Pace and Temporality in Safety Critical Medical Work: Concepts for Understanding Adaptation Behaviors

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Abstract
Drawing on the concepts of temporality and pace to analyze the experience of a new technology for transfusion practice, our analysis articulates the relationship between adoption experiences, task dimensions, and the coping strategies that emerge. We discuss the implications for design of interactive systems in healthcare as well as the theoretical implications for understanding unfolding healthcare practices.

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Collaborative computing; health; human performance.

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H.4.1. Groupware, J.3 Medical information systems, H.5.3 Collaborative computing

Introduction
Medical settings present a challenging research domain for human computer interaction (HCI). The complexity of work, variability of work, richness of, and reliance on information, and continuous collaborative activity [1,4,5] provide opportunities to explore new forms of interaction and to advance theory.

Each ERBI system is networked to the blood bank laboratory information system and allows electronic cross matching of red blood cell units remote from the blood bank. At the operating suite is an electronically controlled fridge and interactive kiosk.

In this paper, we review HCI approaches to understanding work practices in medical settings focusing on notions of *space*, *time*, and *temporality* [6]. In addition, we extend current approaches by investigating a mismatch between a new technology solution for transfusion procedures (Electronic Remote Blood Issue (ERBI)) and the dimensions of the work practices of the OR suite through the lens of *pace* [2].

RELATED WORK

Several researchers have explored the concept of temporality and applied it to medical work. For instance, Dourish, Reddy, and Bardram [1, 26] have discussed sequencing and simultaneity of work, complexities around how work practices unfold over time with respect to attributes such as information and information transfer between members of healthcare teams, and the way in which work is reorganized in a mobile context. More recently, Reddy, Dourish and Pratt [6] described features, such as temporal trajectories, temporal rhythms, and temporal horizons. Temporal trajectories describe how a situation changes over time whilst temporal rhythms describe recurring patterns. Flexibility and urgency determine the temporal horizon chosen. For instance, if there is greater flexibility and little urgency for a task a distant time horizon could be chosen by an individual. Pace as a concept is part of this idea, but has been discussed briefly in relation to near or distant temporal horizons necessitating a change in pace of a person's activity in order to achieve an overall work commitment and schedule. Alan Dix introduced the concept of pace to interaction research in 1998 [2] in a different manner. Drawing on concepts from information theory, Dix identified several coping strategies, which emerge as a result of a mismatch in pace between task and interactive system. He characterized these strategies as delegation, laziness/eagerness, or multiplexing. Our aim in this abstract is to explore new work practices as they unfold in response to a technology implementation through the lens of both pace and temporality concepts. We use a conceptual diagram (figure 1.) to illustrate this interplay.

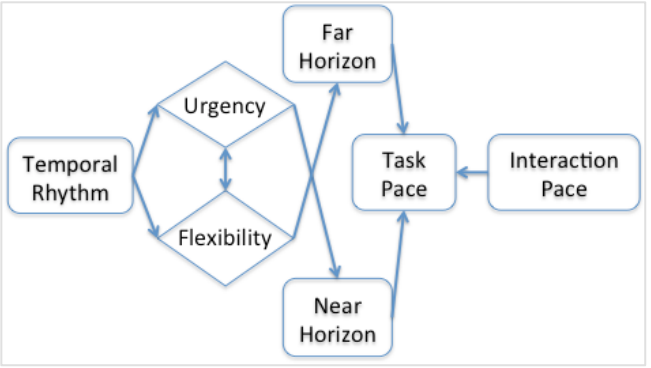

Figure 1. Conceptual Diagram Linking Temporality and Pace. Ideally, the task pace matches the interaction pace.

STUDY DESIGN

The fieldwork for this study was carried out in the operating suites and blood banks of three large urban hospitals. The study was conducted over three years between 2008-2011, and included collection of qualitative and quantitative user survey data, formal and informal interviews with managers and staff, 6 weeks of observation at each site with 24 hr video capture and in person observation, and analysis of software log data. Two researchers carried out qualitative inductive content analysis, using survey and interview data, following suggested practices for ensuring quality of qualitative research of this type [3].

FINDINGS

We used Dix's predictions about coping strategies and applied them to an understanding of ERBI system use.

Missmatch and Breakdown

As users became familiar with the system and started to try to interact with the system at the pace that the blood request demanded a breakdown in the interaction was observed. As Dix predicted "cooperation can only succeed if the pace of interaction is sufficient for the task" [2]. Users started to skip confirmatory steps in the interaction missing key information and consequently triggering error messages and then a delay in the task completion (delivery of blood to the patient). OR nurses, in particular, felt the spatial and temporal configuration of the new blood issue system to be mismatched to the task.

"Like "I just want some blood! Let me have my blood!*." Nurse*

Delegating

Nurses were considered the primary users of the ERBI system. Training efforts concentrated on this group from the outset. However, the mismatch between the pace of interaction with the system and the pace of time horizon in the OR rooms meant that nurses were seeking workarounds to using the system. One way to achieve a better match between the interaction channel of the ERBI system and the pace of the task was to delegate to those staff not facing the same constraints.

""It might be just as easy to send an inexperienced PSP to just come to the blood …Don't try and learn it when your patient's not doing well." Nurse

Eagerness

The software logs for 120 days for the first study site were examined and in some cases the final safety step in blood unit issue with ERBI (scanning the unit) was missed (a 'no scan' event). The final scan of a blood unit completed the safety procedure for checking that the blood supplied for transfusion is compatible with the patient's blood. An error at this stage could cause a serious adverse event. The number of 'no scans' did not decrease over time as staff got used to the new system. The instances of multiple 'no scans' coincide with trauma patients who required an unusually high number of blood units in a short space of time. Applying a near time horizon to the task of blood supply for a large bleed, the teams had adapted by quickening the interaction pace (eagerness). Alternatively, in order to avoid issues of pace mismatch, fresh frozen plasma could be ordered and delivered in a cooler, the OR team could secure a place to store red blood cells in the operating room, then a porter or support staff could retrieve blood from the ERBI system whether blood was needed or not.

"cooler can be in room ready", RN, Site 2.

Multiplexing

Mulitplexing involved simultaneously interacting with the ERBI system to retrieve blood whilst calling the blood bank to order a cooler containing blood units. Thus the required 'bandwidth' of the task was achieved using two channels of interaction. This workaround caused confusion between the two channels with redundant blood orders and a confused blood bank staff. With one communication channel to the blood bank for large blood orders (usually by phone) the urgency and volume of blood require is directly communicated to the blood bank staff, and they can then respond accordingly. If the communication and interaction is split into two channels (blood bank via phone plus ERBI) some of the information involved in the interaction (volume and pace of red blood cell need) is lost in turn affecting the response of the blood bank. Disruption to the flow of information has the potential to create a critical situation for the patient.

DISCUSSION

Several researchers have explored concepts related to temporality in HCI research but few have applied the concept of pace specifically, as an extension of temporality to medical work practice. Drawing on theoretical concepts, we presented the findings from a study of work practice adaptation with the introduction of a new technology for blood unit issue for operating room use (ERBI).

In this research case study, using the concept of the temporal horizon helps us to understand the dynamic nature of the task itself, and the circumstances of the individual healthcare worker. The idea of pace is key here. The pace of activity necessarily quickens when a close temporal horizon is called for, whereas, a distant temporal horizon may accommodate a slower pace or result in postponement of activity. The temporal horizon for the OR nurse retrieving a unit of red blood cells for a patient would be different from a porter's temporal horizon for the same activity.

Using the concepts of pace and temporality together aids us in the analysis of work practices and the interactive systems that support them such that these dimensions become more apparent. This also helps us make the bridge to potential solutions whether it be variable pace of interaction, or communication of knowledge about pace for the reassessment and planning of temporal horizons.

CONCLUSION

Studying the process of adoption and adaptation to a new interactive system reveals some of the characteristics of the tasks and context that shape work practices. While these characteristics might seem particular to the task of blood issue only, when the lens of temporality and pace are applied we see a more general pattern emerge that may be applicable to other settings. The concepts of temporality and pace offer a theoretical lens with which to understand how medical professionals adapt to new healthcare information systems.

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