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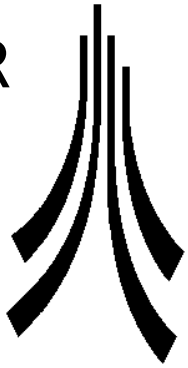

A Survey of Applications of CSCW for Digital Libraries

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Cooperative Systems Engineering Group

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ABSTRACT

This paper is a review of the field of computer-supported cooperative work (CSCW) with respect to digital libraries. The literature surveyed covers both library & information science and computer science. An overview of the field of CSCW is provided including requirements capture, ethnography, interfaces, toolkits, organisational memory etc. Collaboration is interpreted in a wide sense and systems supporting user-staff (e.g. remote reference) and user-user (e.g. collaborative filtering) interactions are described.

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A Survey of Applications of CSCW for Digital Libraries

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Abstract

This paper is a review of the field of computer-supported cooperative work (CSCW) with respect to digital libraries. The literature surveyed covers both library & information science and computer science. An overview of the field of CSCW is provided including requirements capture, ethnography, interfaces, toolkits, organisational memory etc. Collaboration is interpreted in a wide sense and systems supporting user-staff (e.g. remote reference) and user-user (e.g. collaborative filtering) interactions are described.

AIMS

The purpose of this review is to consider how the research in collaborative technologies can inform the development of systems to support information search and retrieval. Although we focus on literature from outside conventional library and information science, we wish to acknowledge at the outset that interfaces and collaboration are not new ideas to the field. What after all is a well laid out library with carefully designed signage and access points to cataloguing and indexing sources (even if embodied in the medium of paper and index cards rather than more glamorous technologies) but an interface to an information system? What is a reference desk but an interface to support collaborative working and learning? Before we get too swept up in the potential of some exciting new technologies (a danger that as computer scientists we are only too aware) we need to ground this study in an awareness that librarians have already been doing something directly analogous for many years, that with careful analysis and evolution of the design of these physical artefacts and conventional face to face collaborative interactions, much progress has been made and that much can be learned from existing practice to inform the design of computer systems not merely for library design but also for other contexts where the task is complex and people must navigate an immense information space and will need to work with specialists to understand their task. Librarians should be wary of the brash colonialism of some computer scientists who may be in danger of seeing a 'primitive' low-tech structure and instantly planning how it can be replaced by a new glitzy technologies whose use is unproven but which have been in search of an application. Nevertheless, these technologies do offer intriguing possibilities for supporting different kinds of information retrieval and supporting the usability, usefulness and acceptability of digital libraries.

The Case for Interfaces and Collaboration

It is a truism within user interface design that for the user the interface IS the system. The design of interfaces to computer systems has grown in importance along with the remarkable progress in the manufacture of increasingly powerful but cheaper computer hardware. The falling cost of hardware leads to the potential for a wider degree of access to computer systems and consequently a more divergent user base.

For the purpose of this review however, we wish to focus on techniques and set of technologies that are complementary to (if not completely interleaved with) the techniques of designing easier to use interfaces. This is the issue of help and support and co-working between people. Work in this area is often done under the name of Computer Supported Cooperative Work (CSCW). This looks at how computing technologies can be used and developed to enable groups of people to get their work done. It is based on the rather obvious principle that most people do not work in a solitary vacuum. They interact with other people (a principle nonetheless that much existing software seems to ignore). People are usually part of an organisation and work with others in that and other organisations in order to complete tasks. However until the advent of work in CSCW, most computer systems could be viewed as embodying the implicit assumption that people worked alone and needed systems that would help them do that better. Indeed in some cases where they had to work with other people (e.g., to ask for help or to share the workload), this was regarded as something of a 'failure'

and if only we could design a system that allowed them to accomplish their goals on their own, that this was progress.

Within the context of libraries, we shall see that forms of collaboration take many forms, including most obviously the help or reference desk. In this review we will consider a range of forms of collaborative working and technologies that might be employed to improve the effectiveness of these forms. Note that we see this as strongly related to the aims of the designers of interfaces, who are in effect pursuing a similar goal.

We survey research undertaken in CSCW and related areas that we believe can serve as a useful starting point for someone considering the implementation of collaborative technologies in a information retrieval and usage context (such as a library) or someone considering research in the area. Although a number of very good survey articles on CSCW were published in the early 1990s, we are not aware of any recent ones and so in part this review also attempts to fulfil that role. As there is a substantial body of work in the field, our selection of papers has to be somewhat restrictive (despite this, it is still substantial). Therefore our survey necessarily provides only a cursory overview of some topics. We have chosen papers that themselves contain thorough reviews of a subtopic of CSCW, and those that we believe are illustrative of an approach and are particularly accessible to a reader from outside the discipline.

Clarifying Collaboration

In this paper we use the term *'collaborative'* extensively. It is important to be clear about its meaning. Within library science the term is often used to mean collaboration between organisations in order to share resources or information, to unite collections, catalogues etc. We might call this kind of collaboration *'strategic'*. By contrast, we are focusing on collaborations that are interactions between individuals. Such collaborations may be within or across organisations. They are ad-hoc, may last only short periods of time and may be best described as *'tactical'*. Such collaborations are always occurring spontaneously. They can be hindered or helped by technology. They may also be a part of a strategic inter-organisational collaborative project. Collaborative working may not be easy or unproblematic. It may involve conflict as well (Easterbrook 1993). A system that assumes uncomplicated harmonious synoptic working is unlikely to be used for very long. Within computer science, the term 'collaborative' is sometimes also used in work on agents - small programs that interact to achieve a larger goal. We are not reviewing agent technology and inter-agent collaboration, even though some work has been done on their use in Digital Libraries.

VISIONARY ARTICLES IN LIBRARY AND INFORMATION SCIENCE

Most of this review will consider papers published in computer science journals and illustrating concepts that have potential to be used in library and information science (LIS). However it is important to acknowledge that there have been visionary papers within LIS considering the potential of the collaborative viewpoint well before the technologies caught up. It is intriguing to note that many of the ideas being reviewed in this paper as state of the art, (or even somewhat futuristic) are previewed in the paper by (Swanson 1964).
Among the issues relating to collaboration and digital libraries which Swanson covers are:

- Full-text retrieval (envisaged as via microfilm)
- Requests based on previous use
- Recovery of materials used previously by the user, or those than another specified person has used before
- Matchmaking by usage
- Permissions, privacy
- Discovery of groups of people with similar interests
- Discovery of "groups of books which share a high incidence of similar use and which grouping therefore ought to be reflected in the catalog"
- Analysis of the variation of such groups over time
- Reuse of prior searches as enabling the creation of a private "demand library" as a way of reducing the need for users to hoard books
- User annotations (e.g., of similarity of two works)
- Retrieval of similar works by common users, or recorded judgements by users
- Different interfaces to the system for different contexts of use
- Incremental feedback of intermediate results (how many results would be obtainable from the users search so far, as well as for various combinations of the search elements described thus far)
- Custom-built journals

These ideas will be elaborated in subsequent sections. Swanson's approach to the issue of raising agendas for the design of computerised catalogues has much to recommend it. He chose to focus on the needs of users as informed by his research and understanding of the topic, fully expecting that the capabilities of information systems (and especially computer hardware) would eventually catch up in terms of functionality and cost to enable his envisaged functionalities to be developed. They certainly have. His speculations of costs of approximately $20 million (in 1964 dollars) can perhaps now be realised in high end PCs costing little more than $3000 (in 1998 dollars). What is puzzling is why so many of his more intriguing ideas seem to have been ignored, or at best rarely implemented. A citation search (ISI Social Sciences Citation Index) revealed that only 3 articles had cited this visionary paper, none of which involved describing the design of new systems.

It seems that much subsequent systems development has been technology-led rather than rooted in careful analysis of user needs. The focus of much systems development in the library world appears to have been focused on the practical implementation of full-scale working systems. There is of course nothing wrong with that. However there does not appear to have been as much speculative development of systems and interfaces in a research context of proof by construction and discovery–by–building as has been used to great effect in other areas of computer science, not least in the field of CSCW. The process of scenario-based design (Carroll 1995; Carroll 1995) is a powerful mechanism for envisioning potential technologies and how they can be efficiently and effectively developed and integrated into the work practice.

(Taylor 1968) classic analysis of the traditional reference interview has implications for the design of systems to enhance both human-human and human-computer interaction as part of the problem-solving process.

> An inquiry is merely a micro-event in a shifting non-linear adaptive mechanism. Consequently [] an inquiry is looked upon not as a command, as in conventional search strategy, but rather as a description of an area of doubt in which the question is open-ended, negotiable and dynamic"
>
> p188 "We view the inquiry not as a command but rather as an adaptive self-organizing system in which the question is open-ended and dynamic. In fact [] the inquirer's original question may change during the search, as he adapts to the feedback of the search process."
>
> (Taylor 1968)

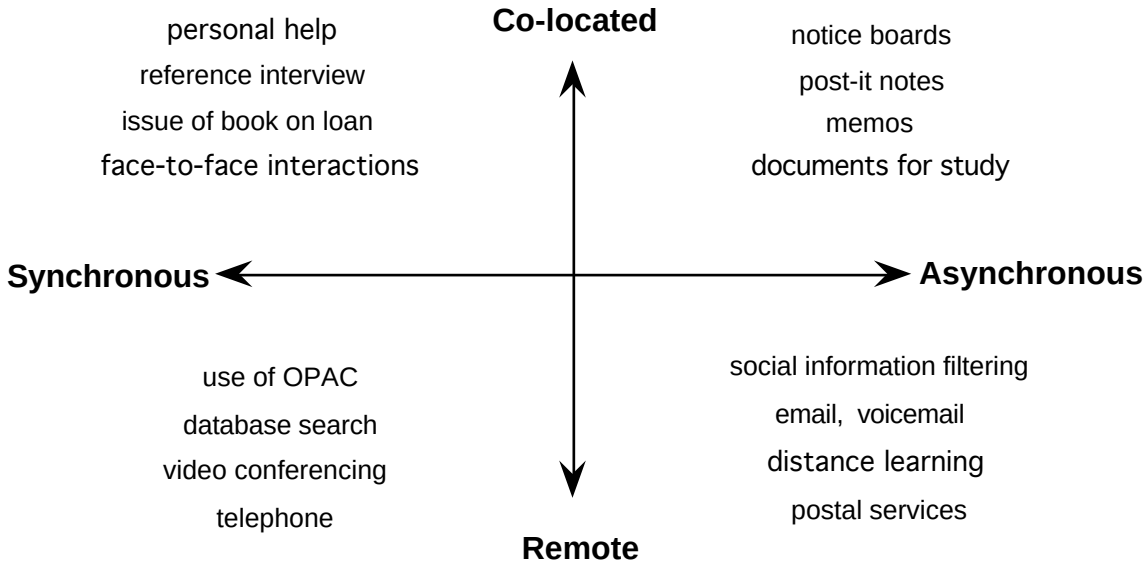
We concur with this viewpoint and use it to draw implications for the design of systems that should better support this evolving information need over both time and space, involving both solitary computer use and interaction with people around and using the available systems. Taylor notes the difficulties that enquirers have in articulating their need, including "that inquirers seldom ask at first for what they want". This requires the skills of a reference librarian in obtaining a rich picture of the enquirer, including their background and the context of the query. The issue of supporting the timely and efficient acquisition of context is one we shall return to later.

Taylor also notes some of the additional expertise that the librarian brings to the negotiation process with the inquirer. This includes "who knows what", previous requests, as well as checking who the inquirer has talked to and referring people to other people. These are all techniques that potentially can be supported by CSCW systems (although probably should not be automated).

Perhaps most intriguing of all, Taylor mentions in passing: "(t)he work by Doug Englebart and others at the Stanford Research Institute on the augmentation of human intellect by computers may generate interesting systems some time in the future, but appears to have little pertinance at this time to the problems under consideration here" Englebart's work (Engelbart 1962; Engelbart and English 1968) is one of the key foundations of CSCW systems development. Thus, thirty years after Taylor's paper we are making the case that the successors to Englebart's work have reached the stage where they are indeed pertinent.

OVERVIEW OF CSCW

The term Computer Supported Cooperative Work (CSCW) was coined by Cashman & Greif for a workshop in 1984 (Greif 1988). However, as noted, Englebart's work of the 1960s involved the development of many of the features studied in this area and research had continued in a number of fields including computer science, sociology, psychology and linguistics. As with other areas of computer science, publication in refereed conferences is a major part of academic activity and many of the key publications in the discipline are in conference proceedings. The first conference on CSCW was in 1986 in Austin, TX (ACM Press 1986).
Other conferences where CSCW papers are published include: ECSCW (The European Conference on Computer Supported Cooperative Work), HICCS (The Hawaii International Conference on System Sciences), UIST (The ACM Symposium on User Interface Software and technology) and CHI (The Conference on Human Factors in Computing Systems). This list re-emphasises how collaborative working and interface design are so strongly interwoven.



The major journal in the field is "Computer Supported Cooperative Work: The Journal of Collaborative Computing" which began in 1992. Many CSCW papers are also published in Communications of the ACM, ACM Transactions on Office Information Systems and The International Journal of Man-Machine studies, now renamed The International Journal of Human-Computer Studies.

A number of useful survey articles of the whole field were published in the early 1990s. These include (Rodden 1991) and (Ellis, Gibbs et al. 1991)**.** There are also various books of readings that provide a good overview (Greif 1988; Galegher, Kraut et al. 1990; Greenberg 1991; Baecker 1993). (Schmidt and Bannon 1992) in the first issue of the CSCW Journal attempted to clarify the nature of CSCW as a research field. (Grudin 1994) has written a slightly more recent historical overview which also examines the variation in focus between researchers originating in different disciplines as well as variations between researchers in North America and those from Europe and Japan.

One useful way of classifying the various kinds of CSCW systems is by determining the place and time of the collaborative interactions that are being supported. This categorisation was originated by (Johansen 1988) and has been much copied ever since. Collaboration may be between people in the same place or different places (Co-located or Remote). Collaboration may also occur at the same time or separated in time (Synchronous or Asynchronous). Examples from the various quadrants are:

Same time, Same place: meeting support tools.
Same time, Different place: video conferencing.
Different time, Different place: email systems.
Different time, Same place: corporate workflow systems run over an intranet.

Figure 1 illustrates the quadrant, using actual and potential collaborative activities in a library context.

Figure 1. The CSCW spatial and temporal quadrant

As a way of understanding the space of actual and possible systems, the categorisation is useful, but (Grudin 1994) remarks: "Most real work activity does not fall into one or another of these categories."

KINDS OF CSCW SYSTEM

There are a number of kinds of systems that have been developed to support different kinds of collaborative interactions. It would be more correct to say that there have been many systems developed to investigate the support of different kinds of collaborative interactions. An outsider to the computing literature needs to proceed with caution. Systems are developed to investigate a problem space. They may work very successfully in the laboratory, but still be a long way from commercial development. In order to succeed in the marketplace of ideas, some systems and classes of systems enjoy considerable hype, only to be deflated by studies that show that they just don't work very well in practice and that newer technologies have superseded them. Both extremes of optimism and pessimism need to be allowed for. It is one of the ironies of research that as a technology becomes a success, it figures less in the research literature so that its success is less trumpeted and discussion and investigation returns to the difficult areas that have not yet been developed to a level of general acceptance in use. There are some remarkable successes in collaborative technologies, such as the web and email and increasing corporate use of videoconferencing.

In this section we outline some of the main types of system to figure in the literature. Their rise and fall in prominence in that literature over time perhaps indicate that systems development within computer science research seems to be driven as much by fashion as by real or perceived needs of functionality. It is a messy business attempting to categorise systems. Many provide functionalities that overlap our arbitrary groupings particularly as researchers attempt to develop systems that can mesh with different organisational contexts and a variety of ways of working.

Collaborative Writing

There are inevitable biases of interest that arise from one's own work experience. Thus it should come as no surprise that a group of academics who frequently work together to co-author papers should investigate technologies to support collaborative writing. Indeed given that so many systems development projects have inadequate evaluations of use in real contexts, collaborative writing does at least afford the possibilities of testing authentic use, if only by the authors of the system. The temptation to write a 'how we wrote this paper' paper can be very great.

The co-authoring of documents is clearly a major activity amongst researchers, at least in the sciences, but there are many occurrences of this phenomenon in commerce as well. The paper may be collectively written from scratch, or pass through a series of revisions and editing as it moves through the hierarchy of an organisation. Support may be for synchronous collaborative writing at a distance, where two authors discuss and revise a document as they would sitting together at the same desk, even though they are many miles apart. The style of drafting and redrafting where different people work on the document at different times requires asynchronous collaborative support. The issues that arise in supporting collaborative writing include version control (ensuring that if several people are working on the document, it is clear who is working an which version, and if desired ensuring that there is always a single definitive draft) and awareness of changes (knowing who changed what and when and why and what the previous version was. Note the problem gets greater if there are more than two authors. One can then no longer know that if you did not made the change, it must have been made by the other person). Useful reviews of the state of the art are in (Sharples 1993; Sharples and Geest 1996) and (Rada 1996).

As a recent study by (Tammaro, Mosier et al. 1997) shows, although collaborative writing was an early area of investigation in CSCW, the task is complex and existing software still problematic. They note that even with modern software, collaborative writing is hard to support. Their findings indicate that current tools are effective for well defined tasks performed by experienced users, but otherwise the tools still need improvement to be more generally usable.

Shared Drawing

Related to collaborative writing is collaborative design, where two or more people gather round a table or a drawing board, pencils in hand and participate in the design process. The bulk of work on CSCW in this context has been to support synchronous remote shared drawing as part of design (Ishii, Kobayashi et al. 1994; Scrivener, Clark et al. 1994). It is important that the systems support the kind of fluid interactions that occur in this extremely creative activity and help people overcome the constraints of remoteness.

Meeting Support

The huge number of meetings and amount of time spent in them across the economy creates a great interest in improving their effectiveness and efficiency. The costs of time and money in enabling the participants to assemble in the same place at the same time leads to the desire to support distributed and even asynchronous meetings. (Mark, Haake et al. 1997) describe a modern system, DOLPHIN, as well as reviewing related work. The technologies may focus on supporting participants who are all co-present in the same meeting. This can be by providing each of them with a keyboard and a monitor recessed into the desk so that they can also maintain eye contact with the other meeting participants. The meeting facilitation functionalities may include support for anonymous brainstorming (everyone types in ideas and they are accumulated for collective discussion and refinement) and various different methods of voting. One member of the meeting may take the floor and highlight or edit the collective display, using the information displayed to back up her discussion. This would be similar to standing at the front and using a whiteboard, flip chart or overhead transparencies, but allows greater speed and flexibility in manipulating computational representations such as diagrams or concept maps).

In addition to those technologies, to support distributed meetings, systems include live video links and suitable displays. The issues of turn taking, floor control, sketching at a distance and telepointing (pointing to or within a document) become more complicated when supporting a distributed meeting. As studies of these tools have been made it has become clear that important but subtle issues in human communication need to be accounted for if people are to be comfortable with their use. For example a small monitor that contains the picture of a

remote participant may mean that it is easier to ignore that participant than people who are actually co-present. Ideally the virtual representations of the remote participants should be life size to help the impression of equal access. Frequently in remote video arrangements (including those on people's desks for person-to-person meetings) the camera is mounted on top of the computer monitor. Although this allows the capture of the user's face, it fails to account for the crucial effect of gaze in communication. The user will be looking into the eyes of the remote user as represented on her monitor, but the camera is not immediately behind that picture of the face. Thus the image sent to that user (from the camera mounted on top of the monitor) will show downcast eyes. In Western cultures avoiding eye contact (as this will appear to be) conveys impressions of failure to engage, or even dishonesty. Thus the users of such a system may have a vague feeling of disquiet about the quality of their remote interaction without necessarily being able to say why.

A substantial amount of research in CSCW has investigated synchronous remote collaboration. In particular, researchers have tried to understand the importance of video links. Providing a video link is expensive and so it is useful to know the degree to which it supports the interaction in order to know whether its advantages outweigh its costs. Some studies have shown that video is relatively less important than audio (Gale 1990). The study by (Tang and Isaacs 1993) by contrast showed how video was considered by users to be very important and that it can be particularly effective in supporting the process of collaboration. They explain the difference in the findings of other research partly because of their concentration on the process of interaction, and partly by the greater authenticity of their experiment, involving the longer-term study of pre-existing groups going about their regular work. This raises an important issue in CSCW evaluation (see later section); the problematic nature of certain controlled experiments. Although these are the gold standard for much of science, their results in this field can be somewhat misleading. This is because CSCW is partly an engineering discipline where the artefacts (CSCW systems) are created out of an immense design space. They are not phenomena of nature that are constant and so justify detailed expensive and time consuming scientific study. They can be (and are) endlessly redesigned. A rigorous experiment may show that a certain feature (say video) makes no difference, but it may be that that fact is an artefact of how the video was implemented, or used, or how easy people found to use it, or the experimental task that people were given, or that the real effects only emerge in days, weeks and months of authentic use, not in a one-hour experiment. CSCW systems are intended to help people in their everyday lives, and yet as systems designers frequently discover, surprisingly little is known about how everyday work is done (This can be the great contribution of ethnography, outlined later). Hence systems that perform well in a lab can often fail catastrophically in real life. This issue is considered further in the section on analytical CSCW. Tang & Isaacs' experiment also showed that audio quality was a crucial issue in usability. They advocate degrading video performance in favour of preserving audio quality.

(Brinck and Gomez 1992) built on the work on the Cruiser system (Kraut, Fish et al. 1993), a video communications system. Observations of the use of Cruiser found that a major disadvantage was that it lacked a way of easily sharing the artefacts that people often use in face to face meetings such as drawings, graphs and photographs. These are termed conversational props - elements which add 'communicative realism' to conversations and which need to be re-inserted into remote conversations. An example would be sharing a high quality x-ray image in a remote conversation between doctors. In order to understand the desired functionality, they studied the use of office whiteboards in conventional face to face meetings. This approach of studying existing practice in order to inform design of novel systems functionality in the new context of remote working is one that will recur throughout this survey, especially of the more successful work that is reported. As Brinck and Gomez note "Our goal was not to build an electronic duplicate of a physical whiteboard, but instead to discover the communication intent and to use that information to inform the design of an electronic medium which supports the use of conversational props" This quotation typifies a common and successful development methodology; determination of existing work practice in order to understand its underlying structure and use this knowledge to inform innovative design. It does not mean the slavish imitation of the structures of existing practice and their porting to a new context such as remote working. Their study revealed that whiteboards are more than drawing spaces - considerable amounts of text are produced and rich semantics are used. Physical whiteboards do not support these kinds of features particularly well. An electronic whiteboard might even be an improvement, supporting the selection from a palette of objects and easier revision and rearrangement of structure. In particular it becomes possible to provide persistence of the objects which was of great importance to users. This and other work on whiteboards and other conversational props emphasises that they are used as a way of supplementing a conversation between people. We shall see that issue reappearing when we consider aspects of collaboration around technology in libraries.

(Karsenty 1997) studied help-giving interactions between an expert and novice word processor user. This kind of interaction has many manifestations including technical software support over the telephone and the kinds of help given to users of catalogues and bibliographic databases in libraries (see the section on remote reference). Often the expert who can give the help is not in the same place as the learner and so the question arises of the functionalities that should be provided to approximate to the (presumably ideal but unrealisable or infeasibly

expensive) side-by side interaction. The experimental comparison of side-by-side and remote dialogues led to three recommendations: greater integration of the system to be supported with the available communication facilities, as it was found that novices' current goals were often too poorly specified for experts to supply appropriate help; there should be more structure to the users' messages especially with respect to goal and request description; and finally that it is futile to aspire to single-pass help dialogues and consequently that interaction-based approaches should be developed (note the similarity to Taylor's point).

(Watson and Sasse 1996) examined the usability and effectiveness of a remote language teaching system. This involved multicast conferencing, using video, audio and a shared whiteboard, over the Internet . It was found that audio is clearly key in this application and the video is more psychological than functional. As a result, reinforcing Tang & Isaccs finding, a downgraded video connection is acceptable - the bandwidth does not have to be sufficient to synchronise properly. Full duplex audio was however found to be important. Interestingly the subjective and objective evaluations especially of audio quality did not correlate. In terms of student activity, it was found that they used the whiteboard more than in a normal classroom, possibly because they were less intimidated by having a remote tutor. The system allowed simultaneous reading, writing, speaking & listening which is not easily achieved in normal lessons. Consequently a new form of interaction which has desirable pedagogy arrives by an accident of the technology and its context of use.

Awareness

In an organisation an important prerequisite of smoothly operating cooperation is an awareness of what one's colleagues are doing. This can help in knowing for example when it is appropriate to disturb someone and ask for help, whether a colleague's current tasks are something on which you happen to have expertise and can offer help and gaining an overall sense of the state of progress of a large number of activities including the strategic changes in the nature of the organisation. All of these awareness features work best in close physical proximity and may involve considerable 'face work' including substantial social interaction in order to achieve the desired quality of interaction (Dourish and Bellotti 1992; Mark, Fuchs et al. 1997).

Even being on a different floor in the same office can reduce the degree of awareness and consequently the effectiveness of collaborative working (Kraut and Galegher 1990). Clearly remote teams, those split between offices in different locations and teleworkers will lack some of these traditional awareness options. Awareness work in CSCW attempts to address this problem by the use of advanced technologies including the use of sound, video and active badges (Gutwin, Roseman et al. 1996; Harper 1996). It will come as no surprise to discover that as well as raising great potential for including peripheral members into a group, these awareness technologies raise many important issues of privacy, e.g., (Hudson and Smith 1996), an issue explored in a later section.

(Kraut, Fish et al. 1993) consider the use of remote video for supporting informal communications. They note the difficulties with supporting eye contact and people moving out of camera range. Even though their technology provided life-size images, the psychological distance between remotely connected users was greater than between co-present ones. Their study emphasises the importance of human factors in systems design. The Cruiser system was developed to support for remote groups the serendipitous interactions that can occur while walking down a corridor. Clearly it is important for such a system to address issues of privacy and access, This is done by having a policy of reciprocal views: if you are seeing someone in their office, they can also see you in yours. There are also mechanisms for warning a user that someone is about to look in, and to indicate that you do not wish to be disturbed. Effectively a whole new social protocol has to be developed that can be influenced (but need not replicate) the protocols we use for face-to-face interactions in people's offices (Bly, Harrison et al. 1993; Fish, Kraut et al. 1993).

(Dourish, Adler et al. 1996) describe their experiences of using media spaces over a period of years. They contrast their work with that of the other studies they review by the length of their study. Admittedly they are describing their own experiences and so the findings may not be representative, but equally, controlled small scale experiments may fail to uncover the adaptations that people make to technologies and how they fit them into their lives as they grow accustomed to their use. As an example they found that over time, users learn how to cope with the lack of direct eye contact and develop other ways of maintaining an awareness of the other participant's attention.

Note that physical proximity is not just a factor in maintaining collaborations, but in initiating them. It can afford the kind of casual social interactions that can lead to the discovery of mutual interests and the beginning of formal collaborative working, as (Kraut and Galegher 1990) discovered in the case of scientific collaboration. Physical proximity can greatly help this, but other ways of intellectual matchmaking are possible, as we note in a later section.

Workflow

Workflow systems are computerised systems that support the way that many offices processes work by passing it through a number of people who deal with different aspects of it. An example would be how a bank processes a loan application. In a paper-based environment, this involves a number of forms and their duplicates being passed from desk to desk as different people work on different aspects of the task. In a computerised environment some (or perhaps even all) of the process may be handled by the passing of electronic messages, the use of forms on computerised screens and the electronic tracking of the whole process (Suchman 1983; Abbott and Sarin 1994; Bowers, Button et al. 1995; Prinz and Kolvenbach 1996). A number of these studies have revealed serious problems with workflow systems, often caused by their overly constraining nature. They may embody the rules of how the work is done but as is elaborated in the section on ethnography below, people often have to deal with exceptions and work round the rules. With paper and written or just understood sets of rules this is possible. When the rules are embodied in the computer system, the inflexibility can paralyse the working of an office, leading to the system being subverted, lied to or abandoned. Note this need not be anything to do with fear of the system or Luddism, but just a sincere wish of the workers to get their job done effectively.

Many workflow systems are influenced by speech act theory (Winograd and Flores 1986) including the COORDINATOR system (Winograd 1988). This theory has been the subject of considerable criticism and debate (Suchman 1994; Bannon 1995) The overly constraining nature of the early versions of workflow systems has led them to be abused as 'naziware' (Dourish, Holmes et al. 1996).

HARPER, in his study of knowledge work in the International Monetary Fund (Harper and Sellen 1995; Harper 1998) claims a trade-off between the suitability of asynchronous groupware for supporting knowledge work and the amount of professional judgement used. If so, then in a library context we would predict greater suitability for say interlibrary loan and acquisitions processing than for reference and collection development.

Organisational Memory

An outgrowth of the various management theories that attempt to gain an understanding of an organisation by attempting various anthopomorphising analogies such as the learning organisation (Senge 1990), the idea of organisational memory has become a major centre of attention recently for researchers from many disciplines (Walsh and Ungson 1991). The effect of many radical business restructuring activities of the early 1990s such as business process reengineering was that many layers of middle management lost their jobs. This resulted in decision-making responsibility moving down to lower levels of the organisation, but also meant that as those middle managers left the organisation, the knowledge and expertise that they possessed was also lost. The aim of organisational memory is both to record some of the expertise of the members of an organisation in case they should leave or be unavailable to share it and also to allow an organisation to make more effective use of the data it necessarily collects in computer files as part of doing business. The attempts to classify and catalogue this disparate information clearly has many parallels with some of the traditional activities of librarians.

One interesting example of organisational memory is the Answer Garden (Ackerman 1994). This attempts to grow expertise by its usage. Within computer systems use there is often a file called the Frequently Asked Questions (FAQ). It is a useful starting point for novices to read to see if it solves their problem in dealing with the new system. If not, they may still need to have recourse to an expert, but the FAQ serves as a useful mechanism for saving the time of both novices and experts should it be able to address some of the frequently occurring problems. Note that for any one user, the ideal FAQ should address all and only the questions that she has and explain in detail how to cope with these problems. It is one of the ironies of an FAQ that its utility can decrease as the information contained in it grows - the more questions it contains the harder it is for a user to find whether her question is there. This is a difficult task because a novice will probably not know the correct terminology or classification schemes used to organise information about the subject area as a whole. The Answer Garden extends the FAQ idea by making it easier for a novice to search within an FAQ and, if she does not find an answer to her problem, can use the Answer Garden to send off a request for help. The novice therefore does not have to know who is the person with the right level of expertise and who is available to answer her question most quickly. In addition to determining who should receive the request and forwarding the response back to the novice, both question and answer are added back into the Answer Garden in the hopes that this piece of information may help a subsequent user. We can regard the Answer Garden as an attempt to embody in a system a small part of the expertise of an individual, say a reference librarian who having determined the answer to a request for one patron is able to use that knowledge to very rapidly answer a closely related (ideally identical) request from another patron.

A later version of Answer Garden (Ackerman and McDonald 1996) built on the studies of the system in use. These emphasised the importance of context to understand an earlier answer. The new system provides an escalation agent to support the search for the person likely to have the knowledge to answer the request. Note that escalation is a term from software support help lines. A caller's request may be escalated if the person

taking the call is unable to deal with it. It is escalated (hopefully) to someone with more expertise. Nevertheless, there remain major problems to be resolved in addressing issues of usability usefulness and acceptability to enable such systems to be widely used in practice (Hughes, Kristoffersen et al. 1996).

Computer Mediated Communication

This is a research field in its own right, with its own conferences and journals. The focus of this work is to support the process of communications by detailed analyses of how those occur, both by micro-analyses of conversations and discovery of communication patterns of individuals with others over long periods of time. Useful introductions can be found in (Daft and Lengel 1986; Fulk and Steinfield 1990; McGrath and Hollingshead 1994; Jones 1995; Kiesler 1997; Haythornthwaite, Wellman et al. in press).

Substantial work has been done in CMC to understand how people use technologies that are now widespread such as email, mailing lists and bulletin boards. Usage is studied for different groups and over time so that the effects of learning, the gaining of expertise and acculturation into the new medium can be observed as well as the overall global learning as new norms such as 'netiquette' are developed and evolve. By contrast, CSCW researchers tend to concentrate on the development of the more expensive 'glamorous' high-tech applications such as shared video.

Computer Supported Cooperative Learning

This is a field of research that considers how computer systems can be used to support collaborative learning. Although some papers on CSCL are published in CSCW journals and conferences, CSCL may be usefully considered a separate discipline owing as much to education research as to computer science. There are dedicated conferences, CSCL95 (Schnase and Cunnius 1995) and CSCL97 (Hall, Miyake et al. 1997), and various edited books: (Hiltz 1994; O'Malley 1995; Koschmann 1996).

MUDs and MOOs

Originating as a computer game at the University of Essex in 1979, the Multi-User Dungeon (MUD) concept has grown and developed. It is a form of remote synchronous communication, mostly involving text-based interactions. Participants navigate a textually constructed virtual space, interacting with other people that they meet in the various locations. An influential extension is the MOO (MUD, Object-Oriented) from Xerox PARC. A MOO allows users to extend the virtual environment by creating objects, locations and behaviours that are then available to other users. (Dourish 1998) outlines the history of MUDs and MOOs and their relationship to CSCW research. MUDs are gaining increasing interest as venues for learning, as a form of CSCL (Bruckman 1998; O'Day, Bobrow et al. 1998).

CSCW and the World Wide Web

The extremely rapid growth of the World Wide Web means that it provides an infrastructure for supporting collaborative interactions at a relatively low cost. This enables researchers to move from technologies that necessarily can only initially be studied in the laboratory to those that as soon as they are developed are available for use worldwide. In order to exploit and study this potential, a number of research groups are developing toolkits and functionalities to exploit the protocols of the web for collaborative working. As (Dix 1997) notes there are distinct advantages that the web provides including the standards and protocols which enable the use of the web to be free to join, work across different hardware platforms and indeed be extendible by the introduction of newer updated functionalities and standards. The overwhelming advantage which both causes and is caused by the other factors is that so many people already use it, ensuring that it is worthwhile to continue using and adapting it. This is the critical mass issue that as (Grudin 1989) has identified is crucial in the success of collaborative systems. Thus in developing a web-based collaborative system one knows that already there are a large pool of potential users who will be able to take advantage of your system with relatively little difficulty of installation, and that these groups span organisational boundaries. Just using the web may not be sufficient, however. There are problems with the basic client-server architecture of the web. In particular the protocol (HTTP) is stateless. That is, no information is stored between requests. The consequence is that while the web can support asynchronous collaboration, the synchronous forms are more problematic. There are a range of solutions including the use of cookies and Javascript as well as the development of web applications specifically to address this need, e.g., (Bentley, Horstmann et al. 1997). (Trevor, Koch et al. 1997) review these options as well as proposing their own system as a potential solution.

Toolkits

In order to provide the different technologies that are needed in different work environments, researchers are developing CSCW construction toolkits that will allow the easy composition of functionalities to fit the needs of a particular context of working. Such toolkits can be used for the more rapid prototyping and testing of concepts for supporting cooperative working (research and the early stages of development) as well as the

generation of bespoke applications to fit the particular needs of an organisation and the context of the work to be supported. There is also the potential of involving end-users in the tailoring of a more general application to their particular needs, although that in itself may uncover as many problems as it solves; the end users can not be assumed to be experts in design so that they may have difficulties in developing an easy to use combination of options. Furthermore, a very team-oriented workgroup may have difficulty in supporting awareness and informal learning and help-giving if everyone has tailored their personal workstation in a unique manner. Examples of toolkits include those by (Kaplan, Tolone et al. 1992; Smith and Rodden 1993; Hill, Brinck et al. 1994; Prakash and Shim 1994; Roseman and Greenberg 1996).

ANALYTICAL CSCW

Papers in the CSCW conferences and journals might be crudely split into those on synthesis (building systems) by computer scientists and those on analysis (understanding systems and their usage in the workplace) by sociologists. This is clearly a wild exaggeration, but we believe does contain a germ of truth (even though the authors have published analytical papers including some on evaluation noted later ,while still strongly denying any wish to be considered as sociologists). Recent CSCW conferences have had pairs of parallel sessions which could be identified as vaguely fitting within the two labels of analysis and synthesis. It would be possible to go to such a conference and only attend the synthesis sessions and only talk to computer scientists or only attend the analysis sessions and only talk to sociologists. We regard this as particularly unfortunate for the reasons outlined below.
There are clear differences in the backgrounds of researchers in CSCW. As with all interdisciplinary research this has substantial advantages but also a few disadvantages. The advantages are the different perspectives that the different participants bring, their focus on different aspects of the overall problem and the usual synergies that arise from such interactions.

Human computer interaction research and the design and development of more usable interfaces has been substantially enriched by the participation of psychologists, especially cognitive psychologists in the process. Clearly if you are attempting to design a system that a person will find easy to learn, understand and use, the insights from psychological theory and the methodologies developed there for gaining a deeper understanding of precisely those issues in differing circumstances can play an important role. Similarly, in CSCW where all those issues apply but to them are added the further complication of designing systems that can fit within people's work practices and how they interact with other people within and across organisational structures, the insights from sociology; theories and methodologies are equally important. The alternative is to continually develop elegant systems with amazing functionalities that either no-one wants or no-one can bear to use because they just don't fit with how people actually work. The disadvantages result from the difficulties of learning to work together. These can be caused by differences in terminology (different words that mean basically the same concept and the use of the same word to mean completely different concepts) as well as differences in worldview, ways of undertaking research and of what is deemed to be important and worth studying. The disadvantages result from the difficulties of learning to work together. These can be caused by differences in terminology (different words that mean basically the same concept and the use of the same word to mean completely different concepts) as well as differences in worldview, ways of undertaking research and of what is deemed to be important and worth studying. Nevertheless, there is a growing understanding of the importance and power of this interdisciplinary working as well as an evolving understanding of how to do it (Bowker, Star et al. 1997).

Ethnography

In a similar way that an aspect of psychology, cognitive psychology, has played a major role within HCI research, so in CSCW, an aspect of sociology, (also drawing from anthropology) ethnography has been especially prominent. The theory and practice of ethnography is complex and subtle and beyond the competence of these reviewers to detail. Useful overviews can be found in (Garfinkel 1967; Benson and Hughes 1983). Ethnographic techniques have also been coupled with insights and methods from cognitive psychology (Hutchins 1995).

To grossly simplify ethnography, it involves the study of how people do their work in the actual setting in which it occurs, attempting to understand that work in its own context and to describe what people actually do, rather than what they 'ought' or are 'meant' to do. The description attempts to explain the activities from the perspective of the participants - how they describe and understand their work rather than how it might be perceived by someone with a different perspective (such as a systems developer). We will not explore here the distinctions between ethnography and ethnomethodology (see the papers cited in this section for more details).

Suchman's book 'Plans and Situated actions' (Suchman 1987) has been widely cited in the CSCW literature as advocating the ethnographic approach to studying work practice and revealing how people engage in complex problem-solving that can otherwise be overlooked. If these complexities are not taken into account in systems

design, then one has effectively designed a system that supports an idealised version of the work practice and consequently one that fails to mesh with how people actually work.

Examples of the use of this technique include:

Exception Handling. (Suchman 1983) notes how supposedly routine activities involve considerable judgement and problem-solving, including negotiation with co-workers. (Schmidt and Bannon 1992) emphasise the importance of articulation work; the coordination, scheduling and error-recovery activities that people do that enables them to get the job done. Most importantly this allows a means for people to handle the endless contingencies and exceptions of everyday life. It is all too easy for a computer systems developer to attempt to automate the 'standard' way of doing work, but for the resultant system to be unusable because it does not allow for the inevitable exceptions that constantly arise. Schmidt and Bannon consider the key issue in CSCW to be: "the problem of how to support the ongoing dynamic articulation of distributed activities and the cooperative management of the mechanisms of interaction themselves". That is, that the system should support the user in understanding the structure of the model and so to apply and adapt it to their current task. Furthermore it means allowing users to adjust the model as circumstances dictate, allowing for graceful adaptation to exceptions and the inevitable evolution in the work that is done. All this is substantially different to the rigid controlling information structure that forces its users to work in the 'right' way and leads to the frequently observed irritating inflexibilities of workers being unable to serve their customers because 'the computer won't let me do that'. As they point out, there is substantial evidence for this - the form of industrial action known as working to rule, where workers act precisely according to the official procedures but do no more and in particular show no initiative in dealing with exceptions to these defined procedures, can quickly lead to the office grinding to a halt.

(Button and Harper 1996) studies of two very different systems, one for police crime reporting and one for manufacturing sales and invoicing reveal the problems that were caused by the significant difference between the assumptions of how the work was (or ought to be) done as embodied in the documentation and codes of practice and the much more reactive and complex (and responsive and effective) actual detail of activity. Their work shows how a more detailed prior analysis of the work practice could have informed more effective systems design.

Cooperation and Competition. (Orlikowski 1992) studied the use of Lotus Notes, by a large firm of consultants. Although the tool provided many potentially useful features, there were significant problems with its expected use caused by the competitive nature of the organisation. Consultants competed with each other and the reward structure within the organisation reinforced this. Consequently a tool to support cooperation did not deliver some of the benefits that might be expected.

Paperwork. A number of ethnographic studies (Luff, Heath et al. 1992; Harper and Sellen 1995; Hughes, King et al. 1996) have uncovered the complex ways in which paper is used. Consider how a paper form can be annotated, duplicated, have other bits of paper stapled or clipped to it, have sticky notes attached, have the boxes for form entry used for entering exceptional information that although it does not belong there, does not belong anywhere else in the form either. This flexibility of use in addition to the 'proper' use allows people to adapt to changing circumstances and exceptions. This is important to understand because it may give insights both into why the often promised paperless office never seems to appear, and to be a warning to systems developers of the kinds of functionalities that should be supported in their applications, including making allowance for occasions when people will opt to use a paper based approach as more efficient.

Systems Design. This is perhaps the most problematic but potentially most rewarding contribution - a direct collaboration between ethnographers and computer scientists to inform the systems development process (Sommerville, Rodden et al. 1992; Hughes, Randall et al. 1993). The difficulty of undertaking such an interdisciplinary collaboration is due to the problems of terminology and worldview mentioned above. For example, much of traditional ethnography is descriptive and tries hard not to be judgemental or prescriptive. But in order to inform systems design, a computer scientist may expect prescriptive information in order to help her decide what to build. This methodological tension pervades the working relationship. As a consequence, it has been proposed that a variant of 'pure' ethnography be developed to support the needs of interdisciplinary working and the time constraints that collaboration with a design team impose (Hughes, King et al. 1994; Shapiro 1994). Sometimes these difficulties and the work required to overcome them can become so great that there is a danger of two subdisciplines developing which, although they attend the same conferences, go to different parallel sessions and do not interact with people 'from the other side'. Nevertheless, there are various fruitful and ongoing collaborations between sociologists and computer scientists (Hughes, Randall et al. 1992; Sommerville, Rodden et al. 1992; Button 1993; Pycock and Bowers 1996; Crabtree, Twidale et al. 1997). What emerges from the descriptions of these collaborations is the importance of taking time to understand the different outlooks and use of language, as well as an evolving understanding of the potential uses of ethnography.

The analytical work in CSCW can help in several other ways, as the next two sections illustrate.

Requirements Capture

This involves determining in detail what people actually do in an organisation and consequently how systems can be designed to help that process. Such studies can be contrasted with idealisations of how people work that might be obtained from work practice manuals or by interviewing managers who either have only an overview of how their subordinates achieve their work, or even if they once undertook the tasks themselves are somewhat out of date as the technologies available and the nature of the work constantly change. Even asking a person who does the work may not be sufficient. People are inclined to give overview in terms of an idealisation of what they are meant to do rather than what they actually do. For reasons of simplicity they may describe an ideal case in which there are no exceptions. However when observing actual work practice, one is able to see these exceptions and how they are resolved. Indeed it may be that every activity includes at least one exception and the idealisation is but a useful fiction to describe activity in general. It should be clear why designing system to support such fictions is a bad idea.

What emerges from this work in a range of different work contexts is that work is situated and complex. We don't really understand how people do their jobs and need to know more if we are to develop tools to help them. A whole style of design, participatory design, has been developed to address these problems (Bjerknes, Ehn et al. 1987; Greenbaum and Kyng 1991). Originating in Scandinavia, PD was partly a response to labour laws that required that workers or their representatives (usually trade unions) should be involved in the process of introducing new technology. PD attempts to involve intended users in the design process, particularly requirements capture. However, in addition to fulfilling desirable social purposes (and / or legal requirements) as implied above, it can actually lead to a more effective, efficient and usable end product. Researchers and developers outside Scandinavia, especially the USA have been investigating the extent to which PD can be applied in different social and organisational cultures (Muller and Kuhn 1993; Blomberg, Kensing et al. 1996).

Evaluation of CSCW systems

Several studies of collaborative systems revealed disappointing results, eg. (Kirkwood, Furner et al. 1993). The studies were extremely useful in deepening understanding of the importance of the work context. (Grudin 1989; Grudin 1994) has produced a number of highly influential papers on the problems of introducing CSCW systems into organisations. He has identified a set of factors that can contribute to the success or failure of the process. One of them involves identifying who benefits from the introduction of the new technology. If the new system imposes extra work for many people in order to benefit others, there will be a natural reluctance to use it. Sometimes this can be overcome if management determine that it is a requirement to use the system, but even so, it is sometimes possible for workers to sabotage such a disliked system by blaming it for all the inevitable problems that arise. If the system can be designed so that everyone using it benefits somewhat (by its improving their work problems) then acceptance and adoption will be far more likely to be successful.

The work of Grudin has many parallels with the ongoing debate about the productivity paradox of computing (Landauer 1995), that organisations have spent billions on computers to support office staff and yet attempts to measure productivity have yielded feeble numbers and sometimes no improvement at all. (Plowman, Rogers et al. 1995) review a large number of workplace studies and consider the different ways in which they can contribute to the systems design process**.** Not all the news is bad. For example, (Bikson and Eveland 1996) study of meeting support technology at the World Bank reveals many successes and applies sociotechnical systems theory to account for these successes and generate predictors for subsequent implementations of technology into organisations.

(Twidale, Randall et al. 1994) explore several of the issues and complications of CSCW evaluation and advocate ethnographic techniques for addressing some of these problems. For example, the nature of a CSCW system is to support work that is situated in a complex environment and (obviously) involves interactions with other people. It may be that a laboratory experiment would fail to uncover aspects of actual use that could have a serious effect on overall effectiveness.

COLLABORATIVE WORKING AND LIBRARY AND INFORMATION SCIENCE

From a general review of CSCW we now move to an examination of work that relates particularly to collaborative work involving library and information science. Broadly put, this includes work with, in and using libraries and the activities of information retrieval and their potential impact when viewed as examples of or parts of collaborative work practice. We shall move between existing systems, experimental systems and considerations of potential systems, their requirements and implications for issues of privacy and changing work roles. (Marchionini 1992) identifies support for collaboration as a research direction for Information

Retrieval. (Shaw 1994) describes (in rather general terms) various computer technologies that will have implications for libraries, including CSCW and Collaboratories. As well as our focus on the use to be made by libraries of CSCW, she notes that libraries will collect the work of collaborative research. She notes that implications for the notion of authorship will stretch as the infrastructure for CSCW develops. Librarians may become involved in the activity of the collaboratories e.g., in supporting the management of the virtual blackboards and message systems. Considerations of privacy and ownership arise especially with evolving documents. Which is the definitive version? Is this even a sensible question? How does the library as archive play a role? These are issues that have strong parallels with version control in software engineering (Sommerville 1995).

Libraries and Organisational CSCW

We can consider some of the activities of a library as analogous to those of any organisation and consequently examine how CSCW technologies might be applied. Meetings occur, so meeting support technologies may help. Libraries may be part of larger distributed organisations (such as a metropolitan central library and a number of satellite branch libraries) so the technologies to support remote collaboration both synchronous and asynchronous may be of use. Libraries collaborate with other institutions (including other libraries, schools, universities, corporations, various levels of government) and so again the technologies that explicitly address this kind of work may have a role. Work passes through a number of hands (such as acquisitions, inter library loan requests, purchasing decisions and outreach activities) so workflow systems may be useful. However, libraries also undertake activities which are more specialised even though they may have parallels with work activities in other organisations. It is those activities and the potential of CSCW to support them that we will consider here. Continuing our view of collaboration at the micro level, we can see this occurring in a library in three ways:

- Collaboration between library staff
- Collaboration between a patron and a member of staff
- Collaboration between library users

For the first, we have the conventional activities and technologies as briefly skimmed above. There are also the specialist activities which have received some consideration, but deserve more. (Shapiro and Long 1994) examine library services in the light of business process reengineering and among other issues point to the growing importance of team-based work groups.

In terms of reference support, reference librarians within and across institutions may collaborate with each other in sharing particularly tricky requests or in sharing their process - telling colleagues how they solved a particularly obscure request. Note that in computer science the sharing of 'war stories' about debugging and indeed the sharing of suggestions for tackling a difficult problem has been recognised as an important part of software productivity even if at first glance it appears to be merely unproductive social chat around a coffee machine (Weinberg 1971; Root 1988). (Erickson and Salomon 1991) found that expert on-line searchers spent considerable time sharing information between themselves at their weekly status meetings.

Asynchronous collaboration on reference issues may occur by conventional means (face to face, telephone, letter or even publication such as 'The Exchange' in RQ) or can be computer mediated, either direct colleague-to-colleague email or via groups, such as the Stumpers-L mailing list.

Collaborative learning whether computer supported or not is of growing interest in schools and universities and includes aspects of other popular educational theories such as constructivism, problem based learning and situated learning (Lave and Wenger 1991). This carries implications for use of libraries and library resources and consequently for aspects of bibliographic instruction and support. They are likely to lead to far more diverse use of library resources by individuals and groups working on their own projects, rather than the traditional model of a class working through a prescribed set of readings, as well as greater involvement of library personnel in the development and operation of curricula.

The following sections consider user-user collaboration in the search for information in more detail.

Searcher Behaviour

(Bates 1989) notes the interactive way that people search. She proposes berrypicking as a model of searching. We can go on from there and propose interactions with other people as part of the berrypicking process. Those people might be librarians giving help or friends and colleagues offering suggestions or sharing past experiences. This is extending the idea of what an information search is, so that it can extend over time consisting of a chain of more intensive visible searching activities. This raises the need for representations that are persistent over time, similar to Brinck and Gomez's analysis and development of conversational props in the section on meeting support.

In a subsequent paper, (Bates 1990) considers the relationship between a user and a search interface in order to set an agenda for systems development. Bates' exploration of the range and degree of functionalities that could be provided in the interface to an information system reveals a gap in research and development activity, as much work is focused on the glamorous goal of the perfect automatic search. The aim, much like the aim of research in Artificial Intelligence is to automate a complex process - here the identification and location of the information that the user is looking for. We would concur with her analysis and add that the delineated more intermediate levels of support should include easy access and recourse to human based help for occasions when the user gets into difficulty. Furthermore, the levels of system support that she advocates activity on (including explicit representation of plans and goals) are precisely those that would be of advantage in supporting a more efficient collaborative interaction. The rush to automation which she describes is unfortunate for several reasons:

- As she identifies, there can be occasions when the user wants to be in control of the process
- The task may be currently impossible by analogy with some of the wilder claims of AI in the 1980s
- The intermediate research results, while being of great scholarly interest and vital to the progress to the ultimate goal, may not be usable
- The simpler, semi-automated mechanisms may just be better - yield interesting research avenues when studied, be more tractable, more usable, fit better with existing practice, including help-giving, be more empowering, but less glamorous in attracting research funding, be overshadowed by the grander claims of the more prestigious research projects.

Remote Reference

There are many possible forms of collaboration in the information search process and only a small proportion of them occur in synchronous and co-located situations. The 'gold standard' of the person-to-person reference interview has to be reconciled with the distributed networked users of information services. (Nardi and O'Day 1996) performed an ethnographic study of reference librarians as a way of understanding which aspects of the work realistically could and could not be supported by the use of intelligent agents. Remote Reference is a topic that deserves an ARIST chapter in its own right. There are however a number of reviews (Ferguson and Bunge 1997; Sloan 1997).

(Martin 1986) gives an early example of distance collaboration: the telephone reference interview. With the advent of collaborative technologies, variants on this theme become possible. (Swigger, Thomas et al. 1992) explicitly address the area of CSCW as a focus of interest, indeed using the remote information searching task almost as an arbitrary task to be used to investigate issues of generic relevance to CSCW. Although their later work focuses much more on what collaborative technologies can contribute to supporting information searching, this work serves as evidence that the exchange of ideas can be two-way: that studying the technological support an information searching context can not only be informed by CSCW but can give valuable insights into general CSCW research.

A later paper by (Swigger and Hartness 1996) investigated the remote synchronous support of searchers. A range of tools were provided consisting of text input/output screens designed to support different aspects of a search dialogue. The end user and the search intermediary used these screens to interact with each other and to present the results of the intermediary's searches on a range of databases. Surprisingly, their experiments showed that the remote collaborative interface was actually superior to face-to face interaction. One factor that may account for this is that the end users were novices in information searching and imposing the structure of the interface may help people to understand the nature of the interaction and how they are to participate in it.

Perhaps the simplest way of introducing remote reference is by email. (Abels 1996; Bushallow-Wilber, DeVinney et al. 1996; Hahn 1997). This can be easily integrated into newly developed web based searching environments. The advantages of simplicity and low cost of setup must be offset against the lack of structured support for the work activity. The same is true of many CSCW contexts. Indeed sometimes it can be sensible to begin using a familiar and easy to use but basic technology such as email to support the work practice and study the interaction in order to determine what is missing and what needs to be provided in terms of more sophisticated functionality.

In addition to text, live videoconferencing offers intriguing possibilities for supporting remote reference. It may be that the patron and librarian being able to see each other and undertake a variant of the traditional reference interview offers a smoother transition from the status quo in terms of familiarity and ease of use, even though it may require more sophisticated hardware and software and definitely much greater bandwidth. This area has been explored by (Sugimoto, Gotou et al. 1995; Morgan 1996) and (Lessick, Kjaer et al. 1997). The findings from the CSCW work on use of video noted above, especially the crucial importance of audio quality, need to be considered in designing a suitable practical configuration.

It is becoming clear that simply using a communication medium such as email is inadequate to support the detailed context-dependent interactions that occur between library staff and users (Twidale, Chaplin et al. 1997). Indeed, study of interactions between librarians and users reveal the problems inherent in many help-giving interactions - the act of seeking help (e.g., by walking to an enquiry desk) can destroy the context and short-term memory of the help-seeker's problem. Observations of librarian-user interactions show that a common activity is the re-construction of the sequence of actions that led to the impasse (Twidale, Chaplin et al. 1997). This re-construction is subject to the limitations of the user's memory and vocabulary.

Different communication media can be used to support users in different ways: provision of an FAQ repository is very different from a video-conferencing service. (Proctor, Goldenberg et al. 1998) characterise these differences in terms of effectiveness, availability and responsiveness: for example, an FAQ list may rate highly for responsiveness and availability but its effectiveness is unpredictable. These different forms of interactions are termed 'genres' and their prototype network reference consultation support system integrates several genres including email, text conferencing, audio and video (Proctor, Mckinlay et al. 1997). Their prototype also enhances the underlying communication facilities by allowing library staff to 'take control' of a user's remote session to interactively demonstrate features of the database that the user is accessing. This approach introduces notions of control and turn-taking into the dialogue which have to be explicitly included in the software - in a conventional library these aspects flow naturally from the affordances of the common physical space.

The notion of taking control of another user's session is also present in the C-TORI system (Hoppe and Zhao 1994), which allows synchronous collaborative searching, including cooperative query formulation, cooperative browsing of results and sharing of search histories. C-TORI also uses a WYSIWIS-like mode (What You See Is What I See) to allow one user to couple one user's environment to another so that two users can share the same interaction. For re-using previous work C-TORI has a shared history mechanism where elements of a user's query history can be copied and merged amongst the members of a group.

Collaborative Information Visualisation

Synchronous query formulation can also be realised by interacting in a virtual reality environment where both information and users can be visualised (Benford and Mariani 1994; Chalmers 1995). (Benford, Snowdon et al. 1995) describe a system, VR-VIBE that provides explicit support for cooperative information retrieval. This is research strongly rooted in the computer science traditions of CSCW and Virtual Reality (VR). As noted in an earlier section, collaboration relies on awareness of the activities of others. When VR is used to support CSCW, awareness can be supported by embodiment; providing appropriate virtual bodies. The constraints of memory, bandwidth and processing power lead to the use of 'blockies' - very simple representations that convey position and spatial orientation using only a few polygons and so are computationally inexpensive. Communication is provided synchronously over a live audio channel and asynchronously through annotations attached to documents.

This is not practical system in its current form, but an exploration of possibilities of radically different interfaces. As such it is a powerful example of the computer science research approach of building in order to learn, discover and refine the problem area. It is also an example of how a consideration of the issues and needs of LIS applications can feed back into general computer science research issues, in this case the design of VR environments. In the study of VR-VIBE it was noted that relevance decisions and the marking of objects as significant or boring by different users are highly likely to be subjective - not surprising to a librarian, but leading to a reassessment of the functionalities that may need to be provided in VR systems to support many different kinds of activity. The prior implicit assumption was that a VR environment should provide an objective view of the world. The VR-VIBE study revealed that there may sometimes be a need for subjectivity in VR applications.

Collaboration and Digital Libraries

Overview. There are now a significant number of digital library projects worldwide (Fox, Akseyn et al. 1995; Kessler 1996; Lesk 1997; Wolf, Ensor et al. 1998). As the review of Social Informatics by (Bishop and Star 1996) reveals, there is a growing awareness that initiatives in this area should not solely be technology-driven. Just as a recognition of the practical, commercial importance of taking account of the needs of users led to the growth of HCI and the growing analysis of work practice as part of CSCW, so digital libraries research and development needs to take greater account of the usefulness and usability of digital libraries (Fox, Hix et al. 1993) and the organisational context of that use (Kling and Elliot 1994; Elliott and Kling 1997). Development techniques such as user centred iterative design (VanHouse, Butler et al. 1996) can help this process. Techniques such as ethnography and social theory (Schiff, House et al. 1997) have provided new insights into the needs and practices of users. Furthermore, developers must make use of the expertise that a long tradition of analysis in library and information science can bring to bear on new manifestations of traditional problems.

Studies of user activity both with existing digital libraries and with conventional paper-based information as a means of informing future design can examine a range of activities from the conventional search and retrieval of information (Barry 1996) to annotation (Marshall 1997) and note-making (O'Hara, Smith et al. 1998). (O'Day and Jeffries 1993) did an ethnographic study of the uses of information search results by regular clients of professional information intermediaries in a commercial context. They found that all the clients acted as intermediaries in their turn, but also often creating new information artifacts by transforming and enhancing the search results before passing them on. This study is illustrative of the power of ethnography to reveal the broader context of work, in this case emphasising that information retrieval is not an end in itself but is part of a wider set of activities. Consequently systems such as digital libraries may need to have an awareness of this wider context in order to maximise their effectiveness. The O'Day and Jeffries study emphasised the importance of technologies for supporting the communication of the results, particularly after they had been further processed by the searchers. (Levy and Marshall 1995) examine some of the assumptions underlying the development of certain digital library projects. In particular they identify the widespread assumption that digital libraries are to be used by individuals working alone.

(Marshall, Shipman et al. 1994) illustrate the concepts of community memory (see the section on organisational memory), how it is acquired, understood and used. They consider the implications for digital libraries design. Note that community memory is much more ephemeral and rapidly evolving that the information usually stored in a traditional library. A lot of it consists of 'how-to' knowledge that enables people to get their work done. Much of it is informal, pragmatic, heuristic, approximate or involving coping behaviour, rather than definitive statements of well-researched study. Indeed some of it may well be wrong, or at least out of date. Nevertheless it can be of great use in helping people in their work. We can see its use in two levels. Firstly as a kind of information and work practice that a digital library ought to support. Secondly as a supporting technology that allows the digital library to work - the community memory of how to use it.

(Ehrlich and Cash 1994) also consider work on supporting corporate memory as part of digital libraries research. They raise interesting parallels with reference interviews. This implies that the support of the remote reference interview can be informed by studies of the more successful customer support organisations, e.g., (Pentland 1992). They identify three myths about information access that may inform the development of digital libraries:

1) Customers understand their own problems, they just don't know how to fix them

2) Customers would use on-line information if it was available

The latter myth can almost be a premise of the justification for the development of a digital library. If it is indeed a myth then the digital library is unlikely to be successful. This would not be because customers were lazy, but because locating the places in a vast quantity of documentation that contain the answers to their questions is so difficult.

3) Customer support analysts could work from home.

Rather they show how the analysts work collaboratively to help their customers. Corporate history databases are collectively created artefacts. Thus it is important to know something about who posted information (and have information about that person) in order to judge reliability and recency, as well as the opportunity to gather (directly from the author) information that was not recorded. Hence having contact (and Ehrlich & Cash advocate face-to-face contact) with the authors is claimed to be important in order to more effectively use the stored information.

A later work by the same authors (Ehrlich and Cash 1998 in press) makes the case for why the role of intermediaries is important and why it is likely to last despite predictions of disintermediation. They advocate technologies such as agents not to replace human intermediaries, but as tools for greater effectiveness. They also note the invisibility of collaboration to management, again leading to the danger that it is assumed that the work could equally be done away from the office. By contrast the analysts in the organisation studies were very sensitive to each others whereabouts. Indeed some used 'gopher-net' - "peeking over cubicle walls, even standing on chairs to see who was free." Face to face sessions, in offices, cubicles, hallways and over lunch were used was to address problems together and test hypotheses. Analysts found it useful to get a second opinion. In summary they claim "what these professionals were aware of, and what many researchers miss, is that while an individual can query the system, making use of that information is a collaborative activity". Their study emphasises the importance of peer support and relying on local acknowledged experts. It also raises a number of concerns with using the various technologies outlined above for supporting remote working. Ehrlich and Cash's study reveals the high quality of face to face working and thus what can potentially be lost. Considerable care needs to be given to attempting to support some of these subtle issues in developing technologies to support remote working.

(Paepcke 1996) studied information workers within a company. He identified the ways that information is shared between people, including different styles of working. Much of this work has parallels with the work of reference librarians in helping others to find information, or as acting as contact brokers, effecting introductions between a person needing help and the appropriate expert (see the section on matchmaking). It is clear that the knowledge that is possessed and traded in the technological environment studied is heterogeneous, constantly changing and lacking much classification. As such it is unlike say the books in a library that have been carefully catalogued, but much more like the know-how of the various librarians of how to choose between and use and integrate different databases and information systems.

(Robertson, Jitan et al. 1997) examine the possibilities for web-based collaborative library use in a corporate setting. They support dialogues between researchers and librarians via web pages. This work aimed to move from their older system of remote reference that relied on telephone and email. Study of this work revealed its highly collaborative nature and the open ended incremental nature of a stream of results (dialogues throughout a research interaction rather than a one-shot request for information, followed by a definitive single answer). The system developed aimed to support these identified needs. This includes the incremental delivery of 'results' and the recording usage information for accounting purposes. They make research interactions visible to take advantage of work already done and for general awareness (e.g., forming interest groups). They consider the importance of creating a 'sense of place' where researchers and clients go to check the status of requests.

Aids to Context (Re)Establishment)

Remote asynchronous collaborative work, of the kind we can expect to dominate in digital libraries, necessarily requires that information abut the work be recorded and communicated. In the case of information searching this implies that some record of the search process and search product be stored. Often this may be a simple free text description by the user; but in computerised environments there is the potential for detailed recording of a user's actions. Automatic recording has clear advantages in that a user's own memory may be partial, inaccurate and is not easily re-used; the disadvantages may be less obvious and are dealt with in the section on privacy. Many systems provide a record of a user's actions (usually in the form of 'these queries produced these hits') but:

- they are usually only partial records
- they are not digital objects that can be edited, communicated, annotated etc. without losing their structure

Once a system supports the creation of such an interaction history, it can used in many ways (Hoppe and Zhao 1994). Single-user uses include: reuse of earlier searches, error recovery, navigation, reminding and user modelling (Lee 1992). Providing a record of a search activity frees users from having to remember low-level goalstack details and enables them to concentrate on more strategic elements of the search process. Such a search object can be stored, highlighted, edited, annotated, replayed and re-executed: typically the kinds of activities that occur in tutorial and help-giving interactions (Lemaire and Moore 1994). Thus we see the communication of context, rather than just a communication channel, as a key requirement of a more supportive environment.

Recording-based support for asynchronous interactions has been referred to as a WYSNIWIST (What You See Now is What I Saw Then) paradigm (Manohar and Prakash 1995). In a multimedia collaborative environment this could extend to audio and video annotations in addition to replaying interactions via the computer interface. A variant of this approach is to record the same information but present it back to users in a slightly different format, for example, in a visualisation which allows easier recognition of certain aspects of the interaction. The ARIADNE system (Twidale, Nichols et al. 1995; Twidale and Nichols 1996; Twidale and Nichols 1998) replays a user’s interaction with a database as a 2-D visualisation which can be edited, annotated and communicated.

One potential use of recorded searches would be for library staff to collect a set of examples (classic mistakes, good strategies etc.) which could be sent to users who exhibit typical problems. These examples, as executable entities, could be much more powerful than paper-based descriptions. In this sense this approach has similarities to users-oriented transaction log analysis (Sandore 1993) and moves closer to user-modelling approaches where the system automatically detects familiar patterns in users' behaviour.

USER-USER COLLABORATION

Although it is now widely recognised that the World Wide Web/Internet has enabled a new low-cost model of publishing documents it has done the same for document fragments, evaluations, annotations and metadata. Whereas previously a library's database of information would be static (the items remain the same for each successive access) these new technologies allow dynamic contents. (Kantor 1994) describes this area as the 'feedback of exogenous information' and mentions examples of annotations and links (between documents). A

seminal article by (Koenig 1990) describes a variety of 'user-supplied data' including query terms and evaluations. (King, Kung et al. 1994) outline a proposal for a 'self-enriching library' (although there appears not to have been any subsequent implementation) and consider links, evaluative commentary and datasets as mechanisms for users to contribute to the library. They summarise that their idea is based on the proposition that, unlike traditional libraries, digital libraries can accept information from, as well as dispense information to, users, and that such libraries can be improved and enriched through use.

Implementation of systems that are improved by, or rely on, user feedback have been largely reported in the computer science literature. The form of the user feedback has been predominantly numerical ratings as they are easier to process computationally than free-text annotations. Although the ideas of annotation and rating are not new, the novel aspect of these systems is that one user's feedback can be computationally processed to enhance the system for others - even though the different users may not know of each other's existence.

Annotations and Ratings

In the Tapestry system, developed at Xerox PARC, users can attach annotations to the items they view, including ratings, free text comments and other indicators (Goldberg, Nichols et al. 1992). Because annotations can be supplied at any time - perhaps even years after receipt of the document itself - each annotation is stored as a separate document containing a link back to the original document. Users set up standing queries which can refer to annotation fields; thus, they can ask to receive documents which have been endorsed by other named users.

In Tapestry, annotations are attached to a whole document. By contrast, in the ComMentor system (Röscheisen, Morgensen et al. 1995) annotations may be attached at points *within* electronic documents. The annotations are accessed by buttons positioned within the text of the document. Moreover, annotations are associated with groups of users, so that a given reader only sees those annotations relevant to her own group. An alternative approach is found in the URN system (Brewer and Johnson 1994). Here users can insert, delete and rate the keywords associated with documents.

A rating is an indication of the usefulness, interest or quality of a document as viewed by a user, e.g., (Allen 1990). Ratings may be supplied deliberately by a user (*explicit feedback*), or may be computed by the system on the basis of the 'interest' which users show in a document (*implicit feedback*).

Explicit ratings are usually supplied on a several-point scale - for instance (Maltz 1994) uses a scale of *terrible*, *ok*, *good* and *great*. In such a system there is a priming problem (variously described as the ‘day one’ problem, the ‘cold start’ problem etc.), in that early users do not see the benefits of supplying ratings and so stop contributing. As fewer ratings are added the benefit of the system to a user falls, fewer users are active and the number of ratings can quickly fall to near-zero. These systems are prime examples of the need to consider the costs and benefits of cooperative systems (Grudin 1989). One potential solution is to create a population of ‘virtual users’ who rate one specific topic (e.g., books on cyberspace) highly and ignore everything else (Maes 1994).

Inferred ratings, from implicit feedback, have the advantage that they do not rely on a special action by users, but the clues they use are indirect and therefore rather ambivalent. Thus, the system may count the number of times a document is opened for reading, relative to the number of times its summary is displayed, or else the average time spent reading a document may be recorded (Nichols, Twidale et al. 1997). The PHOAKS system (Terveen, Hill et al. 1997) identifies significant mentions of URLs from Usenet messages and rates the recommended resources according to the number of mentions.

One way to use document ratings is to aggregate the ratings for each document into an overall quality score. The rating could be displayed during online inspection of document details, or it could be used to adjust the likelihood of the item being retrieved during a search. This approach may be useful within a group of people who all share a similar interest, but will be virtually useless for users at large, since many documents are of great interest to a few people and of zero interest to the rest. Another use of ratings is to create filters such as 'show me the articles that Jane Doe liked' (Maltz 1994); this allows a user to export their expertise to other users.

A more effective option is to use ratings values to identify pairs of searchers with similar interests: this is variously known as collaborative filtering, social filtering or recommender systems (Oard 1997). It seems the first appearance of this idea (in computational terms) was (Kochen and Wong 1962); they proposed a system for automatically passing details of interesting retrievals on to other appropriate users. Relevance judgements (i.e., binary ratings) were used to identify those pairs of users who tended to show interest in the same documents, the links being stored as a binary matrix.

One current example is the GroupLens system (Konstan, Miller et al. 1997), which allows collaborative filtering of Usenet Netnews articles by allowing users to assign ratings on a 5-point scale. A profile is constructed which contains all of the document ratings contributed by a user. Users with highly similar profiles are identified, and an item can then be recommended to a user if other similar users have already approved of it. (Shardanand and Maes 1995) describes the Ringo system (which has subsequently changed its name to HOMR and then to firefly) which uses a similar approach to make personalised recommendations about music albums and artists and uses the term *social information filtering*. (Hill, Stead et al. 1995) prefer the term *community of use* in describing a similar explicit rating scheme for recommending videos. Calculations of the 'similarity' of users can also be used for other purposes - such as matchmaking (see below).

Inferred ratings can be regarded as document *wear*; physical objects naturally show signs of wear caused by usage, but many digital objects do not reflect whether (and by whom) they have been used. Thus we can recreate the implicit information of the well thumbed, often used text on a library shelf that conveys its popularity compared to its peers on the same shelf by the degree of wear, and when picked up, falls open at a particularly popular page. This is just one of the kinds of information that can be recorded, but illustrates how the implicit power of paper can be overlooked in early implementation of a digital equivalent, and yet can serve as a starting point for firstly recovering useful functionality and subsequently introducing quite new functionalities that are infeasible without digitisation. A variety of *history-enriched digital objects* have been described including *edit wear* and *read wear* (Hill and Hollan 1994). That is, a document can record and display information on its history of edits and reading patterns; metadata on the document's history (Böhm and Rakow 1994). A library database that records and uses the searches of its users can be regarded as a history-enriched digital object. Concepts such as *browse wear* and *borrow wear* could be added to existing history-of-use information to facilitate user searching rather than just collection management. The open question is posed by (Kantor 1993): does such an addition to a system 'add more value than it costs to build and maintain?' Systems such as those described above are proliferating rapidly and we will not mention them all here: recent reviews can be found in (Oard 1997) and (Twidale, Nichols et al. 1997).

The personalisation of content is an issue that goes beyond the world of library and information science. The marketing community have realised that individualised advertising may well be more effective than mass marketing techniques. Thus, the term *one-to-one marketing* has been coined (Peppers and Rogers 1993). The central message for vendors is to integrate their information systems to enable all their customer-related knowledge to be deployed in highly targeted marketing aimed at increasing customer loyalty. With the appropriate information at their fingertips they can also perform recommending activities based on any implicit ratings they hold, such as those derived from purchase records, suggesting products that have been purchased by customers with similar buying patterns to the individual under consideration.

Although it may be stretching the term collaboration, the systems and techniques described in this section are potentially very important as they enable virtual communities to help their members without some of the restrictions of space, time or even identity. They permit a digital library, if its users so wish, to respond to requests such as "show me some articles that are new to me and that people with similar interests to me have found interesting".

Matchmaking

One of the problems inherent in user-user collaboration is that of how the users become aware of each other. In a physical library presence in the same area may indicate similar interests and an accidental meeting with another user could be the start of a collaborative relationship (Nichols and Twidale 1997). The major limiting factor on this scenario is the requirement for co-location and synchronicity (Chang and Rice 1993) – in the digital library computerisation of access to materials will force remote asynchronous interactions. There are several reasons why the introduction of people with similar interests, matchmaking, may be a useful service for a DL:

- the network of awareness of the activities of others is known to be a powerfully efficient mechanism, for example in academia leading to the formation of 'invisible colleges' (Crane 1972).
- traditional forms of matchmaking (such as attending international conferences for academics) serve as a useful proof of the concept. However, for new entrants to a research field, it can be difficult (and expensive) to use these methods.
- people working on similar projects may be unaware of each other (Foner and Crabtree 1996) - particularly if they have a background in different subject areas.
- other users may be useful filters and sources of recommendations (Nichols, Twidale et al. 1997) that can help to prevent the continuous 're-invention of the wheel'.

- some users, especially those new to a field, are not 'plugged-in' to the word-of-mouth in a subject area (Foner and Crabtree 1996).

Locating people with similar interests can be considered as equivalent to matching queries and documents: personal profiles can just as easily be compared with each other as they can with a stream of documents e.g., (Streeter and Lochbaum 1988; Ahuvia and Adelman 1992; Foner and Crabtree 1996). However, the idea of similar users, as used in collaborative filtering systems, provides an additional mechanism for introducing users to potential collaborators. This form of matchmaking is based on the similarity of users' evaluations or usage patterns; and so is not subject to self-reporting bias.

Potential Consequences for Professional Librarianship

(Swanson 1964) article, already cited as visionary about many aspects of advanced functionality also touches on the implications of these systems for the profession of librarianship. He notes the fear that discussions of automation can engender but claims that: "Librarians who accept systems analysis and mechanization as legitimate subjects to be studied and mastered will fall heir to the responsibility of planning future libraries and to planning tasks that machines will perform. There will be no threat to, nor question of, their professional status." Although technological developments described in this paper are usually described from the user's point of view it is important to consider the implications for the library staff. (Fowell and Levy 1995) describe these changes as contributing towards a new model of professional practice for librarians - one they term 'networked learner support'.

Privacy

With the introduction of new technologies it is important to consider their social impacts. With collaborative technologies, those impacts are likely to be all the greater, given that they can gave such an immediate effect of how we work and interact with one another. (Kling 1996) provides a good introduction to the broader issue of social implications. Here we will consider just one, the issue of privacy. (Bellotti and Sellen 1993) consider the privacy implications of a range of CSCW technologies. In the context of information access and retrieval and digital libraries, a major implication of the move to remote and asynchronous interactions is that computers will be storing increasing amounts of personal information on library users. In principle, a DL could record everything from borrowing physical books, through searches, purchases and the reading of individual pages (Nichols 1998).

We can take a general principle of a trade-off in such systems: *sacrificing privacy permits increased collaborative functionality.* It remains to be seen where people wish to locate themselves along this continuum. More accurately, people will wish to have control and position themselves at different places for different kinds of work, in a manner analogous to the different levels of privacy afforded by shared file systems.

In the case of digital libraries anonymous recording of usage can allow recommending activities. If named recording is permitted, additional functionality such as matchmaking becomes possible. The principle also applies in the case of non technological systems. Telling colleagues about what you are working on in the hopes of getting recommending feedback, or even just asking a librarian for help clearly involves a loss of privacy that may be regarded as undesirable and unacceptable in certain contexts and circumstances.

Librarians have a long tradition of protecting the privacy of their patrons. It may be that the collaborative functionalities and the benefits that they offer are considered insufficient to outweigh the actual or assumed potential loss of privacy. There are several valid concerns that are distinct but all significant:

- The loss of privacy from using a given functionality
- The fear of signing a blank cheque - that although the purported loss of privacy is acceptable (because it affords for using a certain form of collaborative benefit), the user does not trust that the information will not be used for some undeclared reason and so refuses to use the service
- The fear of setting a precedent – permitting the thin end of the wedge. Although the privacy / benefit tradeoff is acceptable, and the organisation is trusted to make appropriate use of the information, it is feared that by countenancing this minor, seemingly benign and voluntary erosion of privacy, it will be harder to oppose subsequent slight variants with more malign consequences

We can see the evolution of privacy policies occurring at various commercial websites which require the submission of demographic information and subsequently are able to track and make use of data based on all subsequent usage of the site.

One common approach to dealing with privacy problems is cryptography, e.g., (Bookstein 1996), and many Web systems employ such techniques for concealing credit card details. As more CSCW applications are deployed on the Internet it can be expected that more of them will include similar features for dealing with other types of personal information - including details of information searching activities.

CONCLUSION

There is much discussion of an emerging Information Society, or Information Economy. Although it is hard to comprehend major transitions while one is in the midst of one, there does indeed seem to be a combination of innovations and implementations of technologies that have the potential for supporting new ways of working and living. Research in CSCW has concentrated on technologies to support people working together to solve problems. A particular are of interest has been supporting people separated by distance, helping the establishment of distributed teams that can draw on a wider pool of expertise. Various studies of collaborative working and the use of technologies have revealed that difficulties that can arise if technologies are introduced without an understanding of the work context and the way that people work. We believe that many of these technologies can be used to support the information search and retrieval process, provided that careful account of that work process is made in the development of appropriate systems. The support of cooperative working is an approach that in some ways runs counter to much of the work in information retrieval research. We may regard the work on developing systems that are both more powerful and easier to use as a classic attempt at automation - trying to provide functionalities that an end user will be able to use without the bother and expense of going via a (human) intermediary. By contrast, we may regard a lot of the work in professional librarianship as an example of cooperative working with a rich history of practice, analysis and theory. These insights and perspectives should be used in designing collaborative technologies to further enhance the reach and kinds of support that can be offered. However, this should not be just a one way traffic in ideas; using the theory and technologies of CSCW to improve support and functionalities in libraries is one aspect, but equally, the theory and practical insights from existing collaborative work in libraries should inform CSCW research. This can be done by providing an important context of use for collaborative systems that is distinctly under-represented in the CSCW literature. Furthermore the substantial body of knowledge on organising information structures for usability by others and supporting searchers of information in collaborative interactions such as the reference literature have great potential to inform CSCW research and development.

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