FSA and professional requirements
I wanted to know what the managers forum was for	What is the Managers Forum?
whos my contact (aldgate) for leader ship and development	Leadership and Development contacts (Aldgate)
What do I do abput getting my eyes tested	What do I do about getting my eyes tested?
I use a vdu and need glasses what do I do	Use a VDU and need glasses?
Are there any forms for use in an interview	Details on forms used in interviews?
Answered my query directly	{could not be used}
Simple and clear with all appropriate onward links.	{could not be used}
how do I order nice one cards?	Ordering Nice One cards
On my floor there is no one to do first aid and I wanted to know what I could about that or if training was needed, one woman is trained already and I wanted to know if more than one person could be a responsabile for the floor this page had most of what I wanted	First aid training: who is responsible?

Original Annotation	Modified Annotation
It told me what qualifications were needed to become geta place on the graduate programme	Qualifications needed for graduate programme
Information on Child care Leave	Child care leave
How do I find out what the FSA Approved person standard is	FSA Approved Person standard
How do you get Free glasses	Free glasses ? Eye test vouchers
Management forum details (not in search me)	What is the Managers Forum?
I was searching for Source Self Service, and found the link I was looking for.	The Source Self Service (SSS) system
I didn't know there was more than one recognition shop	Which is my Recognition Shop?
looking for bonus details found them in here	Details on company bonus scheme
One of my team phoned in sick so what should I do, this page helped	Team member phoned in sick - what next?
Info on our company cars very good	Company car information
who's responsible for looking after the health and safety of non axa employees when they visit us	Health and Safety of non AXA employees during a visit
I was loking for what to do if someone hurts themselves in the office	What to do if someone hurts themselves in the office
It helps the user to understand which courses are available	Course information
its a success as its a quick and easy way to access much needed features	{could not be used}
gets me to the recognition shop - although the link name is not totally clear	The Recognition Shop
A man on my team is coming to the end of his service - clear instructions here	End of service for a team member

Original Annotation	Modified Annotation
I don't understand why this page is headlined "Reward" when it's actually about Remuneration. However the info on the page is very comprehensive.	Remuneration and Reward
I found the Compass site using the link at the bottom of the page.	Compass information
I wanted information on studying outside AXA	Studying outside AXA

Appendix I

Collaborative Index – **Original and Modified Annotations**

Original Annotation	**Modified Annotation**
Who are the servcie managers and when are they on call	Service Managers on call rota
To have look at the Holiday chart to see what desks were free for Hot desking. This page is also usful for the Floor plan to Mod 6 Level 1 and frequesntly used forms	Life Holiday chart (Good for Hot Desking)
generated >	Life Floor Plan Mod 6 Level 1
What was the sap project	The SAP Project
Who is director for health	Who is the Director for Health ?
Looking for latest project status	Enabling Functions - The Latest Project Status
When is the AXA PPP Crest mainframe system due to be back up	{temporary so not used}
I need to find out new GL account codes and vendor numbers and this page gave me everything I needed	GL Account Codes and Vendor Numbers
Looking for IT Monthly Scorecard information	IT Monthly Scorecard
I wanted information on how to get a mobile phone	How to get a mobile Phone
What types of files should be stored. How long they are to be stored. Tip to saving outlook space	XP - What types of files should be stored ?
generated >	XP - How long should files be stored ?
generated >	Outlook - Saving space
Opearting ratios for PPP	Health - Operating Ratios
Whatis the maturity model	What is the Maturity Model ?

Original Annotation	Modified Annotation
IT Common Project Life Cycle	IT Common Project Life Cycle
IT Programme and Project Management	IT Project Management
generated >	IT Programme Management
Car Hire Booking Request	Car Hire Booking Request
UK IT - Pension Information	UK IT - Pension Information
Who are the TC's in Lytham?	Lytham - TC Technical Consultants
Looking for standard user profiles	Standard User Profiles
I was after TQ3 Info on travel	TQ3 Travel Information
What are the official stages of a project	The Official Project Stages
Information Security information and policies for AXA	Information Security Policies
ISO 17799	What is ISO 17799 ?
Jobs Careers and International Mobility	Jobs Careers and International Mobility
Work Request Management	Work Request Management
I was looking for info on stages and gates	Project Stages and Gates
How to get a UNIX and Oracle Account created	UNIX and Oracle Accounts
How should we Capacity plan	Capacity plans and planning
Previous "not at all" vote was a mistake - sorry	{not used}
I was looking for EUC applications.	EUC - End User Applications
I wanted to know how to purchase products and services from a third party	How to purchase products from a third party
generated >	How to purchase services from a third party
I thought they were called Help Desk not Service Desk and this page had the details I wanted	Help Desk Information

Original Annotation	Modified Annotation
generated >	Service Desk Information
How do you get glasses or your eyes tested, this page had the form I wanted.	Eye Test Form and Glasses for VDU users
STandards and Policies	Architecture Standards and Policies
Giving me the new cost centres and nominal cost codes for expenses use.	Expenses Cost Centres and Nominal Codes
information on getting your password reset	Password Resets
What was the system uptime like last month	System Uptime
Whats the policy for company telephones	Company Telephone Policy
Here you can find details about the warehouse and finance transformation	Finance Transformation and Warehouse
Needed to know more details on how to use some of the harder functions of Outlook	Outlook - Advance Functions
Spirit and Capscan details are here	Spirit and Capscan Information
IT helpdesk number	{not used already available}
It was brilliant. I wanted to find out about how to edit the intranet site and i managed it first time from the site.	How to edit the Intranet
I understand what the page is for but it took me a while to find the page. Anyway we can get a link to this on the front screen of our intranet?	{not used - unclear wording}
Today's problem with Outlook.	{temporary so not used}
Very clear lay out, relevant info and although not much detail, gives enough to understand what has happened, what is happening and when.	Incidents - what is happening?
Accidently clicked on Not at all hence now went for the other extreme to counter. Page very useful, found out why Outlook not working Thanks	{temporary so not used}

Original Annotation	Modified Annotation
How long it would be before we had access to outlook again? It wasn't the answer I was hoping for but appreciated regular updates.	Regular System Status Updates
What is the current system status and when will it be fixed?	{covered in the question above}
My Job is not possible without the data provided for P2P3 on this page.	P2 P3 Reports - Weekly P2 P3 P5 Reports
structure of team	Sarbanes Oxley Team Structure
I FIND IT VERY HELPFULL INDEED, IT SAVES ME TIME AND SEEMS TO BE VERY UP TO DATE	{not a question so not used}

Appendix J

Research Pilot – **Annotation Returned and Followed Counts**

Annotation Id	Returned	Followed
rps1	6	1
rps2	11	11
rps3	6	4
rps4	6	2
rps5	2	0
rps6	4	1
rps7	2	0
rps8	1	1
rps9	14	12
rps10	5	2
rps11	0	0
rps12	0	0
rps13	1	1
rps14	2	0
rps15	2	1
rps16	1	0
rps17	4	0
rps18	5	4
rps19	6	1
rps20	1	0
rps21	8	5
rps22	2	0
rps23	1	1
rps24	0	0
rps25	0	0
rps26	0	0
rps27	1	1
rps28	2	1
rps29	0	0
rps30	18	10
rps31	2	0
Totals [1]	113	59

Appendix J (Continued)

Notes

[1] The total number of annotations listed differs from the number entered as, where suitable, some annotations were combined and some were not used. Additionally some annotations generated more than one Collaborative Index entry and in these cases the total counts have been combined under the original annotation.

Appendix K

Collaborative Index – **Annotation Returned and Followed Counts**

Annotation Id	Returned	Followed	External Link [2]
tci1115628175914	4	5	Yes
tci1115634587614	24	23	
tci1115803305276	19	9	
tci1115821161292	1	1	
tci1115823068360	13	1	
tci1115979385737	2	3	Yes
tci1116246150567	3	2	
tci1116323184087	9	12	Yes
tci1116326861934	25	14	
tci1116420617988	1	0	
tci1116588185700	7	5	
tci1116668219405	28	18	
tci1116668336396	35	22	
tci1116668392245	15	16	Yes
tci1116668590958	4	4	
tci1117039437101	1	2	Yes
tci1117713738312	8	92	Yes
tci1117644286439	23	37	Yes
tci1117636676961	19	11	
tci1117813009465	4	5	Yes
tci1117813045881	0	0	
tci1117875860817	22	31	Yes
tci1117874630728	16	9	
tci1118043371154	13	5	
tci1118155042521	1	2	Yes
tci1118154966123	2	4	Yes
tci1118235670530	0	0	
tci1118402958113	2	4	Yes
tci1118417502356	0	0	
tci1118679916622	10	12	Yes
tci1118738816951	7	9	Yes
tci1118831255950	0	0	
tci1119948298181	21	29	Yes
tci1120495651875	5	6	Yes
tci1120496159372	0	0	
tci1120496276662	11	9	
tci1120667579909	1	3	Yes
tci1120667138617	8	14	Yes

tci1120808955598	2	3	Yes
tci1121077635945	1	3	Yes
tci1121329707392	0	0	
tci1121333758176	0	0	
tci1121328589685	7	8	Yes
Totals [1]	374	433	

Notes

[1] The total number of annotations listed differs from the number entered as, where suitable, some annotations were combined and some were not used. Additionally some annotations generated more than one Collaborative Index entry and in these cases the total counts have been combined under the original annotation.

[2] Some annotations were followed more times than they where returned by the search engine. This was a result of users saving the annotation links as favourites or passing then to other colleagues.

Appendix L

Web Site Traffic Metrics – **Before and During the Collaborative Index Research**

Week	Pages Displayed		Visit Duration (minutes)			Page views per visit					Average Visit Duration (seconds)
	Day	Week	upto 1	1 to 2	2 to 3	1	2	3	4	5	
200502 - 3	878	6340	1351	372	247	94	235	151	76	57	581
200502 - 4	968	7746	2134	490	291	172	506	208	114	81	455
200503 - 1	798	4789	1305	353	174	95	270	146	69	54	454
200503 - 2	952	6670	1687	453	302	159	352	161	119	68	502
200503 - 3	987	6911	1586	417	293	124	303	170	95	71	572
200503 - 4	706	4948	1342	362	233	81	324	167	75	51	437
200503 - 5	676	4738	1351	394	286	91	298	168	91	38	390
200504 - 1	1314	9199	2846	661	351	262	618	318	189	101	422
200504 - 2	1005	7036	2414	506	331	213	582	250	152	72	377
200504 - 3	944	6446	2377	460	315	171	493	262	142	71	373
200504 - 4	1165	8158	2617	479	317	161	549	325	152	90	432
200505 - 1	1057	7400	2282	397	329	150	526	281	114	60	405
200505 - 2	1124	7874	2821	515	426	286	689	315	126	78	421
200505 - 3	1090	7636	2490	423	457	147	478	315	126	86	425
200505 - 4	977	6845	2509	512	316	132	453	347	149	104	354
200506 - 1	761	5333	1824	317	384	99	352	247	87	56	371
200506 - 2	1271	8900	2487	515	462	151	438	316	136	82	444
200506 - 3	1176	8237	2361	486	399	128	455	284	123	73	441
200506 - 4	1167	8172	2153	430	397	135	486	274	122	83	433
200507 - 1	1349	9447	3188	550	456	145	791	441	130	102	439
200507 - 2	1245	8719	2761	571	390	172	661	340	113	81	413
200507 - 3	1404	9830	3261	511	450	184	685	408	161	87	343
200507 - 4	1464	10253	3398	543	417	172	757	433	177	98	312
200507 - 5	1374	8249	2929	577	343	165	693	425	157	94	344

Average Session Duration Before Collaborative Index	450 seconds
Average Session Duration During Collaborative Index	395 seconds
Total Visits Before Collaborative Index	15,644
Total Visits During Collaborative Index	21,135