

On Finding Things Out: Situating Organisational Knowledge in CSCW

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Abstract. We present a field study of an organisation which designs and constructs precision mechatronic devices, which typically integrate electronics, mechanical assemblies, computer hardware and software. We study how organisation members seek out answers to questions and solutions to problems as they arise in their work. We examine how project documentation is used, how chance encounters are capitalised upon, how advice is sought, the role of meetings, training and competence-enhancing activities, and the use of the organisation's information systems. We develop an account of 'finding things out' as an orderly and practically situated organisational affair, and compare this with recent studies in CSCW of 'expertise location'. The paper closes with an examination of potential technology development programs to support people in finding things out in organisations while suggesting the re-specification of research on 'organisational memory', 'knowledge management' and allied notions in CSCW.

Introduction

For a number of years, researchers and practitioners in a variety of communities have become engaged with questions of organisational knowledge. There are many strands to this interest. Some researchers regard the knowledge and skills of an organisation's members to be one of the prime resources of an organisation, yet one which is very hard to account for and manage. It is commonly pointed out that organisations lose valued assets as employees move on and some researchers have looked to technical means for externalising and recording members'

knowledge (e.g. Conklin and Begeman, 1988). Others are concerned to theorise the 'cognitive' aspects of social groups and organisations and put human collective phenomena on a similar theoretical footing to cognitive science's studies of individual mental phenomena (Hutchins, 1995). Relatedly, yet others write about 'organisational memory' and the management challenges there are once one takes the notion seriously (Walsh and Ungson, 1991).

In CSCW, these topics have been addressed for some time, attracting a range of contributions, including critical analyses (Bannon and Kuutti, 1996) and proposals for supportive technologies (e.g. McDonald and Ackerman, 2000). Most recently a research theme has emerged in CSCW which is concerned to study empirically knowledge and expertise within organisations and documenting the methods used by members to find things out.

McDonald and Ackerman's paper (1998) at CSCW'98 is a clear example of the 'turn to the empirical' in studies of organisational knowledge in CSCW. An extensive ethnographic and interview-based study was conducted at an organisation the authors call MSC which builds and supports turnkey medical and dental practice management systems. The authors were particularly concerned to document how members find relevant 'experts' in their organisation to solve problems as they arise. The study's analysis focuses on expertise identification and expertise selection. 'Identification' refers to how members go about discovering what information or special skills others have, while 'selection' concerns choosing among people with the required expertise (p 317) McDonald and Ackerman refer to seeking help as consisting of identification and selection phases (with identification generally preceding selection), though they recognise that in many actual cases participants 'iterate' (p.317) between these behaviours. Interestingly, McDonald and Ackerman identify a phenomenon they name 'escalation', "... the way in which people repair failures in identification and selection" (p.322). If one attempt at seeking help has failed "people ... may go to less desirable sources (e.g., to people with less expertise or to ill-maintained documents), sources with a higher psychological cost (e.g., to objectionable people), or cross departmental or even organisational boundaries". The impression one gets from McDonald and Ackerman is that there is a preferred ordering in help seeking at MSC: keep it local, avoid interrupting a very busy person, use reliable sources but, in the case of 'failure', be prepared to search further afield, risk a tiresome interruption, and use compromised sources

We have spent a little time describing McDonald and Ackerman's research as our study is an attempt to build cumulatively upon their work by presenting a new case in a different industrial sector (mechatronics). We do this to help extend the CSCW community's understanding of the observable methods that organisation members deploy to find things out. As we hope to show through the presentation of ethnographic detail, we have observed methods other than those documented by McDonald and Ackerman and, when we observe similar methods, they seem

to be deployed in ways which suggest another conceptualisation than that given in terms of expertise identification, selection and escalation.

We have conducted our study as part of a longstanding program of research at KTH into organisational knowledge and specifying technologies for its support (see, e.g., Tollmar et al., 1996). A key theme of this work has been to reject the aim of externalising and recording members' knowledge by technical means. Rather, we have been concerned to explore technologies which facilitate social contacts between individuals in such a way as to promote the exchange of knowledge. In this work, technologies mediate social relations rather than act as a shared storage device for 'organisational knowledge' or 'memory'. In addition to empirically elaborating the corpus of studies of expertise-seeking in organisations, then, we wish to proactively inform CSCW technology development. After a presentation of our empirical research, and a critical discussion of it in relation to other work in CSCW concerned with organisational knowledge, we will close with a consideration of the technical implications of our arguments. We pay particular attention as to whether CSCW need concern itself specifically with 'organisational memory/knowledge systems' as if these had a character distinct from other systems for supporting cooperative work.

The Study

The Company

The organisation studied, which we shall anonymise as 'CompC', is a consultancy company which is part of a larger Swedish corporation with similar companies spread all over the country. CompC describes itself, on its public Web pages, as active in the fields of precision mechanics, electronics, computer science, and the combination of these. At the beginning of our study there were about 100 employees within CompC. Critical organisational changes occurred at CompC during our work. First, CompC bought a smaller mechanical engineering company with 20 people, and as a result CompC was itself considerably re-organised. The new organisational form comprised of a total of ten sections (previously there were just eight) spread over three divisions. The software division had four sections, the hardware one, and the mechanical engineering division had four. An administration section completed the new organisational design. Second, CompC was split into two companies, one consisting of the mechanical division and one consisting of the software and hardware divisions.

CompC has many major Swedish industry companies as customers with whom it engages on a project basis. Usually a project lasts for about half a year, and involves about five to ten consultants. Some projects are carried out within CompC's own premises, while in other cases the consultants are located at the customer's office. Consultants working in projects within CompC's premises are physically co-located by project in a common work space, although they are

administratively organised by sections. To find new projects and customers is a major role of the section managers. When a section manager, usually together with a project manager and a technical 'expert', have reached an agreement with the customer, the management group (the section managers and the CEO) at CompC chose a project team. As we shall see, it is at moments of team formation that 'knowing who knows' plays a key role.

Research Methods

Our study is based on nearly a year's contact with CompC. The first author has spent much of this time at the organisation's premises engaged in ethnographic observation. She has sat in on a variety of meetings, as well as shadowed personnel in the conduct of their work. A corpus of materials has been collected which includes field notes, copies of the organisation's documents and brochures, drawings and other specifications which are important to the work and so forth. In addition, several managers, as well as consultants who do not have a management role, have been interviewed in an open-ended style, the discussions being tape-recorded and transcribed. Broadly, our orientation to field research follows the program of 'ethnomethodological ethnography' as exemplified in CSCW by Hughes et al. (1992) amongst several others. Our emphasis is on the description of the observable features of the work in terms which organisation members themselves would recognise. Having set this general scene, let us pick out some features of the work of CompC of analytic interest in the current context.

The Practical Use of Documentation

All projects within CompC are thoroughly documented. It is a strict policy that members regard to be well respected and carefully considered during all project work. In this section, we examine some features of how the organisation's archive of documents was routinely used.

What is Documented and What is Not?

Studies of documentation at least since Garfinkel (1967) have pointed out the selectivity of records. There is not a reasonable sense in which one can attempt to document 'everything'. Indeed, it is not always clear what 'everything' or 'enough' might mean, or at least not clear independently of consideration of purposes. The labour of documentation, and deliberating over what to document and what not, is a central task within a project at CompC. All persons in a project are involved, from time to time, in the documentation task. An archive for a project is likely to contain such heterogeneous elements as product specifications, including co-signed contractual forms of specification documents, order forms, fax papers, lists of suppliers, list of parts needed if something new is constructed, programming code listings and, in electronic form, copies of email written, etc.

Although much in the projects gets documented there are things that are left

out. One example concerns an incident where a change in technical equipment affected the precision of the machine built. One of the project members said to us:

The machine did not work as it should. A supplier came and rebuilt the machine. They were only to upgrade the electronics but it became clear that they actually did much more than that and thereby decreased the precision in one aspect. Then the question is when did this rebuilding take place and who did it. I talked to several colleagues who all gave me the same picture that it was the client's idea to rebuild the electronics. This had been done but there was no protocol on this and it was not written down. Instead I had to go on what I was told.

The change made was never documented, principally because it was made by another supplier under direct instruction from the client, and is not relevant for the documentation of the actions which CompC specifically engaged in and which they uniquely might be held accountable for. However, the problem (of the decreased precision) was solved by talking to other project members and, from that, conclusions were drawn about what had happened. It is worth noting that this example does not entail that more details should be documented than currently are. This did not occur as an upshot to our informant. He did not characterise the records as 'incomplete' or wanting. Other supplier's actions cannot become part of CompC's documentation on pain of doubling the task!

On-Line Overviews and Searching

Each project has its own on-line document overview, a spreadsheet with all documents listed. The document overview is searchable, but only in a limited way by words used in the title or in the document text. There are no advanced search functions available, only those offered by the standard office application which is used. While it is not possible to search in more than one document overview at a time, the absence of such a simple facility did not seem to trouble members. It appeared that people usually knew in which document overview, i.e., project, to look. Consider the following example.

Mike (a project manager) There was a cable that broke in a test. I needed the guy that made the investigation. I had no idea in which document he had written about it. He was working away so I could not reach him. I tried to search on 'cable' and I got all documents that had the word cable included in the text and by using a method of elimination I found what I needed.

By searching on a specific word in the document overview Mike could, by knowing who had written the document and which area it belonged to, find the right document and begin to address the problem of the broken cable. The simple search facilities work in conjunction with Mike's memory of the document and the person who would have written it. The document archive does not stand as a substitute for his organisational and project knowledge. On the contrary, the archive is used with the knowledge he has to effect the search.

It appears then that the simplified search procedure is satisfactory, as long as you have an idea of what you are looking for. Hence, organisational knowledge about the projects of CompC is often necessary for a successful search. While such knowledge could be commonly attributed to established members (like

Mike), the archive was hard to use for novitiates. However, this was not thought to be an extremely critical organisational problem at CompC as coming to know past projects through speaking to people about them would be precisely the main means for finding out about the organisation's work. Browsing the archive, then, was not seen as an actual or potential substitute for learning on the job from co-workers. For the most part, then, the tolerance of restricted search facilities goes hand-in-hand with a particular image of who would and would not need to access the documents and the circumstances under which this would occur.

Troubleshooting Documents and Situated Searching

To be sure, sometimes documentation is not clear enough without help from a key individual. Mike, a project manager, had been absent for a while. When he came back to the office he could not understand a hardware drawing one of the project members had done in his absence, but he was not available in the office. Mike started to look at the documentation, but did not understand it. He, therefore, contacted a section manager to see if he could explain what had been done. Here, we have an example of an organisation member moving from one resource to another in pursuing a solution. If the most ready-to-hand resource is unavailable, others will be turned to, whatever can get the job done in the available time.

The importance of project documentation was rather obvious when observing Mike. He could not find one of the binders that was usually kept in his bookshelf. He asked around and went looking for it in other rooms, but still could not find it. He needed a CAD drawing made by one of the mechanical engineers in the project in order to make an important decision. However, all the mechanists were away this day and could not be reached, even after persistent trying. Mike also could not find the electronic version of the CAD drawing. After a while he asked Susan, a project member sitting across the corridor, for help to find it. Mike had also called one of the companies manufacturing the construction to fax a drawing, but he still wanted to find the binder. After a while Susan happened across it in the room of a person who had recently started on the project. At the outset of his searches, Mike had not thought about this person as being part of the project and had, accordingly, looked elsewhere and pursued other means of exploration.

This example gives an impression of some quite typical themes in our ethnographic observation. First, the identity of people which are turned to in order to address a problem is a radically situated matter. Mike looks for the CAD drawing as a single item because he can't find the binder which normally contains it. He calls another company to see if they can fax the drawing because he cannot find either an electronic or printed form of it. Largely by happenstance, he finds the drawing in the room of a new team member. While there may be, all other things being equal, 'rules-of-thumb' or 'heuristics' (see McDonald and

Ackerman, 1998)¹, which Mike might wish to follow, other things rarely are equal and ad hoc-ing a search in the face of the specific situation Mike finds himself in is the order of the day. While cases like this bring the situated character of searches for information to the fore, situatedness in applying one's 'rules-of-thumb' is not an exceptional matter. As Garfinkel (1967) remarks, "rules do not apply themselves", they need to be artfully worked with in the face of everyday contingency, the occasional failures of documents being one such contingency.

While searching out people to talk to is a natural practice if documents are inadequate to the task, members often found themselves in the situation that key personnel simply were not contactable. This was a noticeable feature in an organisation involved in much on-site work. Often, then, there is no alternative but to artfully persist with documentation. In the example below a member of a project, Cindy, identified a mismatch in the documentation.

I was to find out what kind of components we had bought for this large 'Q-project' So I put together a list of all suppliers that had bought parts and I found there was one supplier that didn't have an address. In fact, there did not exist any such company. I tried to talk to Sam about it but couldn't because he was out of the office at the time. So I sat down and searched among the orders one by one. I did not find the company name which proved that we had not made any registered order from that company of these parts. Then you start getting suspicious that the supplier's list was written wrong. So I searched on a specific drawing and a component and found that it was two other suppliers that had manufactured these parts. I was then able to correct the suppliers list and work out which components we actually had purchased.

This further underlines our remarks about the artfulness of organisational information searching and problem solving. While there is an ordering to Cindy's conduct (notice anomaly, try to contact individual, do item-by-item search, test correctness of list, put things to rights), its exact course is clearly an outcome of the contingencies of the situation (e.g. Sam being unavailable) and Cindy's ingenuity, as it is of any heuristics as to who/what to use as a resource first.

Finding Things Out as a Practical Matter

We have been developing an argument that sees organisational knowledge as a practically situated affair. The rules-of-thumb one observes in people's conduct, or which participants themselves claim to be there, have to be understood in terms of the contingencies of the situations people find themselves in.

Let us give a further vivid example. A member of a project, Bill, first tried to solve a problem by asking the first author of this paper who was the only other person in the room at the time. Unfortunately, she did not have an answer to Bill's question and Bill instead turned to a reference book. Bill needed to use 'structs' in the C++ programming language in an advanced way and he did not know how to

¹ McDonald and Ackerman give particular attention to three heuristics: (i) keep it local; (ii) take into account the workloads of people approached; and (iii) take into account the known or likely 'performance' of experts consulted. It is the status of these with respect to members' real-time searching activity that we ultimately wish to examine.

do that. He still could not find what he was looking for and, therefore, walked out to the open space area where other project members were working. Bill saw a person standing talking to two other persons sitting at their desks, and said, "you are good at structs". They both walked into his room and solved the problem. Again we see an ordering from the ready-to-hand (Kristina!) to the less accessible (the person outside the office who was good at 'structs'). But, we also see a radical situatedness and contingency in who is asked: the researcher who happens to be there and the 'struct-man' who happens to be passing by (and noticeable through the open-plan office ecology, cf., e.g. Anderson and Sharrock, 1993)

The different considerations that members take account of in finding things out are many and varied. Members' methods for organisational knowing comprise a large and flexible repertoire to sustain their everyday enquiries. Our studies of CompC indicate that this repertoire is differently organised from the practices of others who have been studied (e.g. McDonald and Ackerman, 1998) or from what several theories of social conduct would have us believe. Let us say more.

A Culture of Helping Others Beyond Reciprocity

Many traditional social psychological theories of 'helping behaviour' point to the dilemmas involved in seeking and accepting help, on the one hand, and offering and giving it on the other (for reviews, see various contributions to Hewstone et al., 1988). To seek help is, on these views, a face-threatening act which manifests incompetence. To offer help can be seen to reinforce that view of the person seeking help: let me help you, you look like you need it! Help can be refused, withdrawn or not even sought on these grounds. Other theories would point to a 'market of favours' surrounding help organised around principles of reciprocity and equity: one should not, on these views, offer or receive help beyond some form of 'reciprocal balance' with others (again see Hewstone et al.). While these accounts point to recognisable phenomena (of course people do refuse help on the grounds that it is patronising or whatever), it seems inadvisable to erect any wide-ranging theory of helping-behaviour on these grounds. At CompC, we saw no evidence of people being reticent in asking for help on face-saving grounds. When they were reticent it was for practical, work-related reasons. Equally we saw no market of favours. People were delighted to help there and then, if they had the time and the ability. The demands of getting the job collectively done were more important than any insistence on or hope for return².

Steve needed to test a hardware construction. The person working with

2 The social psychological literature on helping and reciprocity often takes as its point of departure extraordinary events e.g. bystanders not intervening to help an injured person. Various theoretical notions are developed for these cases which are then read back into everyday interaction, no matter how implausibly. A full critique of this tendency, would take us way beyond the remit of the current paper. We find it necessary to mention this literature, though, as we feel that it lies behind some of the interpretation of interaction between organisation members one encounters in the CSCW literature and could occur to reader seeped in this theoretical background at this juncture in our paper.

hardware in the project was away from the office and directed Steve to a person he thought could help. However, this person was no longer working with testing hardware, but, as Steve had no one else to turn to, she contributed anyway

Another example: Steve had presented an internal course within CompC. One of the participants came and asked for advice about a problem, but Steve was extremely busy. Even so, he did not want to re-direct the query because the question was about a course topic he had specific responsibility for. Instead, Steve arranged to discuss the question at a later time. Of course, Steve could have sent the course-participant off to someone else. But, here and on this occasion, Steve's specific relationship to the course defeated this possibility.

Non-Local Help Freely Given

McDonald and Ackerman notice that members at MSC often seem to follow a heuristic of 'keep it local'. However, we (as they must have done) have observed numerous examples of non-local help being sought and freely given. One of the project managers, Mike, received a phone call from a person working at another corporation company. As it happened, the person calling was actually trying to reach another manager, who was not available. Mike himself could not solve the person's problem, but he took the time to distribute a memo about it to people he thought could help. Again we see an organisation member 'geared up' to help. The fact that the enquirer is from outside the company is not a countervailing consideration. Indeed, much effort was expended on this outsider, even though it would have been in one sense 'easier' to have asked the caller to try again when the manager he sought was available or to get the manager to call back.

What is more, we have several examples of personnel directly contacting customers for the answer to a query. If the matter were important, something that the customer might also know about, and if relations with the customer were cordial, there would be no necessary barrier to even these forms of non-local help.

Knowing the Suppliers

It is important for CompC to maintain good relations with suppliers of components. CompC projects typically involve some kind of physical device, e.g. medical equipment, for which components are sourced from different specialist suppliers. CompC's suppliers are selected not just because they offer competitive prices or reliable delivery. Suppliers are also preferred who can serve as reliable information sources that can be trusted to discuss problems with, e.g., when it is unclear what components to use in a construction. In this respect, suppliers are another source of non-local help. This help can go way beyond narrow understandings of customer-supplier relationships. Let us give an example:

Cindy I was looking for a certain type of sensor the other day and called around without success. Then I realised after a while that this was the wrong track, I should have another kind of sensor. One supplier was very helpful and we reasoned about it and found another way to

solve the problem to use [another kind of] sensor Yes I say but where can I find that kind then One moment he says, then he starts looking [and says] yes this and this supplier you could call and here is another one Then I think, but hey you are looking somewhere, do you have some kind of table or something [The supplier says] no I sit here and look in an advertisement catalogue with many suppliers sorted by branch, it is very good [I say] couldn't you fax me that page [The supplier says] yes sure and then I got that page with twenty suppliers that I could start calling.

Managers

Project and section managers were, by most persons interviewed, considered to be a main source of organisationally-relevant knowledge – especially section managers. To be there for questions asked by the section members was something one of the section managers saw as a basic role of a section manager. Managers tended to be the longer serving personnel within the organisation and, through this, had encountered and worked on more projects and were likely to be useful resources not just for their own knowledge but for their ability to 'know who knows' McDonald and Ackerman (1998) note the existence of personnel who serve as 'expertise concierges'. These are people with considerable knowledge about who knows what: they do not necessarily know the solution to a problem themselves but they know who might. At CompC, managers (especially section managers) often served this role. For many of the people we asked, it was their greater experience, rather than the management role per se or any status that might go with it, which was the justification for consulting managers in times of trouble In practice, though, whether a manager is consulted or not hinges on all the kinds of situated detail that we have been at pains to emphasise: the manager's availability, how quickly a solution is needed, whether a KTH ethnographer happens to be in the office right now and knows the answer, and so forth.

Not surprisingly, then, we observed people consulting managers, not because of the manager's credentials, but because the manager happened to be available. The example above where Mike turned to the hardware section manager for clarification of a technical drawing, rather than the consultant who authored the drawing and happened to be out of the office, is an instance of this Once again, we see the sheer availability of persons at the moment to be a major mitigating factor in knowing how to find something out.

Indeed, another feature of section managers, which made them commonly approached over work-issues, was their knowledge of the availability and commitments of others. Through routine reporting, section and project managers were likely to know what the consultants working for them were doing. A consultant working on a project who was taking a course would be highly likely to inform his section and project manager of this commitment. These people in turn would be able to manage how queries directed to the consultant would be dealt with. In short, to paraphrase McDonald and Ackerman, managers often acted as 'availability concierges' with special knowledge of the commitments of

others. In an organisation where workers may oftentimes be out of the office or committed on a variety of intercalated activities, knowing the availability of others is at least as important as knowing what others know.

To be sure, at CompC, the long-serving project and section managers tend to be the ones who 'know who knows' too. Commonly a project manager will be able to recall most of the persons active on recent projects. Indeed, we have seen this kind of remembering in practical action in supporting people's use of the document archive. Through working with people, especially if project teams rotate personnel over the years as is typically the case at CompC, the managers become acquainted with people's skills and competencies as a natural byproduct of project work. This is not to say, of course, that managers are never unable to give a recommendation as to who to ask for help.

In interview, Mike described a case where he neither had an answer to a question, nor did he know who else to ask.

Mike We had this new guy in the project We talked about different novel technical solutions that he should investigate He asked who should I talk to for further information In this case I had no idea I gave him the name of a section manager but that was actually a shot in the dark because usually he has a lot of answers to everything but not this time. By chance we had a meeting one morning where we had brought in a guy who had worked in this project before with the software We sat down and talked about different things and then we happened to come in on this subject and then he said yes but talk to A He is an expert on those things.

Once every week, all the section managers and the CEO met to review each ongoing project and discuss immediately upcoming ones. Important matters emerging in projects could be raised at this meeting. In this way, the meeting served as a means for participants to become aware of the status of projects that they were not personally involved with. A common topic at such meetings was the allocation of personnel to projects. An existing project might be deficient in a needed competence. A new project might need to have its mix of personnel assembled. A typical format for proceeding with the meeting would be to review the availability of consultants both at the time and over the months to follow, as well as picking out individuals with a needed skill, experience or interest. This review can be quite detailed, enabling all present to pick up on the availability of others and their skills as a natural byproduct of finding out about current projects, planning future ones and keeping the CEO informed. While managers may come to act as 'expertise concierges' (or 'availability concierges'), this should be seen as an entirely natural feature of their work and how it is organised.

Local Questions

We have noted a number of times how personnel at CompC can go beyond the immediately local context in order to find things out. Seeking help with a problem is noticeably opportunistic and a situated matter. Personnel do not experience it as 'face-threatening' or find themselves entering into a 'market of favours' to seek help beyond their own project team, if there are good practical work-related

reasons for so doing.

However, this is not to deny that many of the questions asked among the consultants are dealt with locally. Naturally, if these questions are project specific and other project team members are at hand, then it will often be possible to ‘keep it local’. This can be so, even if an answer is not immediately forthcoming. Indeed, questions can remain unanswered because the person identified as the one to address the issue is not available and no one else is regarded as having the specific knowledge needed.

For example, Bill, a member of the E project, was discussing whether to make some variables static or not with Barb, another project member. It depended on how the database should be accessed and they both agreed that they needed to discuss this with either the project manager or another project member with specific technical skills in C++, but both of these individuals were away for the rest of the week. In the absence of colleagues with the necessary combination of specific project and technical skills, Bill and Barb had to wait – to ask elsewhere, in this case, would not have been helpful or appropriate.

Let us give a second example of the occasional necessity of local knowledge about a specific project. A supplier to CompC had not fulfilled all of the requirements of a job they were to deliver and yet had raised an invoice at the agreed price. Under such circumstances, CompC would typically withhold full payment or request a credit with the supplier. It fell to Tim, a section manager, to decide exactly how this should be handled. The manager for the project itself, though, was away on a course. Tim did not feel that he knew the background to the problem well enough to make a decision there and then. As with Bill, Barb and their variable declaration problem, it was necessary to wait until uniquely relevant personnel became available again to discuss the matter.

Thus, keeping questions local within the project is often a matter of convenience and necessity. Questions can, simply, be impossible for persons outside the project to answer. In other words, whether a problem needs to be dealt with locally or can be raised elsewhere are practical matters, depending in great part on specific features of the problem and the project-context it arises in.

Existing Information Systems

Several different information systems exist at CompC, each relevant to supporting a different aspect of their work. We have already mentioned the on-line document archive of project-related material. Other systems are available by means of the company’s intranet, containing web pages divided into a list of links to, for example, important internal documents, common information for employees, address information to other companies within the corporation, internal web pages of the corporation, and so forth.

On each section’s web page there is a list of the section member’s names, technical skills, the project they currently work on, where the project is located

and how long it will last. On the pages of most of the sections of the software division there are also links to meeting protocols from section meetings and to the competence groups (about which, see below).

Although much information is available on the intranet (over 100 pages), we have observed that its pages are relatively rarely used in day-to-day working activity. Project-specific documents – drawings, programming code, diagrams, specifications, correspondence, et cetera – are the most likely things to be found on a consultant's screen, not corporate web pages.

However, one should not get the impression that the intranet is entirely useless. Indeed, we observed a number of specific uses of it. These include finding out individuals' telephone numbers, their usual physical location and mailing address, employment-related details such as how to apply for vacation time, local train service information, and other such mundane matters. One section manager had the habit of posting occasional articles on the intranet which a number of people found interesting. In addition, people new to the company were also often directed to the intranet as a way of finding out the basics. Similarly, people who had been working at a customer's site for a long time might use the intranet to alert them of changes to expect on return – for example, new personnel in their section. All these uses are rather more mundane and varied than one would perhaps expect from an information system functioning as an 'organisational memory' or as a 'knowledge management system'. At CompC, you are more likely to use the intranet to check on the time of the last train home than to find out who can tell you about structs in C++!

An impression should be developing about CompC's usage of their information systems. Different systems have different organisationally-specific purposes in their use. The on-line project document system is predominantly used for archival purposes. The intranet is used for a host of everyday purposes which, though seemingly mundane, are nevertheless important to the work (missing the last train home could be a serious matter!). However, none of these systems substitute more routine methods such as talking to others.

Learning on the Job

We have examined the various ways in which people at CompC search out others who can help with problems they encounter in their work. We have looked at some aspects of how project documentation is consulted. We have seen how seeking out expertise or asking for help is a situated affair, contingent upon the availability of others amongst other considerations. Such occasioned instances of raising problems, asking questions or seeking help take place against a background of what we can call 'learning on the job'. That is, CompC workers are continually listening in, finding things out, picking up details relevant to their own and other's projects as well as to CompC's work in general and the kind of business it does. In a sense, learning often takes place as a 'side-effect' of having

a problem that needs help from others. Being helped with a solution is often at one and the same time to learn about a technique, principle or useful component which can be used again in similar circumstances in the future. Even when individuals do not have a particular problem that is concerning them, they are often attuned to opportunities to learn and enhance their skills as part of everyday work on projects. In short, much learning takes place as a natural feature of ordinary participation in project work.

In addition to the hurly-burly of everyday activities, there are occasions for learning which are more staged or planned as such. Let us discuss some of these.

Training

CompC provides an introductory course for new, less experienced recruits to the organisation. This is three to five weeks in duration. The course tends to focus on project organisation and management issues, and general matters about CompC, rather than specialised technical topics. Training courses related to more specialised topics are provided or arranged when the need becomes apparent. For example, a course dedicated to BlueTooth was purchased from external consultants with ten people from CompC in attendance.

The E-project at CompC is a long-term activity of several years' duration with a reliable customer whose business is well known within CompC. This project involves only software. Unlike other CompC projects, it is not necessary to get software to interoperate with electronic or mechanical components. The work involves maintaining and updating existing software while also addressing new specifications. This balance of the old and the new in the work, its relative homogeneity (software only) and the fact that it takes place with a well established customer makes the E-project well suited for new, less experienced employees to be assigned to. Indeed, this is routine practice. During management meetings, when personnel are assigned to projects, the E-project is, in many respects, the default assignment for new recruits.

Competence Groups

In 1996, CompC inaugurated 'competence groups' as a means for giving shape to the development of people's knowledge and skills. These enable personnel, who might otherwise be working on different projects, to help each other and to attend or arrange courses or share literature. Members of a competence group might even work together to build a small application or part of a development platform if that was considered to be the most effective way of enhancing their abilities. Additionally, people without a current project might devote their time to building up the resources of a competence group.

Competence groups have formed around topics such as 'internet', 'database techniques', 'user interfaces' and so forth. Typically, a competence group would have between three and eight members with individuals being constrained to be

members of only one group at any one time. Groups pass in and out of existence. A group might break up if collectively the members have learned as much about the topic as they wish at the moment or if membership dwindles to one or two persons or if new topics come to be seen as more urgent or relevant. Commonly, new topics and groups emerge as a result of proposals consultants make to the section manager or following from a manager's suggestion. There is no formal procedure governing the formation of groups but CompC does insist that each consultant is a member of one. Equally, there is not a formal allocation of resources to competence groups (e.g. they do not have a 'budget'). However, the existence of a group under a particular topic gives a warrant to group members to ask section managers for support on topic-relevant activities. For example, a consultant is relatively more likely to be released to attend a BlueTooth course if mobile computing has been the topic of their competence group.

Discussion

We have presented in detail some of the methods used by personnel at a consultancy company specialising in mechatronics to find things out. This has included examinations of how documents are used, how people are sought out and consulted, how opportunistic encounters are exploited, how workers learn on the job, how specific support for training and competence development is offered, and how their workplace enables encounters between individuals to take place through which expertise might be disseminated. Our emphasis throughout has been to attend to the real-time, social interactional features of 'knowing' and 'coming to know' as these become visible as everyday organisational affairs. We would like to draw out some features of our research so as to connect with questions of expertise and organisational knowledge as these topics have been discussed in the CSCW literature. We will also suggest some emphases for technology development which we believe arise from our work

Situatedness and Accomplishing Orderliness

An overwhelming feature of our observations has been the situatedness of members' deployment of methods to find things out (as also strongly emphasised by Ackerman and Halverson, 1998). What a worker at CompC will do is very variable with respect to the character of the problem and the nature of the situation she finds herself in as attempts to seek solutions unfold. Mike assembled a variety of methods to find the missing CAD drawing (see above). These included looking around the office, trying to contact the mechanical engineers, searching for the electronic version and telling others of his plight. Cindy noticed an anomaly with a components listing, tried to contact someone, did an item-by-item check. And so forth. In both of these cases, as in others we have observed, there is a clear ordering to members' conduct as they try to find things out but exactly how their searches unfold, and exactly which method they will turn to

next, is strongly contextually tied at each moment

A clearly noticeable feature of work at CompC is how the availability of personnel impacts upon what can be done. Workers can be at the customer's site, away on courses or attending to other matters which take them away from the office. At any moment who will and who will not be present at their workstation or in their project room is a highly contingent matter. While many features contribute to the situatedness and contingency involved in person's attempts to get answer to questions or to solve problem, it is perhaps the sheer availability of people which most notably influences the course of members' activities.

The fact that people are often not available when desired is, of course, a common non-exceptional feature of contemporary working life. Indeed, many of CompC's 'arrangements' can be thought of as ways to compensate for this or help negotiate it. Managers are folk who are likely to know the commitments of others. Our awkward coinage of 'availability concierge' parallels McDonald and Ackerman's notion of 'expertise concierge' in underlining this utterly mundane feature of managers' knowledge at CompC. The weekly meetings with the CEO allow the exchange of knowledge about persons' availability, as do routine project reporting relationships. The office ecology further enables co-workers to check on each other's presence and freedom to help. It is hardly a grand empirical finding to point out that the availability of people is a major mitigating factor in how people at CompC seek help and advice on work issues. But it does point us in a particular design direction – a matter we return to.

While people within the same project are commonly consulted first when problems arise, this is more for mundane reasons such that co-project members are more likely to share concerns about the issue in question as well as knowledge of the context in which to solve it than others might. It is rarely at CompC to do with any "higher psychological cost" or critical organisational obstruction in looking for help further afield. Indeed, we have many examples of non-local help being freely given, even when this means consulting customers and suppliers. If the supplier in question is trusted and long-serving, they may indeed be the very best source of information. It all depends upon the specific nature of the parties involved, the problem and the situation people find themselves in.

The varied practices surrounding the use of documentation further illustrate our emphasis on the situatedness and contingency in people's efforts at findings things out. We have argued that document archives do not stand in lieu of skilled know-how and organisational knowledge. They are not a repository or an externalization of what people know such that they could substitute the embodied knowledge people do have. On the contrary, as evidenced by CompC's tolerance of unsophisticated search facilities, it is organisational knowledge and skill which enable effective and appropriate use of the archives in the first place. Naturally, one can imagine CompC using more advanced document systems and we do not wish to be heard as arguing that they shouldn't. Rather, our point is to understand

the purposes behind project documentation and consultation. The level and kind of detail in a project's archive relates, not to some ideal of a 'perfect' record, but oftentimes to what the organisation might be held accountable for in the future. Supporting the traceability of design decisions is more important than developing an organisational 'knowledge system' whether it is one which supposedly externalises worker-skill or supports 'knowledge brokerage' or whatever. To use organisational records for this purpose would be quite a shift in what they are seen as relevant for and, hence, what they currently consist of.

Under such circumstances, it is entirely typical to work with document archives alongside consulting original authors or other project members when required. However, our observations would not be consistent with any simplification of the activities surrounding document usage. We cannot claim that CompC personnel noticeably follow a heuristic such as 'ask the people first, only then look to project documentation' (or its opposite). If the relevant document is already there, open on your desk, to be sure it might be looked at first. If a document cannot be found, then a relevant person might be approached...if they are available, not on a course, not tied up with urgent business...and so forth. There are many, variable problems which occasion consulting documents and many, varied courses of action in which members partake in consequence.

A summary impression should be developing from our work by now. Our study has emphasised following organisational members in real-time as they address problems in their work and described how they locally and situatedly order their searchings for information and persons for help. In each example we have presented, members are seen to go about such searches in an orderly way. They first do one thing, then do another. If one method fails, another will be explored. And so forth. However, this orderliness arises through locally organised activity. It is not provided for through the mere execution of a rule of conduct. Orderliness in searching out information is a practical accomplishment.

This makes us sceptical of theoretical schemas which might simplify the complexity of observed behaviour. On the basis of their study at MSC, McDonald and Ackerman argue that finding things out in an organisation is often a matter of expertise 'identification' and person 'selection' phases, and that people quite commonly reiterate between them, if necessary 'escalating' their searches to more organisational distant or undesirable sources. While we have observed moments which fit this schema of how searching out expertise is ordered, we have described many which do not. For us, 'escalation' has no special status as description of the orderliness in members' conduct. The subtle rationality of organisational conduct cannot be captured in any simple schema or small set of heuristics. Any heuristic one might identify from our study like 'keep it local' would have no special status above 'go non-local if you have a special trusted source'. Keeping it local and other phenomena are, when observed, a practical *outcome* of members' orderly responses to the situation, they are not the result of

a *prior* heuristic appropriately applied. Or, to put the point another way, there is a difference between observable phenomena and the organisational rationale for them. We argue, for example, that problems tend to be kept local *because* co-project members are likely to share contexts of project-relevant knowledge and *because* persons and information in the local environment are more likely to be ready-to-hand. If either of those situational conditions turn out false, then naturally members' activities will be differently ordered.

Designing 'Organisational Knowledge Systems'

These points become important when one considers implications for systems design. McDonald and Ackerman (2000) present ER (for Expertise Recommender) which applies technologies from 'recommendation systems' to problems of expertise location in organisations. This is clearly innovative work in the area of organisational knowledge systems and represents a substantial development activity as both a generic platform and a specific application instance for supporting MSC are worked through. However, in many respects, the platform reifies the model of expertise location we have argued does not compellingly fit our data. ER has separate architectural components for expertise identification and selection, and the process of escalation is specifically supported at a system architectural, and not merely application, level. We have noted above how important the availability of persons and an awareness of others' commitments are in shaping the orderliness of members' efforts to find things out. Architectural components corresponding to this feature (e.g. ones which inform on the patterns of people's availability) are not given focal design effort in ER. ER clearly represents a particular design trajectory for organisational knowledge systems and one which may well work in some organisational settings. However, our study suggests to us an alternative design orientation and set of development priorities.

As a first step it is important to note that expertise and information location problems at CompC, though irksome, are not regarded as major organisational concerns. CompC's mission is not jeopardised because its workers can't get the information they need. In other words, there's no convincing organisational mandate for the extensive redesign of information systems there. The practices we have described, for the most part, work well. If this were not the case, and this was manifest to members and researchers equally, then we would feel more entitled to suggest a radical intervention. The 'lack of fit' of the assumptions embodied in a technical system with observable social practice would not then be an argument against considering a system as changing practice would be the whole point. As it is, as researchers, we can learn from CompC.

In their existing use of IT, CompC are happy to work with a family of loosely connected purpose-specific systems. While the non-integration of systems is an occasional problem, it is (again) not mission-critical. There is no strong

organisational reason to devote considerable resources to integrating systems. There is not a business sector which would clearly profit from web-delivery of services and products so there are not, in that respect, strong arguments to integrate around internet/intranet technologies. Equally, their document database has predominantly and specifically an archival function so developing that into a core resource to support additional activities might also be effort ill-spent. It must be noted that the ER system, when applied to real records from MSC, involved McDonald and Ackerman in extensive pre-processing of data to get it into a form that their algorithms could work with. Such a degree of preparatory work and algorithm fine-tuning would be very hard to justify at CompC, even if we could find an analogous records database (and the document archive is not it).

In a sense, it is the entire panoply of office ecology, unexpected encounters, scheduled meetings, training and competence groups which – together with a varied family of information systems – constitute CompC's 'organisational knowledge system' (cf. Anderson and Sharrock, 1993). And an adequately effective one it is too. Improvements need to be seen against that background and here we have a number of modest suggestions.

Recall that an awareness of others' activities and availability is a key issue in shaping how expertise and information are sought. Supporting activity awareness is a longstanding topic in CSCW and has led to a number of technical developments (e.g. Sandor et al., 1997). This existing line of research can be given a new inflection given our studies of expertise and information seeking in CompC. That is, giving persons a rich understanding of the activities of their co-workers and how their engagement and disengagement with matters of varying urgency and importance is patterned over time might be a valuable resource for facilitating expertise and information seeking. While we (as others have done) started out investigating 'expertise location' and related topics under the rubrics of 'organisational memory' and 'organisational knowledge systems', our empirical work takes us to other topics (how to enhance members' awareness of activity and personal availability).

In this regard the research exemplified by @work (Tollmar et al, 1996) seems to us to be a promising lightweight approach to consider in contexts like CompC. @work enables users to set availability information viewed by others in a variety of simple ways. The essential design emphasis of @work is to capture awareness information from existing sources and allow easy access to awareness setting mechanisms which do not require special hardware or complex applications to be used. This lightweight approach of increasing other person's awareness of one's availability informs the design work we are now embarking on. We want to explore how to support people in knowing about others' availability and activities using technology such as mobile phones, swipe cards, sensors etc, that build upon systems and routines already in place in people's work.

Our fundamental concerns are shared with many researchers in CSCW

studying 'organisational knowledge' We wish to study how people search out information and expertise and we wish to consider technical support for this. However, our study suggests that not all organisations would benefit from systems directly dedicated to the support of such matters especially if those systems would require extensive technical work or organisational redesign in turn. In our case, we feel that considering lightweight approaches which add value to existing systems would be a better strategy. As such we have indicated how research in a different subfield in CSCW – one more concerned with 'awareness systems' than 'organisational knowledge or memory' – might be most appropriately built upon, at least for applications in organisations like the one we have studied. This conclusion we hope is generally instructive. If one's concern is for supporting some feature of cooperative work, X, one does not necessarily have to build an X-system. In our case, the situated features of organisational knowledge have led us to re-situate systems which might support it.

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