Design Against Fragmentation: Case Study of ICT in the Healthcare

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How does information and communication technology (ICT), such as telephones and computers, create interruptions for people at work, and how can fragmentation be counteracted? Empirical material was collected during 17 observation and interview sessions, at two surgical wards and one reception. The results show that the most important factor for counteracting fragmented work is that someone takes responsibility for the full picture when developing ICT. A naive user-centered design can produce applications that work well on its own but don't work well together.

1 Introduction

Fragmentation of work develops as a consequence of interruptions in continuous work (e.g. a phone call or a computer that stops working) (Mark et al. 2005). Fragmented work is therefore incomplete. It can be seen as lack of coherency in knowledge about the world and can lead to lack of overview. 'Flow' is a term that also can be thought of as an opposite of fragmented work. It is an optimal state where everything works perfectly and the gap between thought and action and between self and environment ceases to exist (Csíkszentmihályi, 1990). We define fragmentation as when interruptions force focus to be moved from the context of work. In this paper we present a case study of consequences of fragmentation at a surgical clinic, and ideas on how to counteract it in design of information and communication technology (ICT).

One reason for counteracting fragmentation is increased effectiveness (task completion, time to task). Loss of coherence and overview can hamper communication in a team (Coiera 1998). Studies performed with the theoretical perspective of distributed cognition have shown how fragmentation into too many parallel tasks, too much information, and too many interruptions can lead to cognitive overload (Kirsch 2000). This leads not only to loss of time and attention, but also to stress and other social problems. A whole system of multiple people and technologies that suffers from cognitive overload also has safety risks; there is a greater risk of error, and it takes more time to perform correct actions in critical moments (Wickens & Hollands 2000). In order to maintain a reasonable cognitive workload, different offloading strategies can be used (Kirsch 2000).

Many task shifts are due to external factors (like phone calls), but interruptions are however a natural part of work and people can fragment their own work by choosing to interrupt themselves and shift task. Mark et al. (2005) argue that the most frustrating interruptions are the ones that require people to change context of work.

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Interruptions that concern the present work context are usually perceived as helpful interactions, while the interruptions that concern things outside the present work context are perceived as negative. According to Mark et al., the reason for this is that a change of context requires more effort for people to reorient themselves. A problem with this analysis lies however in the concept of context and it is difficult to say what the real activity that is being interrupted is. Where does one task start and another end? Hudson et al. (2002) argues that we should lift the discussion from the task and the interruption to activities where interruptions are tied together and interact with each other. We need to acknowledge that a task looks differently from the perspective of one individual compared to a system perspective (Bannon et al., 1983). Based on activity theory, interruptions can also be thought of in terms of breakdowns and focus shifts (Bødker, 1991; 1996). A breakdown is a moment of interruption in the being-in-the-world, for example when things do not go as expected, or when there is something wrong with a tool. Then the tool itself becomes objectified rather than transparently mediating the actions directed at the object of work. Furthermore, a shift of focus may happen both when the object for action is changed and when the mediating tool is changed. The focus can also be shifted towards the tool by a conscious act, as for example when a user is learning to use it.

2 Aim

In a similar strand of research as Kirsch (2000) and Bødker (1996) we aim to look beyond time and frequency aspects of fragmentation, by focusing our analysis on socially distributed and tool-mediated human action.

3 Methods

A qualitative case study was made at a Swedish hospital. 17 individual observation and interview 3–7 hours sessions were made, at two surgical wards and at one reception. The study started with administrative staff (physician's secretary, office assistant, receptionist, IT-resource, and operation planner) to get a broad view. Focus then changed to care giving staff (surgeons and nurses). The choice of case was based on hospital environment as a complex, dynamic and safety critical working place, with an intense use of technology. The participating wards and the reception together cover examination of patient, admission, operation, aftercare and discharge. Existing documentation was read and informal interviews with systems developers and employees were made to get familiar with the problem. Two semi-structured interviews were also made to get an initial understanding. An iterative work began with fieldwork and analysis. Field notes were taken without a decided scheme in order not to impose descriptions of the work. In the analysis of data, a document was set up where field notes were transcribed into legible text and the notes were complemented with comments. Categories of problems and phenomena were created, and working hypotheses were developed to be tested in the next round of observations. After the fieldwork was completed, a more complete categorisation method was used (Ely, 1991), and the result from this was a set of qualities of the ICT in use. Finally, perspectivization was used to highlight different aspects of use (Arvola, 2006).

4 Case

Healthcare is a well-documented area of ICT deployment (e.g. Alpay et al. 2004, Coiera 2000, Silverman, 1987). Not all efforts of rolling out IT in the healthcare sector has been without problems. Many problems arise when developers attempt to bring proven concepts from the office environment into a clinical setting (Silverman 2001, Coiera 1998). Different types of information and how it changes over time puts different demands on a computer application. An example is the difference between information about how a certain operation is performed (slowly changing), and information about the status of a patient (rapidly changing). Communication is an important part of healthcare work (Alpay et al. 2004) and many different ICT-artefacts

are used, like telephones, beepers, note pads and Dictaphones (Alpay et al. 2004, Coiera 2000). There is research on patient-doctor communication, but only little on the communication among staff (Coiera, 2000).

The case study was conducted at a clinic with two surgical wards and one patient reception at a larger hospital in Sweden. One ward was for emergency surgery and the other for planned surgery. The two wards were located next to each other, but the patient reception was located at a different part of the hospital. The healthcare staff emphasised the need to be flexible and being able to improvise, due to high time pressure and that they are working with people. The workload was high and difficult to control. Much work went into planning and prioritizing, and since the staff changes frequently documentation and communication is important. Telephones, beepers, paper-based patient records, patient binders and face-to-face meetings played important roles in the staff's daily communication. There was also a whiteboard for sharing information and creating a common overview of the present state of the wards: patients, their status, and staff responsibility.

The total IT system at the clinic contained many different applications that to a varying degree communicated with each other. The systems were constantly changing and developing, and the current organization has had great impact on the design of the IT-systems: external demands from the government, but also organisational boundaries like clinics and wards. The development has been user-centred, and since many applications have been developed locally the user representatives have had a say in many decisions. The administrative system and the care giver portal, which held applications for patient records and lab testing, were also used outside of the Surgical Clinic. There were also three applications used only inside the clinic: an operation planner, a quality follow-up application and a publication service for putting together care documentation.

The participants in our study experienced their work as fragmented. The ICT tended to disrupt the flow due to lack of holistic design. Each application did its own work well, but they did not work well together. The activities at the clinic where connected, involving many persons. Participants experienced frustration when they could not come to closure on activities they had started; there was a need to see the utility and outcomes of their own work in order to get a coherent understanding of the entire activity system at the clinic. At the level of small operations a lack of feedback can lead to a breakdown, at which the application itself becomes objectified and in focus. Both the physical and cognitive availability of information was important for people to be able to complete the work that they had started and obtain flow in natural shifts between intertwined activities. Portable and shared information can play a role in achieving this. As stated before, the ICT used at the clinic did not support the collaboration between the many different people who worked in intertwined activities.

There is a need of better conditions for achieving an overview and a coherent view of the shared work at the clinic. These are important conditions for collaboration and can help coordinating people in what they are doing, decrease the need of interrupting other people, not having to redo other people's work and make it easier to plan and organize your day. This can also be connected to the relatively large extent the telephone was used by our participants: Enabling people to find information through other information channels can avoid unnecessary interruptions. These channels, however, have to be both physically and cognitively available for the staff during their work. Visualisations of others current work can be of use, for example public to-do-lists and information pushed to handheld devices. The shared whiteboard is an example of a coordination device that can be exploited further.

5 Discussion

We argue that fragmentation of work can be counteracted both at the level of interaction with technology, and at the level of the organisation. For example, it is at the organisational level that regulations for communication are set and strategies for ICT development are decided. All problems are not solved by new technology. In fact, new technology that does not fit with the practice and existing technology can further contribute to fragmentation. People need to seamlessly be able to shift between applications without focus shifts that cause fragmentation. In a system that consists of many applications, the user's actions are often hindered by spatial, instrumental or communicative reasons. One conclusion of this is to avoid shifts of objects and applications. However, that is not really realistic, and therefore it is important that the different applications in the eyes of the user are experienced as a unit. Our case study corroborates Kirsch's (2000) studies that put emphasis on holistic thinking in the design of ICT, and the possibility of allowing users to treat whole activities within one and the same application in order to avoid unnecessary fragmentation. An important part of designing against fragmentation is to support intertwined activities for all people involved. We should not focus on interruptions in only an individual perspective; instead we need to investigate to how those interruptions relate to the activities of others involved in the shared practise.

The notion of fragmentation is more complex than a time and frequency perspective on the phenomenon will yield. For example, breakdowns and focus shifts are not something that always should be avoided. Some interruptions are in fact necessary for creating moments for reflection and learning and when gathering information. However, the interruptions that are due to shortages in technological integration or organisation could and should be avoided. We saw clearly in our study how breakdowns were avoided for one individual at the cost of fragmentation for someone else. The socio-cultural theories underlying our case study (activity theory and distributed cognition) have a lot to offer for making this *collective fragmentation* visible.

Practical implications

A practical implication from this study is that naive user-centred design of ICT in fact can increase the fragmentation of work: if you focus too much on the primary user of a particular application there is of risk of causing fragmentation for others in the organisation. The applications in our case study were all developed in cooperation of user representatives, but that does not do much good if the user representatives are narrowly selected and if nobody takes responsibility for the full picture. System designers need to look beyond what user representatives say that they need to what the practice as a whole actually needs. Just talking to stakeholders is not enough; designers need to make extensive site visits. For developing usable systems it is important that the scope of usability expands from its traditional view as connected to the design of user interface (for the primary user). The scope must broaden and also include the organization of work where the design of the user interface(s) is an important, but not sufficient, part.

References

ALPAY, L., TOUSSAINT, P., and ZWETSLOOT-SCHONK, B., 2004, Supporting healthcare communication enabled by information and communication technology: can HCI and related cognitive aspects help?, In *ACM International Conference Proceeding Series; Vol. 65, Proceedings of the conference on Dutch directions in HCI*. (New York: ACM Press).

ARVOLA, M., 2006, A use-qualities approach to judgements in interactive media design. In *The Virtual 2006: Designing Digital Experience*, September 14-16, 2006, Rosenön, Dalarö (Haninge: Kommunikation, teknik och design, Södertörns högskola).

BANNON, L., CYPHER A., GREENSPAN, S. and MONTY, M., 1983, Evaluation and analysis of users activity organization. *Proceedings of the SIGCHI conference on Human Factors in Computing Systems, CHI 83*, (New York: ACM Press).

BØDKER, S., 1991, *A Human Activity Approach to User Interfaces*, (New Jersey: Lawrence Elrbaum).

BØDKER, S., 1996, Applying activity theory to video analysis: How to make sense of video data in human-computer interaction. In *Context and Consciousness: Activity Theory and Human-Computer Interaction,* B. Nardi (Ed.) (Cambridge: MIT Press).

COIERA, E., 1998, Four myths about the information revolution in healthcare. In *Rethinking IT and Health*, In J. Leneghan, (Ed.) (London: Institute of Public Policy Research).

COIERA, E., 2000, When conversation is better than computation. *Journal American Medical Informatics Association,* **7**, 277–286.

CSÍKSZENTMIHÁLYI, M., 1990, *Flow: The Psychology of Optimal Experience*, (New York: Harper and Row).

ELY, M. 1991. *Doing Qualitative Research: Circles within Circles,* (London: The Falmer Press).

HUDSON, J. M., CHRISTENSEN, J., KELLOGG, W. A., and ERICKSON, T., 2002, "I'd be overwhelmed, but it's just one more thing to do": availability and interruption in research management. *Proceedings of the SIGCHI conference on Human factors in computing systems: Changing our world, changing ourselves, CHI 2002*, (New York: ACM Press).

KIRSH, D., 2000, A few thoughts on cognitive overload. *Intellectica*, **2000/1** (30), 19–51.

MCFARLANE, D., 1999, Coordinating the interruption of people in human-computer interaction. In *INTERACT'99*, A. Sasse and C. Johnson (Eds.) (Amsterdam: IOS Press).

MCFARLANE, D. and Latorella, K., 2002, The scope and importance of human interruption in human-computer interaction design. *Human-Computer Interaction*, **17**, 1–61.

MARK, G., GONZALEZ, V. and HARRIS, J., 2005, No task left behind? Examining the nature of fragmented work. *Proceedings of CHI 2005*, (New York: ACM Press).

SILVERMAN, D., 1987, *Communication and medical practice: social relations in the clinic*, (London: SAGE).

WICKENS, C. and HOLLANDS J., 2000, *Engineering Psychology and Human Performance: 3 rd edition*, (New Jersey: Prenctice Hall).

XIAO, Y., 2005, Artifacts and collaborative work in healthcare: methodological, theoretical and technological implications of the tangible. *Journal of Biomedical Information*, **38** (1), 26–33.