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Interaction Overload

Managing Context and Modality

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Abstract

The impact of technological advances within information and communication technology (ICT) cannot be exaggerated. Instant availability of communication via faxes, mobile telephones, electronic mail, pagers and video conferencing has enabled people to work or do business together and generally interact despite being temporally and spatially “dislocated”. This is all well and good, but if technology enables you to reach the rest of the world with the push of a button, then simultaneously you also are potentially available to the rest of the world at the touch of a button. Traditionally, the concept *information overload* has been applied to explain situations where the information presented to the individual exceeds his or her cognitive capacity. This paper suggests *interaction overload* as a new concept characterising a mismatch between the demands on the individual to interact, and the person’s co-operative preferences. Interaction overload is characterised in terms of interaction context and modality. A study of how highly skilled professionals manage interaction overload in a pharmaceutical company lends substantial empirical evidence to the viability of the concepts. The study focuses on managing interaction modality and, thus, supplements a previous study of the interaction context. It is argued that in order to effectively manage modes of interaction, people must be able to: (1) plan their accessibility, (2) gain awareness in the process of establishing interaction, and (3) combine modes of interaction.

1. INTRODUCTION

The advances and impact of technological development within information and communication technology cannot be exaggerated. Generally, these developments concern various combinations of three basic technologies: Conversation or messages transmitted by wire, e.g., telephone and telegraph; broadcasts transmitted through the air, e.g., radio and TV broadcasting; and data from transaction processing systems, e.g., computers. This convergence of computing and communication has resulted

in a number of technologies, such as cellular telephone, voice mail, workflow systems, fax, pagers, pay-per-view, cable television, electronic mail, local area networks, the World Wide Web, video conferencing, discussion groups, satellite networks (Yoffie, 1997). Instant availability of interaction through these platforms has meant that people working or doing business together can interact despite being temporally and spatially "dislocated." More and more work involves using these technologies in what has been described as a "communication revolution" (Hiltz and Turoff, 1993). Needless to say, this has led to many new possibilities. Soon the world could potentially see mobile telephones with built-in MP-3 music players and FM receivers, that will enable people to listen to music or important traffic news whilst talking to each other on the phone and sending electronic mail to the person at the other end of the line. Needles to say there are enormous technological possibilities. The question remains, however, what use we will put these possibilities to? Will it only be a technological smorgasbord where we can pick and choose without dramatic consequences? Clearly, the way we interweave people and technology in rich patterns of interaction will affect the lives of the participants.

For example, how often are you, as a busy professional, confronted with the need to decide whether to temporarily disconnect yourself from all communication technology in order to get work done or remaine in cyberspace and risk being 'buried' in emails, telephone calls, faxes, etc.? Initially, we might be thrilled to receive our first email or participate in a first desk-top video conference. Realising the potentials of the technology, however, we may subsequently become aware that we are increasingly spending time on undesired interaction. We may also begin to notice that interaction frequently occurs via an inappropriate mode. For example, receiving telephone calls when preferably we would want to be faxed or emailed. In addition if everyone you are in regular contact with also knows that you have a mobile telephone as well as access to email from home, they may possibly in certain situations choose to ring you on your mobile phone or email you 9pm Saturday evening. Some people are 'tactful' they send an email. They know that you will get the message eventually. Others may ring you wanting to clarify simple and relatively unimportant issues. Others may not ring you even if you would have wanted them to when you subsequently realise what the problem was. People actively engage in processes of prioritising, excluding, postponing and redirecting interaction simply because they have neither the capacity nor the desire to be available to everyone at any point in time through all means of interaction.

Previous studies has highlighted that people who manage large amounts of information may experience information overload, i.e., they are subjected to more information than they can process (Hiltz and Turoff, 1985; Schneider, 1987; Chewning and Harrell, 1990; Whittaker and Sidner, 1996). Similarly, this paper argues that people who are subjected to undesired interaction, or interaction in an undesired mode, experience *interaction overload*. Interaction overload can be characterised in terms of the context of interaction, for example being interrupted in the middle of an important meeting, and the mode of interaction, for example receiving very important information in an ephemeral mode. Previously, Ljungberg (1996) has analysed the importance of managing the context of the interaction, which can be viewed as providing awareness of interaction requests and managing accessibility. This paper investigates, through an empirical study of clinical testing in a medical company, the role of the interaction mode. Furthermore, a framework is developed, unifying the two concerns of interaction context and mode into the concept of *interaction overload*.

The empirical study was carried out in a multinational Swedish pharmaceutical research company employing approximately 1000 people. Of these, around 750 were directly involved in research activities from basic research on cell biology to technological innovation in pharmaceutical

chemistry. The use of communication technologies such as email, fax, telephone, file transfer systems and bulletin boards were vital for research projects all over the world. Other important information technologies were office systems, presentation tools, word processors, and spreadsheets. The research specifically was conducted at the third Clinical Research Management department (CRM III) within the clinical division. CRM III employed approximately 50 of the 350 personnel working in the clinical division and consisted of four research groups, managing clinical testing of drugs before approval for regular use. The fieldwork reported in this paper was mainly conducted in one of these groups; "Ulcer/Dyspepsia." This group consisted of six employees: A group manager, three Clinical Trial Managers, and two secretaries. The research in this group concerned dyspepsia, "a persistent or recurrent abdominal pain or discomfort in the upper abdomen" (Talley et al., 1991). Broadly speaking, this means that people with this condition had serious stomach-ache without any symptoms of a gastric ulcer.

The following section outlines the particular research approach adopted. Section 3 then presents the *interaction overload* framework and relates this to existing research and literature on *information overload.* Section 4 presents the results of the research conducted within the pharmaceutical firm. This is, in Section 5, followed by a discussion of the implications of this research.

2. RESEARCH APPROACH

Artificial sciences concerns the invention, improvement and use of artefacts (Simon, 1981, e.g., p. 7). This goes beyond the classical distinction between the social and the natural sciences, with their ambition to interpret and explain respectively (Dahlbom and Janlert, 1990). Informatics can thus be considered an artificial science concerned with both development and use of ICT. The notion of "use" seeks to understand ICT when situated in use. This is viewed from the perspective of the people affected, and does in this sense relate to the participatory design tradition (Bansler, 1989; Greenbaum and Kyng, 1991; Bjerknes and Bratteteig, 1995).

Studying interaction overload it is important to recognise the rich and contingent aspects of human activities (Suchman, 1987). We need to gain a deep contextual understanding of the conditions under which people experience interaction overload when using ICT. This calls for an ethnographic mode of enquiry concerned with describing a certain domain as seen from the perspective of the people involved (Hughes et al., 1993). This is done by direct involvement of the researcher often during an extended period of time (Hammersley and Atkinson, 1993; Hughes et al., 1994). While conducting the empirical work, the researcher seeks to collect data that sheds light on the focus of the research efforts. Ethnography has been used in many different ways and for many different purposes. It has, for example, been used for long-termed anthropological studies of cultural issues (Alvesson and Sköldberg, 1994), for medium term studies analysing the use of artefacts in co-operative work (Carstensen and Sørensen, 1996), and to provide snapshots for the purpose of systems design (see, Kristoffersen and Rodden, 1995).

Because the key concept, interaction overload, is based on a notion of the individual participant's co-operative preferences, it is important to combine ethnographic observation with interviews probing deeper into individual preferences and interaction patterns. We chose therefore to include semi-structured interviews, which are characterised by openness and flexibility (Mason, 1989). The researcher only sets the overall agenda and then allows the interviewee to shape the interview ideally

within a context with which the interviewee is familiar (Holme and Solvang, 1986). Qualitative interviewing thus favours richness of worldly realism, rather than tightness of control (Mason, 1989).

The fieldwork thus consisted of studying the everyday accomplishment of work within a research group known as the dyspepsia group within the CRM III department. Our role as observers and the purpose of the fieldwork was known by everybody concerned (c.f. Patton, 1990). The dyspepsia group were studied for two months through a combination of close participant observation, on-site observation and interviews. Approximately 80 person-hours of close participant observations (c.f. Patton, 1990) entailed following a particular person through that person's working day whilst taking field notes. The 240 person-hours of on-site observation involved talking to the group members and recording who was doing what. The participant observations were followed by qualitative interviews of 12 key participants (Patton, 1990). Besides the member of the dyspepsia group, interviews were conducted with the manager of the department, three Clinical Trial Managers and two group managers from other groups within CRM III. The reason for this was to gain an exhaustive insight into interaction overload across groups. The approach taken to interviewing was to specify in advance the general topics for each interview, and allow the course of the actual interview to guide the exact wording and sequence of questions (Patton, 1990). A total of 12 interviews of 55 to 90 minutes duration were taped. The interviews were transcribed, and together with the field-notes, analysed based on the concepts described in the previous section. We believe that the insights gained through content analysis of the performance of work tasks through participant observations would have been difficult to obtain by interviews alone.

3. INFORMATION AND INTERACTION OVERLOAD

From a review of the existing literature it is apparent that when a particular communication technology initially is developed, it must be used by a critical mass in order for the technology to successfully diffuse (Grudin, 1989; Grudin and Palen, 1995). However, the concepts explored in this paper aim to explain situations where successful diffusion of the technology is readily acknowledged, and people with little effort can interact using the technology. Widespread use of communication technologies can, however, cause problems (Ljungberg, 1996; Ljungberg and Sørensen, 1996; Ljungberg, 1997a). If you can interact easily with the rest of the world, then the rest of the world also can interact with you. This paper thus aims to understand the effects of complex use of communication technology. Especially situations where the technology is used so intensively that the individual user may be left with only two alternatives, either to disconnect the technology or to spend an inordinate amount of time using the technology. This phenomenon can be viewed from two perspectives, either as problem related to information processing or one of interaction management. In the following subsection we discuss classical information overload themes (Hiltz and Turoff, 1985), and argue for a complementary perspective, *interaction overload.*

From Information to Interaction

The information overload perspective focuses on an individual presented with an amount of information exceeding their cognitive capacity (Hiltz and Turoff, 1985). The emphasis here is on the individual as a cognitive information-processing unit. Information overload occurs when using many different kinds of systems, ranging from people attempting to get an overview of 2000 UseNet News articles on a given subject, or when presented with 500 hypertext links to explore from a search on

the World Wide Web. In the use of email, for example, the problem can occur when the user logs onto the system and finds an inbox with hundreds of new messages (Palme, 1984). Information overload typically occurs then when a user interacts with a database in an attempt to retrieve information. The information overload concept stems from a database oriented view of information technology and is often exemplified by the difficulties related to information retrieval in large databases, rather than focusing on inter-personal interaction patterns (Foltz and Dumais, 1992). In order to reduce the risk of facing information overload, the amount of information must be reduced. This can either be accomplished by inventing more effective tools for information processing, e.g., information retrieval or filtering (c.f., Belkin and Croft, 1992; Resnick et al., 1994), or by increasing our cognitive capacity to process information (c.f., Allwood, 1991). The problem of information overload then has been addressed within several fields, such as, information retrieval (c.f., Salton, 1989; Belkin and Croft, 1992), information filtering (c.f., Malone et al., 1987b; Foltz and Dumais, 1992; Resnick et al., 1994), and intelligent agents (c.f., Maes, 1994; Elofson, 1995)

To summarise, information overload is basically drawn from a data processing paradigm, and as such the concept provides a sound basis for characterising potential problems for individuals using a transaction-based technology. Problems related to the use of technologies supporting interaction amongst people must be addressed however in the context of interaction. In order to address problems related to computer supported interaction among people we then suggest the concept of *interaction overload* as a means of explaining situations where the individual's co-operative preferences concerning interaction are violated. Interaction overload is, therefore, related to, but distinctive from, information overload. For example, unsolicited email messages, *spam email* (Cranor and LaMacchia, 1998), could be viewed as information overload. However, the concept interaction overload more substantially characterises the situation. Viewed as information overload, the main problem is one of supporting the user to filter emails, and providing training to enable the user to process more emails. The majority of people who receive unsolicited email probably do not want to receive this type of email. Viewed then as interaction overload, spam email is simply *undesired* interaction. The interaction perspective thus leads to an acknowledgement of interaction preferences. We are not, for example, necessarily interested in engaging in interaction with everybody, continuously through whatever medium he or she may choose.

Interaction Overload

If we make the analytical distinction between desired and undesired interaction, then most interaction technologies only allow us to either to be connected or disconnected, i.e., accessible or inaccessible. This in turn can lead to two different situations, i.e., we may be subjected to undesired interaction when the technology is switched on, or we may miss desired interaction when the technology is switched off. This imposes an interaction dilemma that demands attention. Leaving the user of the technology with the choices of coping with the overload or switching off the technology, thus experiencing either of the two problems described above does not seem to be a viable strategy. How then can we conceptualise the problem of enabling constant accessibility without risking inappropriate interaction?

In order to characterise interaction overload, research in the field of Computer Supported Co-operative Work (CSCW) is particular useful as it makes a distinction between communication and collaboration. One common example is the model introduced by Dix and Beale (1996). According to this model, interaction between people is either communication or collaboration. Communication is the exchange of information among people, for example via video conferencing systems.

Collaboration, on the other hand, is two or more people operating a common object, such as co-operative authoring where the shared document is the common object. In collaboration, operations produce "feed back" to the operator, but also "feed through" to co-workers. Schmidt & Simone (1996), argues that in co-operative work both communication and collaboration can be viewed as articulation work necessary for resolving mutual interdependencies between the participants. Support for collaboration is sometimes combined with support for communication. Figure 1 shows the model.

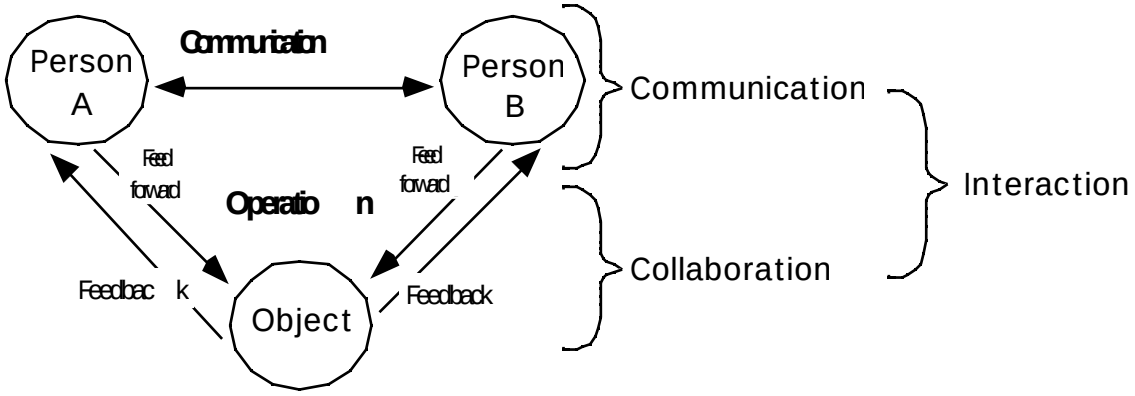

Figure 1. CSCW technologies support communication, collaboration, or both. Based on (Dix and Beale, 1996)).

The model in Figure 1 implies that communication is a subset of interaction, and accordingly, that the "communication dilemma" is a subset of a more general problem, that of enabling constant accessibility to *CSCW technologies* without inappropriate *interaction*. CSCW technology is here defined as communication and collaboration technologies designed to support interaction between people. This can, for example, be direct communication via telephone or email. CSCW technology can also support collaboration through objects such as forms passed on in a workflow system, or through shared information-spaces. CSCW technology can also support people in maintaining mutual awareness of current activities and actors. The model in Figure 1 characterises interaction as the totality of communication and collaboration between actors. Interaction overload highlights that, from the perspective of the individual, communication can be viewed primarily as interaction among people.

Interaction overload can then be divided into two analytically distinct problem areas: The interaction *context* and the interaction *modality* (See Figure 2). The interaction context focuses on the content of the interaction, the person interacting and the situation in which the interaction takes place temporally and spatially. Context relates to an individual's awareness of requests for interaction and the process of managing accessibility. Context is based on the notion of desired versus undesired interaction. Interaction modality relates to desired interaction, emphasising that the same message may be delivered in several ways. The relation between these concepts is illustrated in Figure 2 and is discussed in detail in the following section.

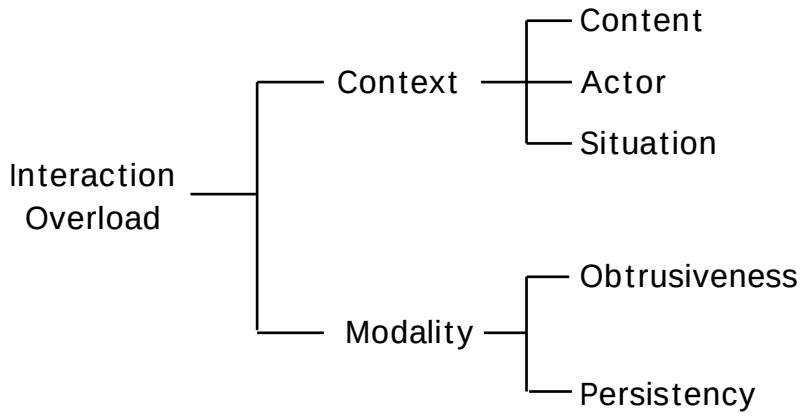

Figure 2: Model characterising interaction overload according to context and mode.

Interaction Context

The notion of context, as opposed to mode, indicates that an individual may not want to interact with another person about a particular topic at any time and place (Ljungberg, 1996). In other situations, a person may be more than willing to interact with anyone about almost anything. Inclinations to interact are influenced by a number of factors. Furthermore, during the course of negotiating interaction, a person may change his of her mind about the importance of the particular interaction. It does not, however, matter how much we attempt to explain the infinite richness of human decision making. If the interaction they engage in is conducted through information and communication technology, they are bound by the basic principles for interaction, which are stipulated by the emergent properties of the technology in question. It also seems viable to discuss the possibilities for providing interaction technology functionality that can support interaction management. Therefore, it seems relevant to attempt a crude characterisation of the main elements involved in the decision to open the interaction floodgates slightly.

The interaction context can then be characterised according to a combination of three factors: content, actor, or situation (Ljungberg, 1996). In terms of the context of the interaction, people may have different preferences depending on the **time** and **place** in which they are confronted with the request to interact. Traditionally, the division between working life and home life has been a very strong indicator of interest in certain types of interaction. Despite this division 'softening' and in some situations breaking down completely, a temporal and spatial component is still likely to be present. There may also be certain **people** who the recipient is more or less interested in interacting with compared to others. Furthermore, when engaged in a critical phase in the clinical testing procedure, a project manager will clearly wish to speak to key members of the team. The topic or **content** of their request could influence the decision as to whether or not the interaction is sufficiently important. In cases of a very tight schedule, even the most interesting person may have to wait if the content of the interaction does not seem to warrant the attention and time needed. Actual situations where decisions have to be made regarding the management of the patterns of interaction can be described as a combination of all of these factors outlined above.

Regulation mechanisms are technological means of managing the context of interaction. They can support people in distinguishing desired from undesired interaction (Ljungberg, 1996). There are two basic types of regulation mechanisms: the *accessibility* and the *awareness* mechanism (Ljungberg,

1997b). Regulation mechanisms have also been used for information filtering and retrieval to avoid information overload (Denning, 1982; Cranor and LaMacchia, 1998). *Accessibility mechanisms* enable people to implement exclusion or inclusion filters that automatically filter interaction based on content, person and situation. Some of the current cellular telephones allow the user to set up filters specifying who is allowed to reach the user. *Awareness mechanisms* provide information about the interaction before the user is subjected to it. For example, at the company studied, for internal calls the receiver's telephone display would display a caller's extension number. As people learned who had which numbers, this display provided the receiver with awareness of the caller's identity prior to engaging in interaction. However, an awareness mechanism has the disadvantage that people must evaluate all interaction, while accessibility mechanisms have the disadvantage that they do not provide awareness about interaction that have been excluded by the filtering. Accordingly, the major disadvantage of accessibility mechanisms is the major advantage of awareness mechanisms, and vice versa. A combination of these two types of regulation mechanisms is, perhaps then, a powerful means for managing the context of interaction overload.

Interaction Modality

Assuming that not all ways of interacting are perceived as equivalent by the user, makes it necessary to investigate the fundamentals of interaction. Interaction modality then, refers to a situation where desired interaction occurs in an undesired mode. Within the field of CSCW, *modes of interaction* characterise interaction in co-operative work settings (Schmidt, 1994; Schmidt and Simone, 1996). Empirical studies of co-operative work highlight the richness of human interaction in terms of; maintaining reciprocal awareness, directing attention, assigning tasks, handing over, etc. The framework shown in Figure 3, characterises interaction modality according to the two dimensions: *unobtrusive versus obtrusive*, and *ephemeral versus persistent* interaction (Chapter 3.4, Schmidt, 1994). Interaction can be more or less obtrusive dependent on how strictly it imposes obligations to notice or react. The distinction between ephemeral and persistent interaction denotes the extent to which the interaction leaves behind any traces. Ephemeral interaction only exists in the flux of unfolding activities. Persistent interaction leaves behind a trace for further inspection and discussion.

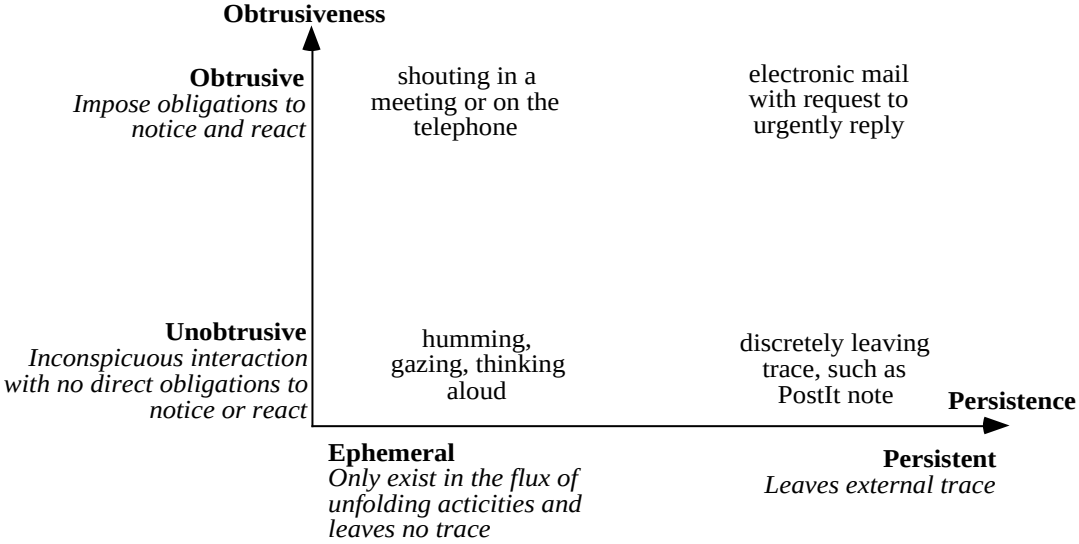

Figure 3. Interaction modality; unobtrusive versus obtrusive, and ephemeral versus persistent interaction, represented as a two-dimensional space. Examples are indicated for each of the four extreme situations.

The framework in Figure 3 can be explained using the following examples. Shouting in a meeting or on the telephone is an example of *obtrusive* and *ephemeral* interaction. The interaction imposes obligations on all involved parties to pay attention, and will distract them from whatever they may be doing. The interaction leaves no traces, and is therefore ephemeral. A document faxed, a Post-It™ Note placed on a person's desk, a telephone message recorded on an answering machine, and interaction via shared common information spaces are all relatively *unobtrusive* and *persistent* modes of interaction (c.f., Schmidt and Bannon, 1992). An incoming email, inasmuch as the email application is configured to notify the user by opening the email inbox and displaying an alert box notifying the user of the email, is an example of a *persistent* and *obtrusive* interaction. A workflow system stipulating a predetermined sequence of steps, which must be completed is also an example of obtrusive and persistent interaction. People working in the same room can engage in *unobtrusive* and *ephemeral* interaction by thinking aloud, gazing, pointing, or humming (c.f. Heath and Luff, 1992). Studies have shown it to be problematic to provide support for computer mediated unobtrusive and ephemeral interaction (Bellotti and Sellen, 1993; Heath et al., 1995; Dourish et al., 1996). The classification of a particular technology in this framework depends to a great extent on the configuration of the technology. For example, changing the settings of an email application so it does not demand the user's full attention when there is a new email will make the interaction less obtrusive. Redirecting the telephone from ringing to automatically record messages on an answering machine will both change the degree of obtrusiveness and redirect the interaction from an ephemeral to a persistent mode.

Summarising the proposed theoretical framework

Interaction overload is related to but differs from information overload. Interaction overload emphasises communication viewed as *interaction among people* from the *perspective of the individual* who is *subjected to interaction*, and their *preferences*. Information overload addresses *information* with a *global view* of *the amount* of information, and the human *cognitive inability* to cope with large amounts of information. Accordingly, interaction overload is concerned with:

- Interaction, as opposed to information,
- The subjective preferences of the individual, as opposed to objective facts about human cognitive capabilities.
- The situation when someone is being approached by requests for interaction from others, as opposed to a situation when one faces large amount of information.

Table 1 summarises the key differences. There are, however, also many similarities between the concepts. They are, for instance, very likely to emerge in the same work situations, because work that involves constant interaction often involves considerable information as well.

Type		Problem	Perspective	Technology
Information Overload		The amount of information exceeds the cognitive capacity of the individual	The total amount of information in a particular setting	Processing: Information processing tools: information retrieval, filtering, intelligent agents.
Interaction Overload	Context	Being subjected to undesired interaction due to combination of interaction content, person, and situation	The individual who is subjected to interaction	Shielding and notifying: Accessibility and awareness mechanisms filtering and acknowledging interaction in a particular interaction technology
	Modality	Being subjected to desired interaction through an undesired interaction mode		Re-directing and postponing: Switching mechanisms supporting management of interaction modes between interaction technologies

Table 1: The differences in problem, perspective and technological support regarding the three concepts information overload, communication overflow and communication deficiency

In the following section we present and analyse in detail situations from clinical testing work where the pharmaceutical staff manage interaction in order to minimise interaction overload.

4. INTERACTION OVERLOAD IN CLINICAL TESTING

In order to consider how professionals actively manage interaction modality in order to reduce interaction overload the following examples from the empirical study, and analysis focus on the interaction modality. After a brief presentation of the main activities in clinical testing, we discuss a number of themes related to managing interaction that emerged from the empirical study.

The Clinical Testing Process

The clinical division CRM III focused on drugs that had passed pre-clinical research. However, because the authorities certified drugs for certain indications and not the drug *per se*, clinical research generally explored new indications for already approved drugs. Project groups, also called research programs, were formed for six-year periods in order to manage clinical trials investigating a set of related hypotheses. The project groups consisted of a group manager, Clinical Trial Managers and secretaries. The primary objective for the organisation was evident to everyone. Lead-time was the critical issue in clinical testing. Each day the launch of a particular pharmaceutical product was delayed because the drug had not been approved for a particular condition, the company would miss an opportunity to sell a product it already produced and marketed for other conditions, potentially losing substantial revenue. The work in the trial projects relied heavily on the participants' ability to act appropriately in new situations. The work process of the clinical trial projects comprised the following distinct steps:

Composing the study protocol: The trial manager co-ordinating the collaborative effort of composing a "study protocol" described what the study concerned: what to study, variables, patient criteria, etc. Interaction among the involved people was mainly conducted electronically.

Composing the Clinical Research File (CRF): The CRF contained a detailed description of the trial. This involved specifying when it began, when it would end, and the questionnaires that should be used in the study.

Preparing the study: Secretaries assisted the trial managers in preparing and distributing equipment for the trial to the 10 to 15 local monitors in the countries involved in the project. The monitors managed the project activities in one country, where they were employed at the company's local subsidiary, and they handled most of the contacts with the clinics.

Initiating the clinical trial: The trial manager, in collaboration with the group manager, medical experts, and others, arranged meetings in all countries participating in the study, where they described the details of the study for the local monitors and testers (doctors).

Collecting data: The testers asked potential patients to participate in the study. The medical examination took place, and the tester sent the CRF to the local monitor. The monitors checked the CRFs and returned to the testers the files that were not correct. Validated CRFs were sent to the trial manager.

Analysing the data: The statisticians analysed the data and prepared a statistical report of the study.

Writing the clinical report and applying for a new drug or indication: Based on the statistical report, the trial manager and the group manager wrote a clinical report concluding the study. If the hypothesis was confirmed the company applied for certification with the authorities.

The defining characteristic of all projects in this organization was that they were all conducted across geographically dispersed locations. Although the main participants in managing the projects were located in the same building in Sweden, the monitor and the testers in each participating country would be located in that particular country. Conversely, a large part of the project work would be conducted in a distributed manner and co-ordinated via information and communication technology. In the situations where a Clinical Trial Manager would travel to a particular country, important co-ordination work with people at the headquarters would have to be conducted using technology. In the following five sections (I)-(V) we consider some of the interaction problems experienced by the pharmaceutical staff in the dyspepsia group.

(I) Initiating Interaction

The pharmaceutical staff frequently experienced problems in coping effectively with the initiation of synchronous conversations, e.g., telephone calls. Telephone calls only notified receivers that someone wanted to talk to them, but not who it was or the nature of the communication. Furthermore, callers were not provided with much information about the receivers' current activities. Were they engaged in important activities or could they be interrupted? It was, therefore, difficult for the caller to assess whether or not they were interrupting. Poor mechanisms for handling the initiation of conversations seemed to be the main reason for inappropriate conversations. From the receiver's point of view, this could cause reluctance to engage in this form of synchronous communication.

The group members often had a considerable amount of highly prioritised project work to complete close to deadlines. This forced them to share the workload among each other as much as possible. In these situations the research staff were often contacted by people who wanted to discuss *other* issues, e.g., future trial projects. Such interruptions were recurrent, amongst others because researchers frequently were involved in several projects. It also occurred because work at the company relied heavily on personal networks transcending the formal organisation. DJ, a trial manager, described the problem as follows:

> "For example, the monitor of one country called when we were doing the "clean file" work, and he wanted to discuss something that was going to happen in half a year... About a meeting we were going to organise. And I felt... it was uninteresting and very frustrating to spend my time discussing that meeting, because I had 1000 other very important things to do. " (DJ, Clinical Trial Manager)

Being extremely busy at that particular time, DJ did not find the conversation important. She had a heavy workload, and it was crucial to meet the deadline. Nonetheless, she was forced to involve herself in the issues raised by the monitor.

(II) Managing Modality

The initial assumption that managing interaction in order to avoid interaction overload mostly concerned obtrusive and ephemeral interaction was not supported in the study. The notion of redirecting interaction towards unobtrusive persistent modalities would often fail to characterise situations. Instead, we were forced to adopt a much more proactive view where the pharmaceutical staff actively managed interaction modalities. Several managers in the group expressed the necessity of making themselves available for others through obtrusive and ephemeral modes of interaction, as illustrated in the following:-

> "When I perform administrative work, such as the routine work of going through journals from clinical trials, it doesn't matter if people interrupt or disturb me. On the contrary, it is only good if they interrupt and disturb me more in these situations, then they might not disturb me so much when I don't want to be disturbed. You know, it's when I do brain work I don't want to be disturbed…" (PJ, Clinical Trial Manager)

> "As Group Manager it is partly my responsibility to be accessible to my group, but I'm also involved in clinical trials. At the moment my workload is too high, so...I don't manage to do what I should do. Working as a manager is in conflict with working in clinical trials projects...because the work in the projects require that I can work without being interrupted and disturbed, and the work as a manager very much involves talking to people—the opposite. When my door is open I'm seldom alone.... And I've made it clear; if the door is shut you shouldn't disturb me. But if the door is slightly open, you are welcome to step in." (YF, Clinical Trial Manager)

GW, the Department Manager, had previously struggled with the same competing demands between working in clinical projects and contemporarily as a manager. Performing her role she highlighted that the clinical trial projects took too much of her time. As a consequence, she gradually shifted towards working exclusively as a manager. GW's perspective of her role as manager was similar to YF's:

> "Indeed, I often feel very busy... I have many things to do. But the most important part of my job as manager of the department is to be accessible and listen to the employees. I, therefore, think it's very important that people feel they can come to my office. I'd rather put things

> aside. Actually I often feel ... that people should come and talk to me more often." (GW, Department Manager)

It was also interesting to find that people were much more careful and discreet to people outside their own group compared to their immediate colleagues, for example, by carefully peeking into the office before knocking on the door. Contacting staff in their own group, people appeared to be much more obtrusive, for example, by walking into the office without knocking on the door. The office door was an important mechanism for reducing interaction overload by redirecting or postponing interaction. A closed door signified that the person behind it did not want to be disturbed, others could send an email or come back later. An open door indicated that others were welcome to enter. A Clinical Trial Manager told us that he sometimes even wrote, "close to deadline, please do not disturb!" on a Post-It note and placed it on the door when he did not wanted to be disturbed. KD states:

> "Previously, before the department was moved, there were windows in all the doors. I liked that, because then one could see what people were doing. And by doing so, one could assess if it was appropriate to interrupt them. There are no windows in the doors here, and it's often impossible to see what people are doing even if the door is open, simply because the chink is too small; you cannot see what's happening..." (KD, Clinical Trial Manager)

Similarly, the telephone system was frequently applied to manage interaction modality:

> "I, for example, enter "at meeting until X" into the telephone. And when people try to call me then a message saying I'm at "meeting until X" is displayed on the display of their telephone...and I won't be disturbed. I get the calls on emails instead... or people call later, when the telephone says I'm back..... When I receive the email, a light on the telephone begins to flash, and then I know that someone tried to reach me by phone...the communication is postponed..." (PJ, Clinical Trial Manager)

As a result of leaving a message in the telephone system, for example saying "in a meeting", or "temporarily out of the office", calls were redirected to the switchboard where an operator took a message and sent it in an email. The human telephone operator and the communication technology together constituted a socio-technical switching mechanism redirecting interaction from ephemeral and obtrusive to persistent and unobtrusive interaction. Since callers could try again later, this could also be viewed as a mechanism postponing interaction:

> "I sometimes inactivate MS-Mail and redirect the telephone to my secretary. She takes down notes of; who has called, when they called, whether I should call them back, and so on. This way things accumulate... I don't escape forever, it's just temporary..." (YF, Clinical Trial Manager)

The ability for others to obtain awareness about a person's current activities and degree of accessibility greatly reduced the risk of interrupting and disturbing the person unnecessarily.

(III) Inappropriate and Insufficient Modality

Different modes of interaction were found to be suitable for different kinds of 'conversations'. The pharmaceutical staff pointed out the advantages of the telephone providing synchronous "live communication". It enabled them to effortlessly clear misunderstandings. They could easily interrupt each other and ask clarifying questions, and thus relatively rapidly reach conclusions. Communication that required such interaction would therefore generally be carried out in a synchronous mode to be effective. Otherwise, such conversations would tend to provoke "a huge amount of exchanged

messages during a too long period of time" (JC, Clinical Trial Manager). However, when the interaction required a significant amount of information transferred from one person to another, synchronous interaction tended to be viewed as inappropriate. One such example concerned a secretary who occasionally received orders via the telephone for laboratory equipment from testers and co-ordinators involved in a study. The orders contained information "that only should be mediated from A to B, from them to me," and for that reason, she maintained that the telephone was a poor medium. When she, nevertheless, received orders by the telephone, she had to spend considerable time writing down the particulars of the order. This was ineffective for both her and the other person.

People occasionally failed to explicate the agreements made during a conversation. Let us take one of many examples observed. In the beginning of a 30 minutes long telephone conversation between a trial manager and a co-ordinator, a decision about the organisation of a specific local study was made. According to the trial manager, after the decision was made the co-ordinator described the situation at the participating clinics which "inevitably would have changed the decision" about the local organization of the trial. Neither the trial manager nor the co-ordinator took notice of that at the time, and the decision previously made was not questioned. When the trial manager a couple of days later reflected upon the forthcoming study, he was not sure exactly what decision had been made. One decision had been made in the beginning of the conversation. However, considering the scenario discussed during the main part of the telephone conversation, a different decision would have been more feasible. Since this was not clearly articulated during the conversation, neither of the two people involved knew exactly what they had decided. As a result, they had to discuss the issue again.

In order to manage this type of problem, the pharmaceutical staff frequently combined real-time ephemeral interaction with persistent interaction, for example by:- (1) asking the other party to write down what had been decided during the conversation and to send the memo by email; (2) taking down notes themselves—some people even used special note pads for this purpose; and by (3) recording the key points on a Dictaphone after the conversation, and using telephone logs. As one of the interviewees put it:

> "Combining the telephone; fast, direct access, effective to iron out misunderstandings, etc., with some type of log, making the conversations somewhat persistent, is often very effective"

Due to the time it took to transcribe telephone logs, a copy of the audiocassette was sometime sent for future reference instead of a transcription of the tape.

Although the particular situation would determine the preferred mode of interaction, different modes displayed generic features. For example, ephemeral and obtrusive interaction on the telephone interaction effectively sorted out misunderstandings that would have taken a considerable amount of email messages to sort out. The telephone did, however, force both parties to act instantly and simultaneously (Sproull and Kiesler, 1993). The real-time aspect of ephemeral interaction reduced the risk of facing information overload, while at the same time forcing the pharmaceutical staff to record traces of the interaction (Palme, 1984). This led to the dilemma between either increasing the amount of written documentation or risking to forget important interaction:

> "I certainly don't trust my own memory. If I receive a fax, for instance, and do not make a note of what I'm doing, I might very well forget it. This is sometimes the case; things just "fade away"... On the other hand, if I write things down, I increase an already enormous pile of paper." (KD, Clinical Trial Manager)

(IV) Intellectual Versus Routine Work

Even though communication and co-operation was very important at the company, the participants spent a considerable amount of time working individually. They distinguished between *routine work*, such as editing CRFs, and *intellectual work*, such as writing research reports. While routine work typically was iterative in nature and easy to resume after being interrupted, intellectual work took time to get into, and required considerable cognitive effort and continuity in order to progress. Conducting intellectually taxing work, such as writing scientific papers or planing forthcoming trials, Clinical Trial Managers generally choose not to engage in obtrusive and ephemeral communication, as illustrated in the following:

> "Let's say I'm in my office writing a journal paper and I am interrupted, for example by a telephone call or by someone entering my office. The person might want to discuss something, and it will take up a couple of minutes. When she's left, I cannot immediately go back to work. First I have to gear into the work. This is sometimes impossible, or at least takes a very long time …. Doing intellectually taxing work, every single interruption is negative...even if it is about something I have waited for or am very interested in." (PJ, Clinical Trial Manager)

Intellectual work interrupted by a long telephone conversation requiring full attention would be difficult to resume without the person having to spend time re-acquainting themselves with the problem at hand. There were thus times it was not possible for a person to re-establish their analysis (Dix and Beale, 1996). However, if a particular conversation was deemed very important, e.g., a doctor articulating serious problems in an ongoing trial, then the interruption subsequently was considered worthwhile. The *length* of the interruption mattered. "Trains of thoughts do not disappear immediately, but gradually," a trial manager stated (cf., Dix et al., 1993). Furthermore, people also maintained that "brief" communication (cf., Tang et al., 1994, p. 23 "lightweight communication") normally concerned issues that did not require extensive cognitive efforts. The most disturbing interruptions, however, were the ones forcing people to make telephone calls, go to other people's offices, talk to people they should have contacted, or forced them to take down new notes in the "to-do list". Such situations occurred frequently, and apart from the desire to switch from obtrusive to unobtrusive interaction, they also raised the issue of interaction context. For example, in terms of the need to be aware of who was attempting to interrupt, or in terms of filtering requests for interaction.

(V) Notification of Interaction

The pharmaceutical staff complained that the asynchronous email applications did not announce the arrival of new messages. If they did not ensure to check for new messages frequently, it could result in requests not being processed in a timely fashion. The participants distinguished between different types of messages that required different actions. One distinction made by several participants was between "for-your-information" (FYI) emails and work emails. FYI emails mainly aimed at informing people. They were often sent to a large group of people, were usually not time-critical, and it was not always deemed important to read them carefully. Work emails were typically addressed to one person, or to a small group of people. They usually concerned the receiver's work explicitly. People most often took immediate action when receiving such a message.

The pharmaceutical staff received approximately 30 emails per day, excluding subscriptions to mailing lists. Inasmuch as people are in their offices when these messages are delivered this would result in work being interrupted at least as many times during a day. Frequently they were interrupted by FYI emails, i.e., interaction that was not important, time critical, personal or concerned the

person's work directly. The participants maintained that they wanted the system to distinguish between different *types* of messages. This point has been made in other settings as well. Malone et al. (1987a) argues for the value of structuring email messages as a means of supporting co-ordination, and Robertson et al (1998) reports on a study of how different categories in email was used for managing knowledge in an expert consultancy.

The problems relate to notification of asynchronous communication. The first problem, which has been discussed by others (cf., Ackerman and Starr, 1996), suggests that users wished to be notified about new messages, while the second problem highlights the importance of modifying the notification based on message type. The distinction between FYI and work messages is broad, to say the least, and does not, amongst others, cover messages that are sent to many people asking them to do something, e.g., to check that the configuration of their PCs were the most current one. However, we do not believe the distinction as such is the point here, but rather the lack of capacity to differentiate ICT behaviour based on the type of message. Most applications only notify the user that there is a new message, and the options to make this interaction richer are often limited. Current ICT appears to be based on the assumption that people want to cope with all messages in the same way and therefore want to be notified about all new messages in the same way. This study here contests this assumption, suggesting that people wish to distinguish between different kinds of communication that they plan to cope with in different ways. Thus, people would probably benefit from mechanisms acknowledging new messages in more sophisticated ways.

5. DISCUSSION

In this paper we have investigated interaction overload with a focus on interaction modality. The empirical study highlighted how people in a pharmaceutical company managed their interaction by switching between modalities and by postponing interaction. Based on the study, we draw the following three general requirements for future design of IT artefacts to help people to more effectively manage their interaction:-

- People need to be able to plan their *accessibility* to others: who they want to be accessible to, and their preferred interaction modality. Planning is, however, not enough.
- People also need to become *aware* of each other's activities, e.g., the sender would benefit from being aware of what the receiver is doing.
- People also need to be able to *combine* modes of interaction; one single mode is not always enough.

We find that the information overload perspective to some extent presents a reactive cognitive psychological point of departure emphasising lack of human ability to cope with the amount of information they are confronted with. Instead, we wish to promote a proactive perspective, focusing on desire and need. People should be provided with ICT supporting *active* management of computer-based interaction.

In some situations it might be advantageous to switch off obtrusive and ephemeral interaction and opt for more unobtrusive and persistent interaction. However, as the fieldwork showed, there are also situations where the opposite is preferable. Postponing interaction can be obtained by redirecting from ephemeral to persistent interaction, combined with switching from synchronous to

asynchronous interaction. Switching off asynchronous interaction facilities also implies postponing the interaction.

Interaction overload can be explained from a co-operative perspective by applying Schmidt & Simone's (1996) concepts characterising co-operative work as being carried out by interdependent actors interacting through changing the state of a common field of work. Co-ordination work is a secondary activity required to co-ordinate, schedule, integrate, and mesh distributed and yet interdependent activities. Co-ordination work is recursive, since the management of an established work arrangement may itself be conducted as a co-operative effort which, in turn, may also need to be articulated (Schmidt and Simone, 1996). When people who work together experience interaction overload this can be viewed as a need for co-ordinating a particular type of activity, namely the co-ordination of work itself. This implies that a technology supporting the management of interaction overload must enable the participants to co-ordinate when, and how to apply what modes of interaction. This is exactly co-ordinating co-operative work with the co-ordination of work being the field of work, or, put another way, co-ordinating co-ordination work.

The concept of interdependence in co-operative work has been promoted as a way of analysing co-operative settings without subscribing to the assumption that the common fixture collaborating is a small homogenous group with one shared goal. Schmidt & Bannon (1992) argue that the notion of a 'shared goal' is murky and dubious, and that co-operative ensembles either are large or embedded within larger ensembles with no omniscient agent. They are often transient formations where membership is unstable or non-determinable. The pattern of interaction changes dynamically with the requirements of the situation, and control is distributed logically with agents being semi-autonomous in their partial work (Schmidt and Bannon, 1992). This perspective supports the notion promoted in this paper, that it can be a viable strategy to investigate how technology can support the individual in coping with interaction overload. At the same time it is important to expand the domain of enquiry to also include the design of multi-user technology, making it possible for several people to define and negotiate interaction patterns. There is, in other words, a need for the design of co-ordination mechanisms (Schmidt and Simone, 1996), reducing the complexity of co-ordinating and negotiating who is using which interaction technology, and when.

Ultimately we must acknowledge that in a world of increased interaction, we cannot rely on people only to interact with us when we desire it. All sorts of people may want to interact with us, imposing us with the challenge of 'hiding' whilst at the same time being available. It is difficult to avoid seeing the situation as an interaction 'arms race' between people. If someone desperately want to contact you, this person may send you emails, faxes and letters, whilst at the same time ringing you on all your phones, attempt to initiate video conferencing and perhaps even call by the office. If you are determined not to let the person's requests for interaction interfere with your current activities, you may have to establish an effective shield. At the same time, there may be situations where you wish to get as much interaction out of the way as possible. You may wish to deploy a technology that can obtain awareness of the interaction preferences of potential interaction partners in an attempt to lure them to interact with you when it is convenient for you.

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