An Ethnographic Study of Technical Support Workers: Why We Didn't Build a Tech Support Digital Library

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ABSTRACT

In this paper we describe the results of an ethnographic study of the information behaviourss of university technical support workers and their information needs. The study looked at how the group identified, located and used information from a variety of sources to solve problems arising in the course of their work. The results of the investigation are discussed in the context of the feasibility of developing a potential information base that could be used by all members of the group. Whilst a number of their requirements would easily be fulfilled by the use of a digital library, other requirements would not. The paper illustrates the limitations of a digital library with respect to the information behaviourss of this group of subjects and focuses on why a digital library would not appear to be the ideal support tool for their work**.**

Categories and Subject Descriptors

H.3.7 Digital Libraries: User issues; D.2.1 Requirements/Specifications: Elicitation methods

General Terms

Design, Human Factors

Keywords

Ethnography, user studies, requirements analysis

1. INTRODUCTION

There have been many studies in information science looking at the nature and frequency of information seeking activities by different groups. Many have focused on the differences in how people search, what they search for, and why. They have also identified how people use the information they have obtained and how the original source of this information has been used on subsequent occasions over the longer term. Today, there is a plethora of information sources available in both electronic and paper-based forms to a wide range of user groups. One of the most promising areas for developing information sources to meet the needs of a variety of user groups has been in the construction and accessibility of digital libraries.

Quantitative studies of usage patterns in existing libraries (digital or physical) have, on occasion, contained indications of a less-than-perfect fit between users and libraries; for example, Cunningham and Mahoui [6] note that only 28% of visitors to two computer science digital library make a second visit to those sites. Quantitative studies, such as transaction log analysis, typically give detailed pictures of user actions, but can give little or no insight into users' motivations and needs. For example, we know that the majority of the computer science digital libraries' users do not return to these web sites—but why not? Is it because the users' information needs were perfectly satisfied by a single visit, or because the collections' contents are inadequate, or perhaps because the user interfaces are unacceptable?

Often usability studies, whether quantitative or qualitative, are limited to evaluating the interface to an existing digital library or the ease with which a given user group can find the information in the library. Many of the studies deal with academics or other specific user groups carrying out research activities. The studies do not, however, necessarily evaluate the basic concept of a digital library as a suitable information tool in comparison to other information tools for people who provide a technical support function for those researchers, e.g. a digital library may be constructed for a group of researchers but is developed or maintained by a technical support group. In the case of computer science the researchers may use the library but the specialist computer support staff who themselves 'work' in the same area (computer science) may not actually choose to use the product.

Instead of looking at groups of potential users who have already been studied in detail we identified a specific group who have had little attention paid to their circumstances. This group appear to be a potentially rich source of data for looking at information behaviourss in terms of the types of tasks they perform, the tools they use, their knowledge base, how they interact with one another, etc. The study reported here concerns a group of consultants who provide technical support in a School consisting of computer science, mathematics and statistics departments.

The data gathered during the study was from six members of the group. As the entire technical support group comprised eight members, the number taking part in this study was, we felt, more than satisfactory to get to grips with the essential elements of its operation and behaviours with regard to information seeking and

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use. The size of a subject group is an issue in any study, but even more so when dealing with specialist groups. Such groups are, by their very nature, different to 'general' groupings. They have a more defined focus, whether that be in terms of the work they carry out, the type of people they are and so on. The size of this group and its uniqueness within the institution does not make them less worthy of investigation, indeed it makes them more attractive as a focus of study. In an institution of around seven hundred staff this support group is unique. There may be similar related groups in other institutions that collectively would form a more significant subject base to study. Whilst an increased subject base may raise some underlying level of reliability in the results, the greater influences of the environment (e.g. the nature of the institution, the country, the profile of the department being supported etc.) may negate this. In such instances, the reasons for the variation would also be of great interest and of relevance for those designing information resources such as digital libraries.

In looking at the value of digital libraries it cannot be desirable that only groups with a large membership be studied in any depth. Such a focus would surely result in an architecture that was limited by the characteristics of those groups? Specialist groups provide different challenges to the norm which may be more useful in identifying different behaviours that should be identified. Levy and Marshall [12] assert that the "highest priority of a library, digital or otherwise, is to serve the research needs of its constituents." Different users within that constituency focus on different elements of resources and those developing and supporting digital libraries may tend to "idealize users and uses, projecting or inventing an incomplete or even inaccurate picture of the real work being done." (p 80)

Their recommendation to avoid this is to adopt a work-oriented perspective and instead look at the users, the work they do and how that work is supported through the use of the technologies and documents. To achieve this they suggest the use of ethnographic techniques of observation. This is exactly what this study did and the results demonstrate how valuable such an approach is in terms of the richness of the results. Identifying differences between different user groups will, hopefully, serve to stimulate ideas about the nature of digital libraries and how they might be used.

In considering the depth and breadth of the different facets of the operation of this group we gave a great deal of thought to how we should go about identifying the information behaviourss of this group. We chose to adopt an ethnographic approach to this research.

Ethnographic methods are being used more and more by researchers and practitioners in human-computer interaction studies and in systems analysis and design in an attempt to become more aware of the work circumstances, personal and social characteristics and knowledge base of potential users of proposed systems [4]. Ethnographic techniques are also used to identify the relevance of different information systems to those people and their roles in an organization [17].

The frequently cited usability maxim of 'know thy users' is seen as a critical part of designing any information system. The ethnographic approach appears to provide an ideal opportunity for us to get to know this group in depth and to identify the various types of information behaviourss they exhibit. Technically oriented investigations of work systems are often reductionist and miss important aspects of work activities [3] [4] [18]. For instance, support staff may often continue to problem solve outside the formal workplace in the tea room, pub or via web access at home. The shortcomings of the reductionist approaches are due, in part, to the 'outsider' perspective of the researcher who, having observed the work processes, then attempts to describe them using their own models and vocabulary. The latter may have little meaning for those participating directly in the work and often focus on those aspects that are most relevant to the researcher's preferred model and solutions, for example the creation of a digital library.

The goal of this ethnographic study was firstly to discover the types of information that these technical consultants used in their work; then to understand how they individually and as a group gather and use information. Although adopting the basic principles behind ethnographic forms of investigations was seen as an interesting and potentially valuable way to look at the situation, we acknowledged at the outset that there might be limitations to the investigation, especially in how we might conduct it or draw conclusions from it. For a particularly thoughtful examination of ethnographic techniques in the context of and information science, see [4]. The aim of the study was not use the results to build an information system to support this group, but it did include some element of identifying the requirements such a system might have to meet and the constraints under which such a system might operate. In this sense, the idea of the digital library might be an option to be considered, should the study identify information behaviourss that would be supported by such a tool.

This paper is organized as follows: Section two describes the methodology used in this ethnographic study: the consulting group is described, the ethnographic techniques employed are listed, and the consultants' range of work activities are described. We then briefly discuss Greenstone, the digital library construction software developed by the New Zealand Digital Library Research Group (http://www.nzdl.org). Greenstone shares many characteristics of other examples of the current crop of digital library architectures; its assumptions about collection design, user interface, and user characteristics are discussed in Section 3. Section 4 then examines the information behaviours observed in the ethnographic study; as indicated by the title of this paper, the information gathering and usage behaviourss of the consulting group were not well-suited to support through a Greenstone-like digital library. Section 5 presents our conclusions.

2. Methodology

The authors conducted an ethnographic study of six members of a technical support group (TSG) serving the School of Computing, Mathematics, and Statistics at the University of Waikato.

To those whose expertise is in quantitative empirical methods, six participants may appear rather few but the aim of naturalistic ethnographic techniques is to discover a rich picture by developing an 'appreciative stance' via the researcher's involvement in the setting. The number of participants is therefore not as important as depth of the enquiry.

The difficulties of interdisciplinary working between ethnographers and computer scientists, in terms of language and natural attitude, have been summarized by Crabtree *et al.,* [4]. The approach in this study has been to allow the researcher to view technical knowledge as a socially distributed resource that is often stored primarily through an oral culture [7]. The technical consultants' war stories therefore become texts for both the ethnographer and the

consultants themselves. Thus, data gathering techniques included: semi-structured interviews of participants; 'shadowing' participants as they worked; observation of semi-social discussions in the School tearoom; and examination of various work artifacts (email, bookmarks, webpages, office bulletin boards, etc.).

The data gathering phase of this study ran from May – August 1999.

2.1 Participant Demographics and Description of Consultant Activities

There were six participants in the study. All were male, ranging in age from the mid-twenties to mid-thirties. All have formal tertiary qualifications. Four of the six have bachelor's degrees in computing, and two have Ph.Ds in physics. The group support a range of users of computer systems within the School such as, lecturing staff, administrative and research staff, and university students at undergraduate and postgraduate level. Some members of the group were students at the University, but all have been students, and have worked closely with academic staff both as students and currently as technical support consultants. The group is, therefore, seen as having a special position as a technical support group in the School as well as individually being seen as colleagues by a large number of the staff.

Two members of the group have special roles: the group leader, who holds a managerial position and also provides Unix support; and the undergraduate lab support consultant, who provides primary maintenance for the printers, hardware, and software in the large teaching labs. In terms of physical proximity, the undergraduate lab support consultant has his office in a separate building from the other five consultants, who have offices adjacent to each other in the ground floor of the School of Computing, Mathematics, and Statistics. The separation of the group into two areas has some implications for the degree of 'personal' contact between the technical support staff and the people they support, in terms of 'foot traffic' going past their offices and in terms of the means of contact used (e.g. phone, email, etc.).

Each technical consultant is seen as having a primary area of expertise. Often this is in terms of operating systems (e.g., Windows, Unix, Macintosh, etc.) A consultant may also be identified by responsibility (for example, one consultant is in charge of the first year labs). The group is seen as a central resource for the whole School rather than for individual departments. This means a member of the group tends to be called upon for reasons related to their area of expertise than some organizational role.

The consultants' work is mainly task-based. The nature of the job involves dealing with both poorly and well-defined tasks. In consequence, the consultants often have to employ a range of information seeking techniques. Often projects are relatively flexible in terms of how they may be approached; frequently other members of the group are recruited to deal with specific elements as required, with one person being responsible for the overall project. It is difficult to describe a typical day of a consultant in this group, but depending upon the time of year he may have he might expect to:

- deal with immediate, low-level problems such as fixing a stopped printer queue;
- interact with novice users to answer questions about standard software packages;
- set up new facilities (ranging from complete installation of a 50+ computer lab, down to setting up a single new laptop for an academic);
- proactively investigate potential software and/or hardware problems, and locate solutions to these problems that haven't occurred—yet;
- keep an eye on long term developments in his area of hardware/software expertise, so that he can provide informed advice to decision-makers in the School;
- update information sources used by themselves and their 'customers' in the School; etc.

For some of these tasks there is a level of repetition such that once the initial information seeking activity is completed the results can be applied and re-applied when the situation arises again. Some of the tasks, however, fall into the category of 'one-offs', with the consequence that the problem solving and information seeking behaviourss result in a solution that cannot substantially be used again. It is clear, however, that most of the tasks, despite the level of repetition, share many of the characteristics of information seeking and retrieving activities described in information behaviours studies. In an earlier work [9] we interpreted these activities in terms of a specific information behaviours framework (that of Ellis [7]). In this paper, we examine the potential for supporting these activities through a digital library tailored to the TSG's needs and preferred search behaviourss.

3. THE GREENSTONE DIGITAL LIBRARY ARCHITECTURE

Greenstone (http://www.nzdl.org) is a toolkit for constructing and maintaining digital libraries. A digital library is viewed as a set of collections, where each collection has a focus—typically by type of document (for example, music videos), or by subject (for example, computer science research documents), or by user needs (for example, people working in disaster relief).

Collections can be composed of documents held locally, can be an index to geographically distributed documents, or can be a mix of local and offsite documents. It is expected that a collection will be constructed after a set of documents grows past the point at which a linear search of the set is feasible. A collection, then, is expected to be large: hundreds, thousands, or millions of documents.

Current digital library architectures—of which Greenstone is typical—make a number of assumptions about the documents and users of a collection:

- The primary interaction mode is presumed to be searching, rather than browsing. The collection creator can organize the Greenstone search interface into 'simple search' and 'advanced search' modes. The advanced search mode offers a more extensive set of options for tailoring a search, but at the expense of requiring the user to know more about search strategies, the collection's metadata, and the system's implementation.
- Browsing facilities are relatively crude: the collection builder can specify simple categorizations and sortings of documents (grouped and sorted by author's last name, for example). These browsing facilities cannot be defined in an *ad hoc* manner by users. This situation is common across digital library implementations; while a number of novel browsing

schemes have been prototyped (see, for example, [13]), they are not standard with digital library construction software.

- A document collection can be expected to grow monotonically, with documents remaining in the collection (and assumed to be potentially useful) for the foreseeable future. Discussions in the digital libraries research literature on collection culling have tended to focus on the need to conserve space or to observe memory limitations, rather than on detecting documents whose contents have become obsolete.
- The contents of a collection are relatively static. Groups of documents are added to the collection periodically, rather than having individual documents added in a steady stream, in 'real time'. This limitation arises because rebuilding the collection's index is an expensive operation, and incremental index construction is not a common feature of digital library software. Typically, then, there is a (sometimes significant) gap in time between a document's production and its availability through a digital library.
- Documents can be presumed to be trustworthy, or can be evaluated for trustworthiness solely on their contents. The collection builder is generally, though not always, expected to serve as gatekeeper for the digital library. This role may be served by selecting additions to the collection on a document-by-document basis, or by exercising quality control through choice of reputable document sources from which additions the collection are automatically drawn.
- Documents stand alone, in the sense that a document is viewed with little or no regard to its relationship to other documents. For example, it may be difficult or impossible to view relationships such as a sequential publishing of two documents, or because the documents come from the same source, or because they are distributed by the same mailing list, etc.).
- Documents, once released or published, do not change. Documents are not usually monitored for changes to their contents or metadata, which can mean that the document's description in the collection may be inaccurate if the document is altered.
- The primary scenario for locating information involves a solo user searching a collection of documents. Little, if any, support is provided for collaborative information behaviours.

4. TSG INFORMATION BEHAVIOURS

The properties of the Greenstone Digital Library Architecture offer the potential user all the advantages of a typical digital library. Given the type of activities that the technical support group carry out as part of their work and the associated information seeking behaviourss it is tempting to assume that a digital library would be the most obvious tool for consolidating their information sources. Members of the group share resources, compare information from a number of different sources, keep records of information they have found and search for information often, some times for a specific reason and sometimes for general information gathering to develop specific skills and knowledge in an area. All of these activities would be supported through the architecture of the Greenstone Digital Library. However, the value of adopting an ethnographic approach to the investigation of the group's information seeking and information use, in preference, to other, more structured design based techniques, becomes apparent when looking at how well a digital library would really serve the group's needs.

4.1 Formally Published Documents Usually Aren't Useful

'standard' academic resources such as journals, conference proceedings, bibliographic indexes, etc. were not used by members of the group for work, as their work-related tasks were not seen as 'research'. Interestingly, this was as true of the consultant seconded to an academic research group; he provided programming support, but did not follow the 'research' side of this work.

Popular IT magazines such as MacWorld were irregularly consulted, primarily for pricing information in advertisements. Occasionally the local version of ComputerWorld was read, mainly for New Zealand-specific news or for job adverts: "*I read ComputerWorld for a laugh, because they started sending it to me for no apparent reason. I always hear about non-local things on the web first, the only reason to read it* [ComputerWorld] *is to see what's happening locally. Everything in it is usually old news."* None of the magazines were viewed as core resources.

The printed documentation that accompanied hardware and software purchases in the School was also seen as irrelevant. All members of the TSG had bookshelves full of documentation that they rarely, if ever, consulted. Often the manuals would be saved for years in pristine condition before being thrown away, still shrink-wrapped:

Tom[1] points at his bookshelves "*I've got documentation for the stuff we've bought. It actually gets used less than you'd think, it rarely goes into sort of details I need for the problems I deal with. It's probably useful for tutors to explain software to students."*

This is not that surprising given most of this application documentation is intended for end users rather than technical consultants. For example, the manuals typically focus on how to carry out specific tasks. There is often a simple 'trouble shooting' section that outlines the most frequently encountered problems and how to solve them, but this is generally pitched at a relatively simple level, not necessarily assuming the user has detailed knowledge of the program or the operating system on which it is running. The technical support staff are generally called upon when more complicated or subtle bugs are encountered, and the TSG then require a different level or type of information to solve these problems.

4.2 Many Documents are Ephemeral…

One striking feature of the information sources used by the TSG consultants is that many are extremely ephemeral. The usefulness of a given document tends to be highly time-dependent; for example, they need the latest news about the latest bug found in the latest version of the operating system. The usefulness (and in that sense, the 'quality') of information tends to deteriorate substantially over time.

In many libraries having access to historical records, however, 'recent' that history may be, is often viewed as an advantage for research purposes, where people can go through the background

[1] Consultants' names have been altered for privacy reasons.

material in a subject and use it to study developments in the area. The emphasis on timeliness for the technical support group, however, would necessitate a culling of older documents as they lose relevancy. If this were not done then the older, obsolete, documents would numerically overwhelm the more timely pieces of information.

4.3 But Some Documents Hang Around Forever!

Paradoxically, however, some documents are valuable because they are obsolete! The TSG have to support several 'legacy machines', elderly computers that run long-outdated versions of software that are nonetheless still heavily used by some members of the School. It can be difficult to locate information on the specifications of old computers, or on bugs and fixes for obsolete software. This type of information might not be carried on current websites or other information sources, which tend to cull information on outdated machines; instead, if a spec or bug fix is needed, it is likely to be found on a carefully hoarded document in a consultant's private stash. For example, in trying to locate a part number for an eight year old laptop, the TSG member consulted a long outdated version of a cdrom called 'service Source', distributed to Apple technicians. The TSG member had spotted it in a trash heap in another workshop on campus and retrieved it for his own use, citing the cdrom as "a good starting point for antiques".

At the time of this study, a number of historic documents were held on paper—what one consultant dismissively referred to as "*just rubbish, it's filing cabinet stuff*":

Chris asks about Tom's filing cabinet "*A lot of what goes in there I hope never to see again. Some stuff comes up yearly for staff, [other documents are] vendor product details that I didn't want to hear about in the first place, copies of everything purchased end up in it because sometimes you have to tell them try again, all the leave that anyone does, changes in salary, I file them forever.*"

Chris asks about Tom's bookcase [Those are] "*the folders that Dave* [the former TSG manager] *passed on to me. I don't think I ever looked in them. He did them back in the days when paper really was the best way to pass things on. Now if I print something, it will go out of date, it will go out of date if I print them again. I don't think I've ever looked in those boxes.*"

There is an expectation that much of this "stuff" will never be used—but it should be archived, just in case it: "*like somebody buys something and it comes with instructions and a little plastic whatsit, you give it to the punter and he loses it. I keep it and it turns out that no one ever needs it, but at least we've got it.*"

Gradually much of this documentation was becoming available for storage electronically, rather than on paper. The university was distributing most of its forms as Word files, and many purchasing records were appearing in digital form. This type of record would be well-suited for inclusion in a digital library: once created, the records are unchanging, and many of the records can be easily categorized and cataloged. The ability to easily search for and retrieve a given document could provide a significant advantage over physical filing systems. It was not clear that it would be easy to locate a given document in the cabinets, boxes, and heaps then in use—or even to know whether or not a particular document had been stored!

4.4 Documents Might Not be Trustworthy

Consider one of the many digital libraries intended for computer science researchers. These collections generally contain conference papers, journal articles, and working papers written by members of the computing field. Many documents have undergone the scientific refereeing process, and others (such as the working papers) generally have the imprimatur of a recognized research institution. Digital library users assume that the contents of the documents have been verified or vouched for, and that the documents are, on the whole, trustworthy. Exceptions may arise, but they are expected to be confined to a small minority of the digital library's contents.

In contrast, much of the information that the TSG gather from websites and mailing lists hasn't been verified, and in fact may be expected to contain errors, half-truths, unsubstantiated advertising claims, and rumors. The TSG members recognize that they will often have to do extensive cross-checking to feel assured that the information is reliable. For example, one consultant was observed to regularly monitor the websites of major software producers for news on upcoming and existing products. This information would then be cross-checked with product reviews. The he validity of individual reviews would also then be cross-checked, depending on the source.

Sometimes the trustworthiness of a site or a particular document cannot be immediately evaluated. One consultant saves particularly interesting WWW articles on stickies on his desktop, and consults them occasionally to see how the document's contents hold up over time. "*As things come to pass on the stickies*" [that is, as the events or trends mentioned in the articles actually occur], the consultant can put more trust in the document and, by extension, its source website.

4.5 A Primary Information Source: Other People

Other members of the TSG are a primary, significant source of information. One common strategy for finding a solution to a problem is to ask another member of the group. These interactions are usually not formally recorded; when asked how communications were managed between members of the TSG, the TSG members clearly preferred immediate, personal contact with each other. The following comment was typical: "*For something important I go next door or ring, otherwise it's email. Ringing or going to see someone is the first thing for communication.*" Close physical proximity was seen as a positive advantage in solving problems: "*We used to be in the same room, so we were just a shout away from getting answers. BUT one person's interruption was every person's interruption.*"

TSG members also occasionally use each other as information filters:

Bob: "*Occasionally I see something interesting to Dave, or I pass something to someone else.*"

Tom, a supervisor: "*There's a Linux kernel development mailing list but that's too high volume, I rely on the guys [to keep up with that].*"

A significant amount of 'passive' or serendipitous information gathering also occurs in face-to-face communication with colleagues. One consultant describes himself as frequently "*gossiping*" with other consultants on campus to find out activities

or events that are relevant to his interests but that he's not directly working on. More formally, two of the consultants attended campus-wide informational meetings scheduled and run by the central computing service (irreverently referred to as "*prayer meetings"*). All TSG members attend a weekly local TSG group meeting: "*We send Tom our weeklies [a weekly report on their individual activities]. He goes through them and picks out things he thinks are important and we talk about it in the meetings. When we finish going through that then each person may bring up other stuff and we chat about them. We may talk just between 2 or 3 people in a meeting. "*

The TSG members rarely proactively announce solutions to problems to the group as a whole, possibly because the consultants tend to specialize, and most problems would be of interest only to one or two members of the group; "*Very infrequently someone will go, this is the solution to this problem and then go tell everyone."*

It appears, then, that critical information gathered by TSG consultants is not digitally recorded, and is difficult to formalize for inclusion in a digital library. This is not an unusual situation, of course! Few digital libraries would claim to be a comprehensive source of information for their users. It is, however, important to be aware of the limitations of a proposed information source, particularly in noting the bounds for assembling a complete and comprehensive resource.

4.6 Local Production of DL Documents

Some of the documents used by the TSG (and which presumably should be included in a TSG digital library) must be constructed by the TSG themselves—who as a group aren't known for their love of documentation! These documents are mainly descriptions of the local system: lab configurations, local network descriptions, instructions for setting up new machines, etc.

These documents differ from the static, unchanging documents that typify the contents of most digital libraries. Locally produced documents require considerable maintenance—and are generally not complete or entirely up to date. The TSG recognize that developing documentation necessarily takes time away from other activities. One supervisor pointed out that, "*some of the NT guys got all keen and set up a web based thing to track their work and reports. More often the report is created from stuff scribbled in a diary. I'm more interested in what's coming up and what they'll have to do, than what they've spent their time doing.*"

This concern is not unique to the local group; for example, in an extensive case study of a work-planning process, Soloman [19] describes an information gathering and documentation process gone astray:

"The staff in the regional offices take time away from their technical assistance project activities to fill out project status forms and the study unit's staff takes time away from their program evaluation aims to maintain the project database. Projects fall behind schedule and the goal of evaluation to make things better is thwarted. The well-intentioned drive for accountability and improvement seems to have made things worse." (p. 1106) On the other hand, inadequate or outdated documentation can cause problems if older versions are used to base decisions on or to solve problems with. Keeping some level of version control also means keeping some record of who produced the documentation and where it is kept. At present, the TSG members attempt to find balance by creating 'just enough' documentation.

Internal documentation (intended primarily for use within the TSG) is by no means complete, but is generally sufficient to jog the memory of the documentation's creator, or to be used as a starting point for exploration by the other members of the TSG team. For example, a work diary—paper or electronic—could be referred to later to recall a problem and its solution.

External documentation—intended to more directly support the consultants' client base—appears to be developed in response to sustained demand from students or School academics. One supervisor notes, "*I'm a big fan of automation. Machines should be able to work by themselves.* [TSG] *Staff turnover is a problem. One of the biggest causes is repetitive work. I tell the guys if you have to tell someone something more than twice, set up a web page and give them the URL, if more people need it try to set up a program to do it automatically. We have developed automated things for costs, measuring web surfing traffic."*

Some records of problems and solutions are created by enforcing, where possible, a preference for dealing with "the punters" through email. Email correspondence documents the consultant's activities for internal reports, and can be filed away for later use if the problem is likely to recur. One consultant notes that, "*I don't have voice mail. I don't see any point in voice mail when email is much better. The problem with voice mail is you can't file things, you don't have an accurate representation of the problem because you're coping with voice as well as trying to keep your facts straight. With email you can read it over first. And I try to keep things filed with email. I use… what do you call them, folders I guess."*

In examining the problem of including locally produced documents in a digital library, another point to consider is that the construction of some documents may not be in the individual TSG consultant's best interest (although maintenance and development of these docs may be in the best interest of the group as a whole, and of the university). Chatman [2] identifies *secrecy* as a strategy sometimes employed to give an individual greater control or influence in the communication process. Chatman's study concentrated on various 'outsiders' characterized as members of the 'information poor'—for example, women involved engaged in job training with the CETA (Comprehensive Employment and Training Act) program. These women did not share information about opportunities for permanent jobs, as letting others know about the positions would reduce the probability that they themselves were offered a coveted permanent position.

It is important to note that we did not observe any member of the technical support group consciously employing the secrecy strategy. However, there are obviously opportunities for a technical consultant to create job security by becoming the only person with critical (and undocumented) information about the structure and function of a given system. For example, a supervisor jokingly noted that one consultant had exclusive knowledge of a particular system setup: "*if he leaves, then we will never print again!"* Another supervisor, describing an upcoming lab revamp during a brief semester break, pointed out that, "*Bob has something planned. I know what they are but not the details. If he gets hit by a truck, we're in the poo."*

The idea of someone no longer being a member of the group because of an 'accident' is something that is perceived to be a risk, albeit a remote one. A far greater risk, and an event more likely to occur, is that of the person leaving for more lucrative employment.

This is a real problem that the group has experienced time and time again. Retaining staff is difficult because of the more highly paid opportunities outside of the University. The need to record a person's 'knowledge' as information available to the group is something TSG members are aware of, but again this has to be weighed against the need to solve the problems at hand and deal with the fact that recorded information will become out of date relatively quickly.

The TSG see themselves as, to some extent, outsiders in the world of the university; one TSG member remarked that academics are "*protected to some extent by tenure*," while "*technical staff are just cannon fodder."* It would not be unexpected if consultants occasionally—unconsciously or consciously—utilized the outsider's information tactic of secrecy. The dependence of a collection's integrity on the producers of documents—who may have different priorities than the digital library maintainers—is likely to be an intractable problem.

4.7 Creating Individual Information Resources

All of the TSG members created information resources that they stored on their own computer. Email filters were used by all participants, primarily to filter all messages from a mailing list directly into an associated mailbox. These messages were generally never read, and the mailbox would be consulted only if the consultant encountered a problem related to that mailing list's topics. In essence, a consultant uses his mail filters to build up private, searchable document collections based around the mailing lists to which the consultant subscribes. Some of the consultants also created significant resources based around files downloaded from various websites. These files are not cataloged, and are rarely formally organized. One consultant discovered that he had over 79,000 files (of all possible description) on his Macintosh hard drive. He reported using Sherlock (the Macintosh 'find file' utility, which supports searching both by file name and file contents) to locate a specific file. The files were organized, if that term can be used, in a very flat and wide file hierarchy: "*Quite often it* [Sherlock] *will find it on the desktop!"*

These personal resources should logically be included in a digital library to support TSG activities. Greenstone's definition of a digital library as consisting of a set of focused collections, it would be logical to include a personal resource as a distinct collection, accessible only by the individual TSG member. At present, however, the process of creating and maintaining a digital library is not trivial; it would be overly burdensome for an individual to use a full-fledged digital library tool such as Greenstone to maintain these individual resources as a collection integrated into a TSG digital library.

4.8 Browsing and search by location

Searching is certainly an important technique for locating documents, whether the search is conducted over the WWW as a whole generic WWW search engines such as Google, or over Usenet articles with Deja News, or over a TSG member's own hard drive using Sherlock. As noted in Section 3, digital library architectures assume that the primary access mechanism to the collection is searching. The types of search options supported by Greenstone and other digital libraries tend to closely match the standard options on WWW search engines and other search tools, so that movement between a digital library and other commonly used resources should be relatively painless.

Browsing is also an important technique for navigating information sources, with locational cues playing a part in information storage and subsequent retrieval. Frequently used physical documents (in contrast to "filing cabinet stuff") are strategically placed so as to be easily viewable. For example, large items like the network configuration diagram, lab timetable and the holiday rota are drawn on a whiteboard or pinned to a noticeboard and smaller items, such as a list of shortcut commands, are written on a Post-it note and stuck up anywhere handy. Sometimes the back of the hand is used to note down IP addresses and passwords!

Digitized documents stored on the hard drive are also sometimes retrieved (browsed) by location or appearance. This technique has been noted in earlier studies of file organization [1]. TSG consultants might place files that they expected to use regularly or shortly on their computer's desktop or other readily accessible spot (although this technique falls down if the consultant does not engage in regular housecleaning, as evidenced by the difficulties experienced by the consultant who had accumulated 79,000 files). Color is also sometimes used as an adjunct to location, when browsing through a set of files. One consultant uses color extensively with his stickies, and another consultant uses colored nodes in a mind map to organize information.

Digital libraries, as currently designed, offer little support for the user to structure information for retrieval based on appearance or position in the collection. Documents typically have no location, as such, and their appearance through the library interface cannot be altered by the user.

4.9 Information Might Not Look Like a Document

Sometimes the object of an information search is not a document as such. Instead, the consultant may be looking for an example of some sort—a sample of a type of file setup or a piece of code that solves a problem similar to the situation at hand, for instance. Some examples are located in formal sources, and are intended for use as problem solving aids. IT textbooks recognize this preference for learning through example; some of the most popular technical resources are example-heavy 'cookbooks'. One consultant prefers a particular software development kit because the kit and the associated website include a large amount of sample code. Other examples consulted have not been formally prepared as examples, but are simply remembered portions of the local system that a consultant feels might provide insight into a similar situation being faced. This latter type of example might include the contents of a .login file, a piece of code written by one of the local TSG members, or a particular file organization.

It would be difficult to formalize these examples for inclusion in a digital library. When searching a digital library what type of key search terms could the TSG member use to describe the specific problem that would match to the metadata recorded in the library? The local examples are exceptionally problematic: what sort of metadata would describe a file hierarchy? Formal examples in code libraries, 'cookbooks', and developer's websites are generally accompanied by a description of what the example does, but this description might not include the features that a consultant finds most useful in the example. Working from sets of examples generally entails considerable browsing, trying to match features of

the solutions to the features of the problem at hand—and again, browsing can be difficult to effectively support in digital libraries.

4.10 Collaboration

Twidale and Nichols [20] describe the process of sense-making through interactions with peers as 'Over the Shoulder Learning' (OTSL). In this scenario, formal information sources such as online help, printed manuals, and training materials are regarded as secondary, rather than primary, sources for coming to an understanding of the overall 'shape' of a system. Instead, in OTSL it is interactions with colleagues that provide a great deal of the context in coming to grips with a complex system. These interactions may be prolonged and intensive, or—more typically—can be informal and short, focused on authentic tasks in the work environment.

Clearly the TSG relies to a large extent on OTSL for bring new staff members up to speed; the convention is to have new staff members share an office with a more experienced consultant who works on the same operating system or who supports the same group of labs. In the past, when the consultants all shared the same large office, this OTSL would have been achieved more naturally, with the new staff member being immersed in an ongoing conversation about all the different systems, user groups, and physical labs. As Twidale and Nichols [20] note, facilitating OTSL in a digital environment is problematic: the system must support a collaborative interaction with the document set, preserve a sense of history in the user's interactions, and maintain a task- or work-related focus in the presentation of information. Ideally, the context of the OTSL would be retained, perhaps in the form of a playback facility that would allow the user to review the concepts and procedures presented in OTSL sessions.

Current digital library architectures such as the NZDL do not provide an effective support for collaborative information behaviours such as OTSL. In a physical library, a reference librarian may serve as the expert 'colleague' in OTSL; good reference librarians do not simply give users answers to specific questions, but also who the users how their information needs can be satisfied by guiding a library user to a greater understanding of the library's contents and organization. Peer-to-peer OTSL may also occur as, for example, students working on the same assignment cluster around the same library catalog monitor [3]. Direct communication between digital library users is not currently a feature of digital library architectures such as Greenstone. 'Ask a Reference Librarian' services have been incorporated into digital library frameworks, including Greenstone [5]. The reference librarian services offered in a digital library have impoverished interfaces, in comparison to face-to-face interactions in a physical library. Typically the digital reference librarian services are based on an exchange of email—but email 'conversations' are generally too slow to support the (sometimes extensive) back-and-forth required to reach a consensus on the problem to be explored. Email is generally adequate for one person (a reference librarian or a OTSL participant) to give an answer to a question or to retrospectively explain how a solution was found, but not to allow two people to explore an information source collaboratively.

Experiments in providing digital reference services via synchronous communication software such as video conferencing [11] or a MOO [16] have yielded mixed results. On the one hand, true conversational interactions are made possible. However, these systems introduce problems of their own: users find it difficult to master the MOO interface, the videoconferencing systems require awkward-to-use hardware on participating sites, and the systems are easily crippled by slow (or even merely moderately fast) connect times. Further, the MOO interface is text-based, and videoconference image resolution may be fairly coarse—both limitations making it difficult for one person to observe another's interactions with the digital library or other information source.

Digital Libraries, as many are currently designed, offer little support for the user to select information for retrieval based on appearance or position in the collection. Although significant research has been carried out in terms of visualizing information spaces [10] [14] current DLs do not provide significant levels of support for either individuals structuring that which they have retrieved or for collaborative groups to structure their combined hits. Of course, a digital library could be used in an OTSL fashion by two TSG consultants physically sharing a monitor—so collaboration between members of the local TSG group is possible to the same extent as any piece of software. Collaboration between physically distant members of the greater TSG community, however, is not well supported. In sum, then, digital libraries with an architecture grounded in a view of the user as an individual searcher, such as Greenstone, are not well-suited to supporting collaborative information behaviours.

5. CONCLUSIONS

There are a number of conclusions that can be drawn from this study concerning the value of the ethnographic approach, the nature of the information gathered, the practical needs of the support staff for information seeking and information use, and how well different types of information system might best support such a group.

In terms of the use of ethnographic methods of identifying the information behaviourss of this group, this study should be viewed as a success. The richness of the data gathered and how it was analyzed enabled us to view the situation from several different perspectives. The information gathered demonstrated how each member of the group interacts with his own information sources and those used by others, including colleagues as information sources in their own right.

The information behaviourss we identified through using the ethnographic methods were primarily ones of browsing, cross checking and verifying, filtering information, monitoring sources, working through related information in steps to get to an end point and extracting information that was relevant from that which was not. These behaviourss correspond well with the framework described by Ellis [7].

Of these behaviourss, working through steps from a start point to an end point in its generic form could easily be supported by the searching mechanisms within a digital library. If the user were to begin with a simple reference to a subject or problem and work through to lists of citations and further references this would be similar in many respects to an academic researcher's use of a digital library. Extracting relevant information and differentiating between what was useful and valid would also be relevant behaviourss within a digital library construction.

In terms of the information needs, rather than actions, of the group there are several areas where a digital library might provide the support required. For example, material that is kept for historical

reasons or safety reasons (e.g., supporting legacy systems) and is not actually used on a regular basis would be kept in a secure place, that could accessed easily by any member of the group. This type of material is relatively static.

Documents are generated by different members of the group and as people come into the group or leave it there is a need for continuity of information and recording 'intellectual capital' for use by the rest of the group. There was the recognition by the group that not having central repositories of information meant too much local knowledge resided in individuals and the risk in that was significant. The group members trust each other and respect the level of expertise each person has with respect to a particular area of the job. This would again seem to reinforce the utility of a digital library in reducing the risk of losing local information and the level of trust that the people could place in the content of the library because they would have generated much of it or at least cross-checked the original source with other sources.

Whilst a number of information behaviourss and information needs would, at least on initial inspection, appear to be well served by a digital library, not all would be. This study identified several information behaviourss and several features of the current digital library architectures that conflict with the information requirements or work habits of the TSG consultants.

If we begin with information behaviourss: the activities of browsing are not necessarily well-supported by digital libraries founded on the premise that the basic interaction mode is searching. Browsing is a less well-defined activity but is very relevant when dealing with less well defined problems. Cross-checking different sources is also an activity that is not well-supported in that the relationship of one document to another is only recorded in very limited terms. Often the group members cross-checked reports from different sources, at different times for different reasons. No assumptions about the validity or trustworthiness of the sources would be made until cross checking and verification had been made. In a digital library the need to record the result of this cross checking and validation would be important.

Monitoring sources and filtering information also relates back to the issue of trustworthiness and being able to re-present or re-structure the relationships between documents often to enable the user to deal with timeliness issues. The documents themselves would need to be updated regularly and in doing so this may change the type of relationship the document has to others, again requiring some restructuring or re-presenting of the source.

One critical issue when developing a digital library is defining a set of target users. For the TSG, it is unclear what community should be the focus for a collection. Each member of the TSG participates in a number of communities: the School TSG, the university TSG, the universal set of technical consultants, technical consultants within their individual operating system specialty (Macintosh, Linux, Windows, etc.), and technical consultants by role (security administrator, lab administrator, etc.). A digital library's usefulness would be compromised if it did not support an individual's membership in all of his communities, but at the same time a generic digital library for all TSG members would overwhelm an individual consultant with irrelevant material from communities which he is not a member of. In particular, it would be difficult to seamlessly merge internally and externally produced documents into a single digital library.

During this study a number of very interesting and useful insights into the information behaviourss of this group were gained. While we were aware of previous research on how people use different information sources and how this was partially dependent on the task they were carrying out, the results tested our assumptions about what else the use of such sources was dependent upon. It also enabled us to question assumptions about how appropriate digital libraries are in this situation.

The group studied here does not necessarily have the same mix and proportion of information behaviours exhibited by other groups. It may not be able to make as effective use of a digital library, however broad that definition may be taken to be, as groups such as academic researchers. For a digital library to be viewed by this group as more than just another information source it would need to provide a greater level of support than might currently be seen to be the case.

This group is very adept at using the most efficient technologies or tools to get what they want. These technologies have affordances that digital libraries do not have and may never be able to match. The behaviours of cross-checking, monitoring, re-presenting and re-structuring information have a strong link with the activity of annotation, something that is not that well supported in digital libraries.

There is a relationship between the type of annotation, the tools used to make the annotation and the materials on which the annotation is made. Marshall [15] uses the example of student textbooks where underlining is used to help students identify and reflect on key phrases or terms to demonstrate this relationship. Underlining was used in preference to highlighting (using highlighter pens) in paperback books because the paper is absorbent and the highlighter ink would leak through to the other side of the page. If we look at a simple example of the same type of relationship for the technical support group, the Post-it note or physical yellow sticky for recording useful pieces of information or lists of tasks to remember has value because it can be transported physically from one point to another, over time and edited or amended over time.

The Greenstone architecture can be seen as a good implementation of a typical digital library. At the moment, our results compare the types of information behaviour a typical implementation supports with those undertaken by our subject group. Having reviewed our conclusions, are we being overly harsh in judging the potential value of a digital library for this group? Are we setting a standard that no comprehensive resource for this group could ever meet?

The work context for this group of subjects does provide a picture of information behaviours that perhaps a 'typical' digital library implementation was never designed to support. If that is the case, we should not be surprised the support is not there.

If we adopt a broader view of digital libraries, as advocated by Levy and Marshall [12], would that lessen the significance of our conclusions? The answer is probably yes, but only in part. Re-examining them, in the context of a broader view, still leaves us with the problem that the broader view is not currently the typical implementation. This will change but we would hope that the results of this study may contribute to pushing out those boundaries.

A final lesson to be learned from this study is the rather prosaic observation that the technical consultants use information sources

to support their work. Their job is not to consult digital libraries or to gather information, but rather to selectively use resources that will enable them to effectively and efficiently solve problems. This commonsense point tends to be obscured when system developers concentrate on creating an information system, rather than on ensuring that the system created is useful and usable, or even investigating whether a system should be created at all!

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