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INTRODUCTION

Designing information systems to fit work patterns is becoming a recognized design principle (Greenbaum and Kyng, 1991). Studies of individuals doing their regular work in their usual settings is a growing area of research, for example, for understanding computer system design processes (Curtis, Krasner, and Iscoe, 1988; Davies and Nielsen, 1992; Forsythe, 1992, 1993, 1994; Orlikowski, 1989; Rosson, Maass, and Kellogg, 1988; Shneiderman and Carroll, 1988; Soloway et al., 1988; Suchman, 1987).

In medicine, system developers and evaluators have been investigating the interpretive nature and complexity of routine work practice. New design methodologies are based on the assumption that system design must be based on actual work routines rather than on abstract models of information processing or formal models of reasoning (Nyce and Timpka, 1993). System developers are beginning to realize that more attention should be paid to how to incorporate implicit forms of professional competence and knowledge into system design (Nyce and Graves, 1990; Nyce and Timpka, 1993). Such studies could help developers improve system acceptance by tailoring systems to users' perceived needs in ways that will fit into their work practice patterns and routines (Graves and Nyce, 1992), match their values and provide them with benefits (Kaplan, 1987).

One area ripe for study is the relationship between technologies of image delivery and how they may change the nature of work. Visualization technology, it is claimed, already has significantly changed work in science, engineering, and medicine (Kaufman, 1994). Changing what information is presented, its layout, and its mode of presentation, changes how professionals think about their work (Ruhleder, 1995).

There are few formal studies of visualization systems and their relationship with work practices. Among them are studies of CAD (Computer Assisted Design) systems, (Henderson, forthcoming), CT scanning (Barley 1986), visualization systems in neurology (Nyce and Graves, 1990), and a clinical imaging system (Kaplan and Lundsgaarde, 1994). Barney et al. (1990) express the need to make explicit the modes of understanding involved in accurately translating and using visual information. They advise identifying and describing the forms of reasoning and practice that are important to technological modeling of visualization so that information systems developers can construct environments that support routine practice effectively. For example, Ramey,

Rowberg, and Robinson (1992) studied the task domain in diagnostic radiology for the purpose of designing radiology workstations.

This paper concerns an evaluation study of a physician's work and how that study led to design suggestions for a clinical imaging system. It reports on how formative evaluation can help fit system design to work practice.

CLINICAL IMAGING SYSTEMS

Clinical imaging computer information systems are being developed to provide clinical personnel with images from a variety of clinical services and integrate them with text and other clinical data into on-line computer-based patient records. These systems fit the Institute of Medicine's proposal for computer-based patient records that are expected to combine text, graphics, images, numerical data, sound, and videotapes (Dick and Steen, 1991). The images might be photographs of a patient's dermatological condition, a videotape of a surgical procedure, a movie of an angiogram, pictures of pathology slides, images generated by ultrasound scans, x-rays, CT scans, etc. Currently, only some of these images may be included as part of a paper-based patient record.

METHODS

An evaluation research project was undertaken at a university hospital where a clinical imaging system is being developed. One study goal was formative evaluation intended to generate design suggestions (Lundsgaarde, Gardner, and Menlove, 1989; Forsythe and Buchanan, 1991; Kaplan and Maxwell, 1994). Another goal was to gather data on changes in work and decision making practices consequent to the introduction of the resulting clinical imaging system.

Data collection was done by intensive observation of a physician for an average of nine hours each day during a one week period selected to include both clinical and research activities. Data were collected, analyzed, interpreted, and validated as recommended by Kaplan and Maxwell (1994).

FINDINGS

Several observations led to design suggestions, as follows:

1 Because this physician consulted colleagues in both formal and ad hoc settings, an imaging system may be helpful by providing colleagues with the same images at different convenient locations. Colleagues could view and manipulate images at their individual workstations simultaneously to facilitate ad hoc conferences in which colleagues view images together, but in separate locations. Further, it may be advisable to allow each viewer to arrange films differently, and each to have the ability to control the image arrangement on all workstations during the conference session.

2 The physician often requested patient history, laboratory data, and information on eligibility for treatment protocols while viewing images pertaining to that patient. It could be helpful to include these data on-line together with images.

3 The physician spent part of each day going to different locations throughout the institution. Therefore, having the imaging system accessible from a variety of locations may make it more convenient to use.

4 The physician's work was varied and fragmented. His day was filled with numerous interruptions, trips to different areas of the institution, and interactions with a number of individuals. Conversations between this physician and his staff jumped from patient to patient. Having the workstation interface allow for frequent interruptions could accommodate the fragmented nature of this physician's work day. It seems as though it would be helpful for a user to be able to interrupt an imaging system session, move to another location, and resume the session (as though it had not been interrupted) at a later time. It also could be helpful for the imaging system to allow for frequent jumps between different patients' images and records.

CONCLUSIONS

This study used qualitative methods to investigate the work practices of a physician. Observational methods provided a means for generating design suggestions for system development. This study provides an example of how introducing formative evaluation into systems design can enhance requirements analysis efforts and prove useful for designing systems to fit work practices.

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