Special feature: Healthcare technology assessment

Work, knowledge and argument in specialist consultations: incorporating tacit knowledge into system design and development

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Abstract—*To understand how video telephone technology could support consultations between pathologists and surgeons, this study looked at what constitutes 'work' in clinical consultations. Using several methods (participant observation, video and interviews), we found pathologists and surgeons both share and do not share similar understandings of what a consultation is, what one should achieve in a consultation, and what in fact constitutes a 'successful' consultation. Furthermore, the same objects of consultation (the products of 'offstage' work) can be used and defined quite differently depending on how a consultation is framed. Differences and disjunctions like these have to be better understood if computer-supported co-operative healthcare work (CSCHW) applications are to be adopted and accepted.*

Keywords—*Consultation, General surgery, Pathology, System design, Videophone*

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1 Introduction

THE PRACTICES and knowledge that constitute clinical laboratory work have been little studied. This is surprising given that there is a substantial, analytically strong literature on laboratory practice in science (LATOUR and WOOLGAR, 1979; KNORR-CETINA, 1981; STAR, 1983; LYNCH, 1985; GOODING, 1990). Although this work is not as well known as it should be, it does have intellectual and pragmatic yield. Not only could it give clinical development efforts a firmer empirical base, but also it could extend medical anthropology and sociology (BARTLEY, 1990).

Other kinds of 'offstage' work such as physician consultations, say between specialties, conferences and rounds, where much of the didactic teaching in medicine is done, have also been ignored. In short, although this work is important and significant, it has been little studied. Also, largely because of the methods used and stances taken towards work as an object of study, the medical community tends to misunderstand its own situated practice. In fact, in the medical informatics literature it is difficult to find any reference to consultations or to applications and environments designed to support the work and communicative practices we call 'consultations' (but see TIMPKA, 1989).

If information systems are to support or improve offstage clinical work, it is necessary to take a close look at this work as it naturally occurs. This paper will raise some questions about the actual nature of clinical work and the structures, resources and agendas that inform it. While the nature of clinical work varies from situation to situation, specialty to specialty, department to department, rank to rank, these differences have not been systematically explored (for neurology, however, see NYCE and GRAVES, 1990).

In particular, this study looked at the resources that support consultations between clinical pathologists at a university hospital and surgeons at a community hospital. It was to investigate whether videophone technology might improve the consultation process between clinical pathologists and surgeons. What we wanted to better understand were the knowledge and work routines that constitute 'a clinical consultation'. Thus, the study was based on an interest in the knowledge and practices that define offstage clerical work.

2 Theory and method

To describe clinical work as though it is rule driven or rule bound risks oversimplification. However, whether clinical work can be best described as muddling through or as repair work remains to be seen (LINDBLOM, 1959; GARFINKEL, 1967). Today what is clear is that clinical work, like all work, is situationally determined and defined. While this kind of approach challenges the kind of models cognitive and computer science offer us, it can bring to the development community a more adequate understanding of the work and knowledge practices towards which they wish to build (FORSYTHE and BUCHANAN, 1991). There is in fact emerging a 'second generation' of design methodologies for healthcare that tries to do just

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this (TIMPKA *et al.*, 1991). In short, to be successful, system design agendas must rest on empirical research into work routines found, say, in clinics, not on abstract models of information processing.

This paper reports some results of an eight-month field study (October 1991–May 1992). It is a joint study carried out by staff from the Centre for Medical Technology Assessment and the Department of Computer & Information Science, Linköping University, Linköping, Sweden. The study was carried out at the University Hospital in Linköping (UiL), a teaching and referral hospital in Linköping, and at a hospital in Motala some 40 km from Linköping.

In this study, three qualitative methods (participant observation, video and interviews) were used. Participant observation is a set of methods based on learning the subject's 'world' by participating in, observing and questioning them about their routine activities. In UiL's Department of Clinical Pathology and the Department of Surgery at Motala, office, clinical and laboratory work was systematically observed. At UiL, several teaching conferences in pathology were also videotaped.

A number of physicians, surgeons, residents, nurses, technicians and support staff were interviewed at each hospital. Both departments provided us with forms and documents. Other published texts, written by pathologists and surgeons, were consulted in this study.

3 Results

The results have been divided into two sections. A description and an analysis of the consultations is presented; then the implications this work has for videophone technology are discussed.

3.1 *The practice of pathology consultations*

It became clear that pathology consultations do not set the ground rules for surgical practice. However, their endpoints (findings) are used as evidence to argue for one form of surgical action over another. Essentially these consultations help define what constitutes legitimate (permissible) surgical action. In short, these consultations can be seen as an important rhetorical form that, like the rest of medicine, helps define what should be done (TIMPKA and NYCE, 1992).

For surgeons, we found a 'successful' (a good) consultation is one that answers (or helps answer) questions regarding clinical action. This, from a surgeon's point of view, is 'getting the right results'. However, in part given the exigencies of hospital laboratory work (time, cost, workload, sample quality and the like), diagnostic certainty can be difficult to achieve. Furthermore, a pathological consultation is an exercise in practical reasoning, the application of scientific knowledge to particular, individual cases, and this is neither easy nor certain work. What these consultations provide, case by case, are different kinds and degrees of certainty. When there is too little or sometimes too much, depending on the case, the findings, the evidence and work objects can be renegotiated and reinterpreted.

Pathology consultations do not rest on face-to-face communication. In fact, the pathologists and surgeons we studied seldom even telephoned each other about a report or its findings, except when there were time constraints. In brief, these consultations were paper based and were largely an exchange of (and a negotiation over) paper (reports, case notes) and data (e.g. specimens, slides). This was less true of teaching conferences in pathology, but few of the surgeons we talked with attended them.

While our research shows that the production of slides, the 'fixing' of a specimen, is pragmatic, contingent work, in teaching conferences slides become part of particular arguments. When they are shown and discussed, it is in a serial, progressive order. They in short possess directionality and are used to advance a particular interpretation. They help make a particular diagnosis. They argue for a particular clinical choice. In other words, slides here have much in common with propositions in an argument. They move an audience from A to B. They can advance an argument or they can be used to take one apart. Slides then can be seen as something like visual building blocks. Like axioms in a proof, they form the basis of arguments.

3.2 *Implications for system design*

There are several boundary objects, objects that support negotiations, discussions and interpretations (STAR, 1989), critical to pathology consultations. Among these are the microscope and the slide. While they were not difficult to identify, to see that they serve as boundary objects did require some analysis. This is largely because pathologists and surgeons both take them so much for granted. However, while explicitly part of daily practice, embedded in these objects are some attributes and elements it seems worth building on. What follows, based on a literature review and our field studies, is a discussion of some possible design options and choices.

4 Discussion

If the work and negotiations that pathologists and surgeons do together are to be supported, they have to be better understood. What became clear in this study is that certain objects (laboratory findings) were defined in and through clinical practice. This is not to deny their 'factuality'. However, it does suggest that these negotiations, because they are central to clinical practice, need to be supported. Opening this up as a design question was a positive result of the research we did.

Because in consultations information and work sharing of many kinds occur, often across different categories and communities of practitioners, they can be problematic to study and to design for. The work and knowledge practices we looked at, what pathologists and surgeons bring to and employ in a 'consultation', were particularly difficult to study because the parties involved seldom met and were separated by distance. Furthermore the pathologists and surgeons regarded this as quite natural. This is not unique, however. In a number of consultations in medicine, face-to-face communication occurs only when repair work, such as clarification and elaboration, is necessary.

The offstage work these consultations rest upon, the 'invisible' work practices in pathology departments, has also been ignored. In short, the negotiations and interpretive labour that leads to certain objects (biopsy samples and specimens, slides and reports) being taken seriously (defined as evidence) has largely gone unreported. In the literature there is some recognition that the various kinds of work pathologists do is largely interpretive work. For example one pathologist, when discussing histopathology, had this to say about it: 'Much of our work is based on what is essentially a personal opinion' (RAMSAY, 1991, p. 354). Nevertheless, in the literature, much more attention has been given to problems of error and technique (LEE, 1989, p. 1010). However, at the same time, as Lee explains, in pathology, unlike in other laboratory disciplines, laboratory performance 'is very much a function of consultant (read interpretive) competence' (LEE, 1989, p. 1010). Still,

pathologists, when the subject comes up, tend to gloss (discuss and cover) all this as issues and questions about accuracy, not interpretation.

On the other hand, as PEDLER and BINT point out (and we found much the same thing), 'users . . . take the accuracy of the results for granted' (1991, p. 6). What the surgeons we talked with wanted to know is what these results (and the reports of these results) 'mean'. When a report was questioned (and this occurred very infrequently), it was on these grounds. In short, it was not accuracy that for the most part interested our surgeons but rather using these results and reports to make certain kinds of clinical choices. In other words, the surgeons wanted to know (and here they often had to rely on pathologists, their work and their reports about tissue samples) what they should do next. For surgeons of course this is largely a question of whether and how 'to cut' (operate).

This project was to look at how videophone technology might support consultations of this kind. However, because the consultations we studied were exchanges of paper (reports, case notes) and data (e.g. specimens, slides), the usual applications for videophones, i.e. face-to-face work, did not seem very applicable. In the computer-supported co-operative work (CSCW) literature, it is the communicative aspects of group and individual professional work that tends to be explored. The CSCW literature (for a review, see JOHANSEN, 1988) has also addressed the issue of working across time and distance. However, the solutions posed to both these problems, e.g. meeting room and whiteboard applications, do not seem to be particularly appropriate here.

However, recently there has been some interest shown in extending the functionality of ordinary, everyday work objects. As boundary objects, they support both alternative readings and negotiations over these alternative readings (STAR, 1989). As such (and this is an area the CSCW literature has not emphasised) both domain knowledge and exchange could be supported and extended (NARDI and MILLER, 1991, p. 162). With the practice-specific knowledge requirements pathologists and surgeons bring to these consultations, these would be important attributes to focus on, support and design for. In addition, supporting, in flexible ways, the manipulation of these objects would allow for tacit knowledge to be exchanged (HENDERSON, 1991, p. 450). Given what surgeons and pathologists do and do not share, this would be a useful design goal.

The question was how to use videophone technology to best support the kinds of practical reasoning and labour that make up a pathology consultation. This technology for example could be used to provide long-distance microscopy. Building on this model and our understanding of microscopy, however preliminary, as habitual practice suggests that extending microscopy and microscope views in this way would create a strong boundary object (for enhanced, distributed scientific microscopy see MERCURIO *et al.*, 1992). Furthermore, from what we know of clinical work, building on traditional practice and artefacts makes good design sense. We suggest, as a trial, that synchronous voice, viewing and microscopy supported by efficient record delivery (fax, email) be established between the hospitals in Linköping and Motala. In this trial, power or magnification, focus and slide position could be controlled from either site. This would allow both pathologist(s) and the surgeon(s) to see what the other sees and for either to suggest alternative slides or areas to view.

Given the ISDN technology available to us, graphics tools (perhaps light pens) with which users could draw could also be implemented. These tools could be used much like pointers in teaching conferences—again building on familiar models—to direct attention to, to question and to clarify. This would allow each party, and here the conference metaphor would be elaborated upon, to support readings, re-readings and negotiations over these readings. This could extend (and make more intelligible to the other) the domain-specific and practice-derived knowledge each party brings to these consultations. This in turn could help avoid what in the literature is called 'poor liaison between clinicians and pathologists' (LILLEYMAN, 1990, p. 90).

4.1 *Future work: the need for a visual toolbox*

Rather than just support or build on existing work resources and practices, with videophone technology it may also be possible to extend them in new directions. It is clear from our studies and a review of the literature that the slide is a strong boundary object. It could be an innovative one too.

The visual toolbox we have proposed to support long-distance microscopy would allow users to change focus, shift magnification and position and to point and query. This is not unrealistic. An EC AIM effort (IMPACT) is underway in this area. There is in Norway too a telepathology project in which clinical pathologists read, using a motorised microscope and stage, with some functions remotely controlled, slides at a site 400 km away (NORDRUM *et al.*, 1991). Here identical viewing occurs and pathologists can assist surgeons in sample preparation. By building on these functions, pathologists and surgeons could share work objects (microscope views, slides and slide sets) and work with them in ways they could not before. The idea here of course is both based on and extends the conference metaphor. To do this would require something much like a visual toolbox or database. In particular, its tools would allow users to control and change slides and slide order. Minimally we would want users to be able to take apart and reconnect these visual, argumentative sets. It would be useful too to provide new ways for them to connect and juxtapose slides and slide sets. For this toolbox, exemplars to design from (e.g. linking mechanisms, concurrency protocols) can be found in any robust hypertext application (CONKLIN, 1987).

Extending microscope and slide work, while at the same time elaborating on the conference metaphor, would create new, more flexible boundary objects. This would encourage stronger individual and collective readings and re-readings of these objects. As a result, domain competence and knowledge exchange between specialties would be improved. In short, from working with these objects, not only would some daily work routines, now taken for granted, be strengthened, but new kinds of co-operative work forms and expertise could emerge.

4.2 *Considerations and methodologies for systems development*

What underlies traditional design methodologies is a strong tools tradition that tends to favour coherency and rationality. Consequently, these methodologies tend to move rather quickly from formal methods and notations to descriptions of action and thought that are rule bound and presumably rule generated. On the other hand, qualitative methods attempt to elicit what is significant and important to the organisations, communities and individuals we build for. These methods have something important to contribute to design methodologies because they allow researchers to pick up and understand concepts and principles that are often taken for granted by practitioners

in their routine clinical work. Developers cannot rely upon or expect practitioners to articulate useful analytic frameworks. Nor can they abstract out of, say clinical, context information developers can immediately use (GRAVES and NYCE, 1992). This requires considerable, second-order work.

5 Conclusion

Offstage clinical work is not very well understood. Because its principles are often not built into development paths, applications intended to support work of this kind have not been particularly strong. Nor have they been well accepted. To build and rely on 'common-sense' knowledge, which developers and designers often do, means that real user needs can be neglected or misunderstood. Furthermore, starting from an 'experiential' knowledge of clinical work does not itself guarantee that important aspects of clinical work will be incorporated into a design (GRAVES and NYCE, 1992). Relying upon, in any combination, common sense or expert knowledge can mean that essential elements of clinical work will be taken for granted, ignored or dismissed as having no relevance to a development effort.

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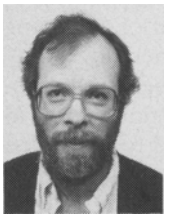

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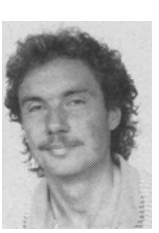

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