Are You "Pulling the Plug" or "Pushing Up the Daisies"?

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We are becoming more and more dependent upon a broad range of more or less ubiquitous communication technologies, and these are increasingly integrated with our PCs. The more connected we become, the more important it is that we pro-actively manage our communication patterns. If not, we risk being forced to either temporarily disconnecting ourselves from communicating, or spend all our time trying to catch up with the demand for communication. None of these two scenarios are desirable. The aim of this paper is to investigate how people manage communication patterns as an integral part of their daily work. Empirical investigation of complex work in a Swedish pharmaceutical company showed a variety of means for managing communication patterns. Based on the fieldwork we present SwitchIT, an application for pro-actively managing communication modes, and discuss the theoretical implications of applying the concepts of communication overflow and communication deficiency to describe communication patterns. It is concluded that there is a need for collaborative technology supporting the negotiation of communication.

1. Introduction

We guarantee that you, as a busy professional, are constantly confronted with the dilemma: should I temporarily disconnect myself from all communication technology in order to get work done — "pulling the plug" — or should I remain in cyberspace and risk being buried in emails, telephone calls, faxes, etc. — "pushing up the daisies"? The modern office is increasingly being equipped with a broad range of communication technology, such as, telephones, fax machines, email, workflow systems, and scheduling systems, and video conferencing systems, both on and off the desk-top. Some of these are stand-alone technologies and others are integrated on the same computer platform. Daily work in an office involves using these technologies in a complex pattern as a part of the communication which also involves face-to-face communication. There is, furthermore,

a trend towards information technology being augmented with the capabilities of communication technology.

At first, we are thrilled by the prospect of using advanced state-of-the-art communication technology, such as receiving the first email or participating in the first desk-top video conference. At this point virtually all communication through the new technology is desirable. We subsequently engage in a process of utilizing the potentials of the technology. Later on, chances are that we use many different communication technologies and experience dramatic increases in the amount of communication. By then, we experience that we spend time on communication which is undesired, and feel that it had been more appropriate if we could have put these efforts into other, more important activities. We also experience that communication is carried out through an inappropriate medium or mode; we are, for example, subjected to telephone calls when we would have preferred emails. People actively engage in a process of prioritizing, excluding, postponing and redirecting communication simply because they have neither the capacity nor the desire to be available to everyone at any point in time through all means of communication.

This situation can both be characterized from the perspective of information overload, where the individual being presented an amount of information exceeding his or her cognitive capacity [17], and the perspective of interaction overload, where the level of interaction which the individual needs to engage in exceeds his or her cooperative desire. It is the aim of this paper to investigate how the concepts of information overload and interaction overload, defined as communication overflow [22] and communication deficiency [23], can describe how people in organizations actively manage their communication with others. The results as a basis for designing information technology to support this process.

In order to explore the problem in practice, we have conducted fieldwork at a Swedish pharmaceutical research organization. This study has provided us with valuable insights in how people actively manage their communication

patterns. Our research focuses on the design and use of information technology [c.f., 5; 8]. We, therefore, attempt to take the analysis of interaction overload one step further by designing technology supporting people in managing interaction overload. This paper presents the results from the fieldwork and a prototype application called SwitchIT, providing computational support for the process of managing modes of communication.

In the following section, we present and discuss theoretical concepts. Section 3 presents the field study site and research approach. Section 4 analyzes how members of an organization manage their communication patterns. Section 5 outlines and discusses the design of a light-weight switching mechanism supporting the process of managing communication deficiency. Section 6 discusses the findings.

2. Concepts

When a particular communication technology initially is adopted, it must be used by a critical mass in order for the technology to succeed [12; 13]. Widespread use of a communication technology can, however, cause problems. This paper aims at understanding 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 as a case of:

Information overload: The individual being presented an amount of information exceeding his or her cognitive capacity [17], or

Interaction overload: The level of interaction which the individual needs to engage in exceeds his or her communicative and cooperative capacity.

2.1 Information Overload

Information overload is a concept stemming from a database oriented view of information technology. It focuses on situations where the amount of information exceeds the cognitive capacity of the recipient of the information. It does not focus on communication patterns, and information overload is often exemplified by the difficulties related to information retrieval in large databases [11]. In order to reduce the risk of facing information overload, the amount of information must be reduced, either by inventing more effective tools for information processing, e.g., information retrieval or filtering [c.f., 3; 29], or by increasing our cognitive capacity, thereby processing the information more efficiently [c.f., 1]. The problem of information overload has been addressed within several fields, such as, information retrieval [c.f., 3; 31], information filtering [c.f., 11; 25; 29], and intelligent agents [c.f., 9; 24].

2.2 Interaction Overload

Interaction overload characterizes problems related to interaction among people. This can, in turn, be characterized as two analytical distinct problems, the problems related to undesired communication, which we denote *communication overflow*, and problems related to desired communication through an undesired mode of communication, which we denote *communication deficiency*. The first concept expresses the notion that not all communication is desired at all times, the second concept denotes that even if the communication is desired, then the way in which it is carried out might not be.

Communication   Overflow

Communication overflow characterizes situations when people are subjected to communication they are not interested in [22]. Augmenting Shannon's [35] simple and powerful model for communication with the notion of context, communication overflow can be characterized as [22]; contents of the communication, communicator(s), and context of the communication in terms of time and place.

Regulation mechanisms support the management of communication overflow by distinguishing desired communication from undesired [22; 23]. There are two distinct types of regulation mechanisms [23]: *filtering mechanisms* which support specification of filters that automatically match and direct incoming communication, and which are an integrated feature in some communication applications, and *acknowledging mechanisms* providing information about communication before the user is subjected to it.

As an example, all internal telephone calls at the company we have studied will display the caller's local extension on the telephone of the receiver of the call. As people learn who has which number, this display provides information that could be used to evaluate the desirability of communication before being subjected to it.

The major disadvantage of acknowledging mechanisms is that people must evaluate all communication, while the major disadvantage of filtering mechanisms is that they do not provide awareness about the communication which have been filtered out. Accordingly, the major disadvantage of filtering mechanisms is the major advantage of acknowledging mechanisms, and vice versa. Therefore, the combination of these two types of regulation mechanisms is potentially a very powerful means for managing undesired communication. Regulation mechanisms have been used within information retrieval to avoid information overload, e.g., filters to avoid experiencing "junk mail" [c.f., 7] and key words to avoid browsing databases which are not relevant.

Some commercially available email clients, such as Eudora and GroupWise, contain both filtering and acknowledging regulation mechanisms. The possibility for attaching

sounds or sampled messages to filters in Eudora 3 Pro illustrates the strength of combining the two approaches.

Communication Deficiency

During the fieldwork studying communication overflow we recognized a related, yet different problem, which we call communication deficiency [23]. Communication deficiency characterizes situations where people are subjected to communication which they are interested in, but where the mode of communication is undesired. Within the field of Computer Supported Cooperative Work (CSCW), the concept of *modes of interaction* has been promoted to characterize interaction in cooperative work settings. Studies of what people do when they conduct work activities has shown a multitude of different types of interactional activities, such as; maintaining reciprocal awareness, directing attention, assigning tasks, handing over, etc. [32]. Based on these, Schmidt [32] has suggested a general framework characterizing general modes of interaction. We have applied these to a general communication contex. The modes of communication in this model is related to the notion of communication medium in Shannon's model, and are characterized according to two modes of communication [Chapter 3.4, 32]; *Unobtrusive versus obtrusive communication* —communication can be more or less obtrusive dependent on how strictly it imposes obligations to notice and react. *Ephemeral versus persistent communication* — ephemeral communication only exist in the flux of unfolding activities and leaves no external trace. Persistent communication leaves behind an external trace. Figure 1 illustrates how the modes of communication can be used as analytical distinctions for classifying actual activities.

A mobile phone call can, for instance, be characterized as both obtrusive and ephemeral. It is necessary for the recipient to direct attention to the communication more or less instantly, and the communication does not leave persistent traces, unless it is an oral message from an automatic answering machine. A talk box or silent video connection constantly running in the background are examples of ephemeral but more unobtrusive modes of communication. An incoming email, inasmuch as the email application is configured to notify the user with alert sound, is on the other hand an example of a persistent and obtrusive mode of communication. The classification of a particular technology is to a great deal dependent on how the technology is configured. Changing the settings of an email application so it does not alert the user when there is a new email, for instance will make the communication less obtrusive. Redirecting the telephone from ringing to automatically recording messages on an answering machine will both change the degree of obtrusiveness and redirect the communication from an ephemeral to a persistent mode of communication. Faxed messages and PostIt notes silently placed on the desk are examples of unobtrusive and persistent communication, as are communication via shared whiteboards and common

information spaces [c.f., 33]. The communication does not in itself require of the recipient to direct all attention towards the communication. People working in the same room can engage in unobtrusive and ephemeral communication by thinking aloud, gazing, pointing, or humming [c.f. 15]. Studies have shown problems in providing support for computer mediated unobtrusive and ephemeral communication [16].

Obtrusive *Impose obligations to notice and react*	shouting in a meeting or on the telephone	electronic mail with request to urgently reply
Unobtrusive *Inconspicuous interaction with no direct obligations to notice or react*	humming, gazing, thinking aloud	discretely leaving trace, such as PostIt note
	Ephemeral *Only exist in the flux of unfolding acticities and leaves no trace*	**Persistent** *Leaves external trace*

Figure 1. The two dimensions of modes of communication; unobtrusive versus obtrusive, and ephemeral versus persistent, represented as a two-by-two matrix. The contents of the cells are examples of how to classify communication patterns according to the dimensions.

Schmidt [32] introduces a third mode of interaction which distinguishes between interaction in cooperative work embedded in the field of work, as opposed to interaction through symbolic representations of the field of work. Since the main objective in this paper is to investigate how information technology can support people in managing interaction overload as a result of using communication technology, the distinction between embedded and symbolic modes of interaction is problematic. Interaction carried out via communication technology is most often symbolic, being concerned with the articulation of who is doing what when and how. It is less often embedded in the field of work, i.e., interaction conducted by embedding cues by highlighting particular items belonging to the field of work. We are, furthermore, in this paper not only concerned with situations where people working together communicate and interact. The perspective adopted in this paper is one of communication and interaction among people in general. We will, therefore, not include the distinction between symbolic interaction and interaction embedded in the field of work in our further analysis.

2.3 Summarizing Key Concepts

This section has presented a set of key concepts to be applied in an analysis of the field study results. The concepts of information overload and interaction overload has been presented. Figure 2 shows a model describing the relationships between the concepts of interaction overload as

	Problem	Perspective	Technology
Information Over-load	The amount of information exceeds the cognitive capacity	The global amount of information in a particular setting	Processing: Information processing tools: information retrieval, filtering, intelligent agents.
Communication overflow	Being subjected to undesired communication due to content and/or communicator, both independent or dependent of the communication context	The individual who is subjected to undesired communication	Shielding and notifying: Regulation mechanisms filtering and acknowledging communication in a particular communication technology
Communication deficiency	Being subjected to desired communication through an undesired mode of communication	The individual who is subjected to undesired mode of communication	Redireting and postponing: Switching mechanisms supporting management of communication modes between technologies

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

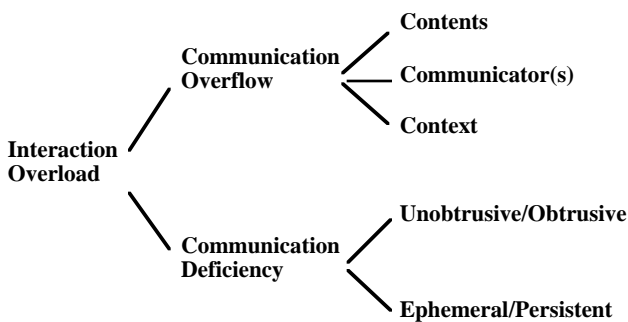characterized by the concepts of communication overflow and communication deficiency.

Figure 2: Model characterizing communication over-flow and deficiency. according to the contents, communicator(s) and context of the communication, as well as the two different modes of communication.

Being subjected to undesired communication, communication overflow, and being subjected to desired communication through an undesired mode of communication, communication deficiency, are both related to, but different from, being subjected to information overload. Communication overflow and deficiency, on the one hand, emphasize [22; 23]; Communication viewed as interaction among people from the perspective of the individual that is subjected to communication, and her desire to avoid or redirect some of the communication. Information overload, on the other hand, addresses information with a global view of the amount of information, and the human cognitive inability to cope with large amounts of information.

Communication overflow and regulation mechanisms can be related to both single and multiple technologies, whereas communication deficiency and switching mecha-

nisms relate to the configuration of multiple communication technologies. Table 1 summarizes the main differences between information overload, communication overflow and communication deficiency concerning the problems they address, the perspectives implied, and the type of technological support promoted.

3. Research Approach

The research approach applied in this paper shares common features with the approach advocated by Dahlbom [5]: "…a theory and design-oriented study of information technology use, an artificial science with the intertwined complex of people and information technology as its subject matter" [5, p. 29]. Our point of departure is that informatics is an artificial science concerned with the use of IT. The knowledge interest of artificial sciences, such as Informatics, is to improve and invent the use of artifacts [36, e.g., p. 7]. Such a knowledge interest goes beyond the classical distinction between social and natural sciences, with their ambition to interpret and explain respectively [6]. The notion of IT use seeks to understand "IT-in-use" from the perspective of the people affected. The term "IT-in-use" intends to emphasize that we do not see IT as a "dead object," but rather as a powerful and complex artifact that more and more seems to be integrated in human practices, enabling but also dictating the conditions, and not seldom act in seemingly uncontrollable ways [5].

3.1 Choice of Techniques

There are in particular two kinds of scientific methods that this perspective of informatics research advocates: ethnography and qualitative interviews. Ethnography is concerned with describing a certain domain, such as a working day, as seen from the people involved [19]. This is done by

direct involvement of the researcher, typically but not necessarily [see, e.g., "quick and dirty ethnography," 20, pp. 432] during an extended period of time [14]. While doing the empirical work, the researcher seeks to collect whatever data available that shed light on the focus of the research efforts [14]. The analysis of the empirical accounts is an important part of ethnography, which formally starts when the data is collected [14]. Ethnography is being used in many different ways and for many different purposes, ranging from long-termed anthropological studies of cultural issues [2, pp. 109], over medium term studies seeking to analyze the use of artifacts in cooperative work [4], to snapshots for the purpose of systems design [see, 21]. Qualitative interviews are characterized by openness and flexibility [26]. The researcher only sets the overall agenda and then lets the person being interviewed be in charge [18]. Ideally the interview takes place within a context with which the interviewee is familiar [18]. Qualitative interviewing thus favors richness of worldly realism, rather than tightness of control [26].

3.2 The Case

The fieldwork has been carried out at a multinational Swedish pharmaceutical research company employing 1000 people. Of these around 750 are directly involved in research activities spanning 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 are of paramount importance for conducting research projects all over the world. Other important information technologies are office systems, presentation tools, word processors, and spreadsheets.

Our research takes place at the third Clinical Research Management department (CRM III) at the clinical division. CRM III employs about 50 of the 350 personnel working at the clinical division. The research activities at the clinical division concern clinical tests on human subjects of drugs that have passed through the pre-clinical research. CRM III consists of four research groups, managing clinical testing of drugs before they are approved for regular use. The fieldwork reported in this paper has mainly been conducted at one of these groups; "Ulcer/Dyspepsia." The group consists of six employees, which is one group manager, three clinical trial managers, and two secretaries. The research in this group concerns dyspepsia, "a persistent or recurrent abdominal pain or discomfort in the upper abdomen" [38]. Broadly speaking, this means that people have serious stomach-ache without any symptoms of a gastric ulcer.

We studied the everyday accomplishment of work in the CRM III group during two months. The approximately 80 man-hours of close participant observations [c.f. 28], i.e., following a particular person through this person's working day and taking field notes, was combined with about 240 man-hours of site observation, i.e., talking to the group members, checking who was doing what, etc., and gained many interesting observations. We believe that the insights of how work actually is performed gained through the participant observations had been hard to get by solely conducting interviews. Our role as observers and the purpose of the fieldwork was known by everybody [c.f. 28]. Field notes were continually taken during the observations.

The participant observations were followed by qualitative interviews [28]. Besides the member of the dyspepsia group, interviews were conducted with the manger of the department, three clinical trial managers and two group managers from other groups within CRM III. The reason for this was simply to gain a more exhaustive insight in the nature of communication deficiency. An interview guide approach was chosen for the interviews. This implied specification of general topics in advance, and the particular course of each interview directing the exact wording and sequence of questions [28]. A total of 12 interviews were conducted. The interviews lasted between 45 and 90 minutes, and were all taped. The interviews were transcribed, coded and together with the fieldnotes, analyzed based on the concepts described in the previous section.

4. Managing Communication

This section presents the field study results with a particular focus on how the members of the group experienced and managed communication deficiency. However, because of the analytical nature of the concepts, communication overflow and information overload will be also be applied in order to explain the observed phenomena.

4.1 Ephemeral Versus Persistent Communication

Although the appropriate mode of communication is contingent on the particular situation in which it is played out, different communication modes display generic features. The fieldwork illustrated this in examples of how the ephemeral and obtrusive real-time telephone communication efficiently sorted out misunderstandings, which would have taken a huge amount of email messages. The telephone does, however, force both parties to act instantly and simultaneously [37]. Ephemeral communication reduces the risk of facing information overload as indicated by the title "You have 134 unread mail! Do you want to read them now?" [27], while at the same time forcing the participants to record traces of the communication. This can lead to the dilemma between increasing the amount of written communication or risking to forget important communication. This can impose a dilemma:

"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. And 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

During both observations and interviews it turned out that people often combined the advantages of real-time ephemeral communication, such as the telephone, with persistent communication. We have evidence of people, for example asking the other part to write down what had been decided in the conversation and to send it by email; taking down notes themselves—some people even used special note pads for this purpose; recording the key points on a dictating machine after the conversation, and using telephone logs.

As one of the interviewees put it: "Combining the telephone; fast, direct access, effective to turn out misunderstandings, etc., and some type of log, making the conversations somewhat persistent, is often very effective," Due to the time it takes to transcribe telephone logs, people sometimes receive a copy of the audio-cassette instead of a transcription of the tape.

4.2 Communication Obtrusiveness

Communication deficiency appears to a great extent to be dependent on the situation. Conducting intellectually taxing work, such as writing scientific papers or planing forthcoming clinical trials, people generally did not choose to engage in obtrusive and ephemeral communication, as the following quotes show:

"Let's say I'm at my office writing a journal paper and I am interrupted, for example by a telephone call or by someone entering my room. She might want to know or discuss something, and it will take a couple of minutes. When she's left, you cannot immediately go back to work. First you have to acquaint yourself with the train of thought. This is sometimes impossible, or takes a very long time...especially if the interruption was long and you had to put cognitive efforts to something. Doing intellectually taxing work, I think every single interruption is negative...even if it is about something I have waited for or am very interested in..."

PJ, Clinical Trial Manager

"I have been very over strained lately, and it's not very good to receive telephone calls, and similar. Especially not calls from long-winded people, or someone call one minute before lunch, when you are extremely busy; you have 30 minutes and you don't want to eat alone. You know, that's simply inappropriate situations for receiving phone calls. I would very much appreciate if I had the possibility to manage my communication more than I am today."

KD, Clinical Trial Manager

During the observations we recognized that people have problems gearing into work when they have been interrupted. Even when using "to-do lists" and writing down short notes when being interrupted, it seemed to be very hard to go back to work immediately after an interruption. This is especially the case when these interruptions force people to make telephone calls, go to other people's offices, talk to people they should have contacted or force them to take down new notes in the "to-do list". Such situations

occurred frequently during the observations and they can be interpreted as both communication overflow and deficiency. The person might be formally responsible for accomplishing the task, but does not give it a very high priority. Furthermore, the mode of communication is obviously not very appropriate. Rouncefield [30] has characterized this phenomenon as a type of work where the core of the activities is constant interruption.

4.3 Actively Managing Constant Interruptions

Communication deficiency does not only arise when people are interrupted by obtrusive and ephemeral communication in situations where they want communication in a more unobtrusive and persistent mode, as the following illustrates:

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 my work is partly 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 manager is somewhat 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. But if the door is slightly open, you are welcome in."

YF, Clinical Trial Manager

Hence, communication deficiency does not have to imply that people are subjected to communication in an obtrusive and ephemeral mode, thereby being interrupted. Sometimes the opposite is true. GW, the department manager, had previously struggled with the same contradiction between working in clinical projects and as a manager. Today she works exclusively as a manager: "working in the projects took too much time," she argued. GW's perspective of her role as manager is very similar to YF's.

"Indeed, I often feel very busy... I've 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. Therefore I think it's very important that people feel they could come to my office. I'd rather put things aside. Actually I often feel the opposite...that people should come and talk to me more often."

GW, Department Manager

4.4 Managing Obtrusiveness Using Doors, Telephone Systems and PostIt Notes

During the observations we found that people are more careful and discreet to people outside their own group, for example, peeking into the office before carefully knocking on the door. Contacting people in the own group, people seem to be more obtrusive, for example, walking into the office without knocking on the door, when they contact colleagues from their own group. One way of reducing the risk of interrupting and disturbing people in inappropriate situations, would be if it was possible to enquire about the accessibility of the others. The door seems to be a very important mechanism for redirecting or postponing the communication. A closed door is often a sign that people do not want to be disturbed, and an open door that people are welcome in:

"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

Hence, YF uses the door to indicate her preferred mode of communication; if it is open or slightly open, please come in, but if it is closed, please send an email, or similar, or come back later. Using the door as a switching mechanism YF reduces her risk of experience both communication deficiency and overflow. A clinical trial manager told us that he sometimes even writes "please do not disturb!" on a PostIt note and places it on the door when she does not want to be disturbed.

The telephone system is also frequently applied to switch modes of communication:

"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 at the telephone begins to flash, and then I know that someone had tried to reach me by phone...the communication is postponed..."

PJ, Clinical Trial Manager

In other words, entering a message into the telephone system, such as: "meeting" or "temporary out of the office", calls are redirected to the switchboard where an operator takes a message and send it in an email. This is an example of a switching mechanism redirecting ephemeral and obtrusive communication to persistent and more unobtrusive communication. However, since callers might try again later, this can also be viewed as a postpone mechanism, as noted by YF:

"I inactivate MS-Mail and redirect the telephone to my secretary. She takes down notes; who has called, when, whether I should call them back, and so on. So things are accumulated... I don't escape forever, it's just temporary..."

YF, Clinical Trial Manager

4.5 Fieldwork Results

The field study clearly pointed out that people experience phenomena which can be described in terms of a mixture of both communication deficiency and overflow. The trend of increasingly applying information technology to connect people will most likely enforce the problem.

People do struggle with both communication overflow and deficiency in their daily working life. Communication deficiency is not just about being interrupted and disturbed by obtrusive and ephemeral modes of communication. Often the opposite can be the case. People want to actively manage their accessible modes of communication, not just hide from obtrusiveness. The type of work which a person is responsible for seems to play a role for the experiences of communication overload and deficiency. To reduce the risk of communication deficiency, people use switching mechanisms, directing one mode of communication to another, and postpone mechanisms, delaying the communication within the same mode to a more appropriate time. A switching mechanisms is sometimes also a postpone mechanisms. Publishing the preferred modes of communication to others seems to be a good idea.

5. Support

This section explores the question of how to provide IT support for managing communication deficiency by means of the prototype application SwitchIT[1], supporting users of multiple communication technologies in easily switching among technologies, and for publishing preferences to others.

5.1 SwitchIT

Our starting point was to design something very simple and at the same time immediately useful and usable. The reason for that was that we do not think it is a realistic starting point for our intention, to construct highly complex technology, for example, embedding models of user-behavior.

SwitchIT enables the user to easily change her desired mode of communication. The application is constantly activated on the desktop, and it only requires a single mouse click to change the accessible mode of communication. Applying the two by two matrix presented in Figure 1, SwitchIT supports the classification of each of the user's

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[1] SwitchIT [10] is an Apple Macintosh application implemented in C++ and Dynaface, an interface design tool, and is a radical redesign of the initial application described by Ljungberg & Sørensen [23].

communication applications in one of the four modes of communication. The user-driven configuration of communication systems has been chosen because most technologies can be configured in several ways, e.g., the email client Eudora which can be configured in various degrees of obtrusiveness dependent on the setting of alert sounds, dialogue boxes and flashing icons in the menu bar. Up to three applications can be entered in each of the four modes of communication. The status of an application is indicated by the button of each application, and a browsing window supports editing the settings. Clicking on one of the applications within a mode toggles the status of the single application between active and inactive. To activate or inactivate all applications within one of the four modes, the user toggles one of the vertical buttons.
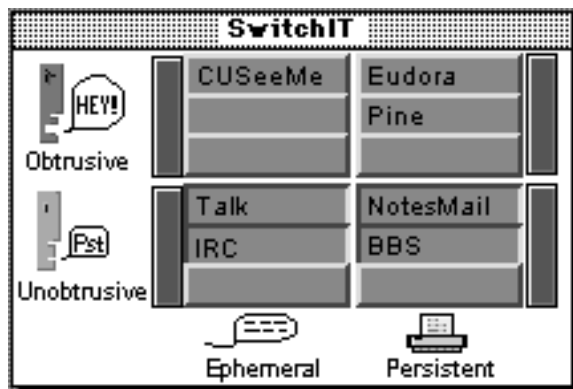

Figure 3. SwicthIT's main window.

SwitchIT supports selective publishing preferred modes of communication to others (Figure 3). Settings can be hidden from or shown to the SwitchIT users listed in the window.
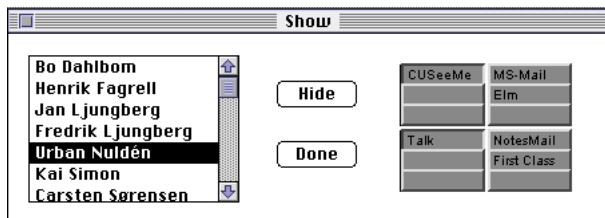

Figure 3. The "Show" menu in SwitchIT.

5.2 Further Development

The version of SwitchIT shown above only provides a first crude functionality. We are currently exploring the possibility for redirecting communication in undesired modes of communication to other, desired ones. Operationally, this could be done by marking an application in the main panel, pressing shift and click on another application, providing communication in a more appropriate mode. Providing support for redirecting is certainly not easy. It is, however, a very exciting challenge for further research.

We are also exploring the possibility to use icons that can be moved optionally within the matrix. The use of icons could reduce the number of operations required to manage the application, e.g., changing the placing of an application. Relating the placing of an application in SwitchIT to its "real" settings according to the two dimensions of communication, the user would benefit even greater. Associating the positioning of an application's icon in SwitchIT with its settings is a non-trivial effor requiring a substantial programming effort. Providing support for while double-clicking and drag-and-drop functionality are much easier to provide.

Inasmuch as users find it useful to have various predefined settings, e.g., for "meetings at the office" and "administrative work," future versions of SwitchIT could make it possible for the users to have pre-defined choices of desired modes of communication, scenario's of communication. For example, during meetings the telephone should always be redirected to an email application, the video conference system to the talk-application, and so on.

The strength and weakness of SwitchIT is the simple design. Even if only one person use it, this person might benefit. At the same time it does not support policies for availability and organizational structures. An issue for further research is therefore to explore the relevance of supporting computer-mediated communication through SwitchIT or for incorporating options for organizational structures. We have contemplated the possibilities for incorporating software-based agents which could also take the form of diplomats and agitators, traversing a work-groups' network and support the negotiation of how SwitchIT settings should be set. Similarly, agents could be applied to install the preferred settings for SwitchIT at each project member at the start of a project.

5.3 SwitchIT as a Communication Technology

SwitchIT can be viewed as a meta-communication technology, in the sense that it is a communication technology which supports the articulation of communication. It can, therefore, as with other communication technologies, be augmented with the regulation mechanisms, extensively discussed by [22] (See Table 1). It could support configuration of filtering and acknowledging mechanisms which could filter communication attempts and provide audible or visible notification when registering others attempting to communicate.

Supposing that two people geographically dispersed are working towards a joint critical deadline. They, therefore, do not want to be subjected to obtrusive communication from others. If, however, one of them wish to establish a video conference with the other, this request for communication should not be excluded. This can be accomplished either by a filter blocking out everybody else except this particular

person, or by an acknowledging mechanism, notifying incoming communication from the person.

6. Discussion

This paper has presented examples of how people in a pharmaceutical company balance between "pulling the plug" and "pushing up the daisies" by switching between modes of communication and by postponing communication. The field study results have informed design of the SwitchIT prototype supporting the management of communication modes. We address how to design information technology supporting the process of actively managing the mode of communication.

Viewing the problem from a proactive view focusing on desire, rather than a reactive cognitive psychologically point of departure emphasizing (in)ability. Adopting a proactive perspective, we argue that people should be provided with IT supporting people in *actively* managing their interaction through communication technology. In some situations it might be advantageous to switch off obtrusive and ephemeral communication and opt for more unobtrusive and persistent communication. However, as the fieldwork showed, there are situations where the opposite is preferable. Postponing communication can be obtained by redirecting ephemeral communication to persistent, switching from synchronous to asynchronous communication. Switching off asynchronous communication facilities should also imply postponing the communication.

Communication deficiency can be explained from a cooperative perspective by applying concepts from Schmidt & Simone [34], characterizing cooperative work as being carried out by interdependent actors interacting through changing the state of a common field of work. Articulation or coordination work is the secondary activities required to coordinate, schedule, integrate, and mesh distributed and yet interdependent activities. Articulation work is recursive, since the management of an established arrangement of articulating a cooperative effort may itself be conducted as a cooperative effort which, in turn, may also need to be articulated [34]. When people working together experience communication deficiency this can be viewed as situations where the need arises to articulate a particular type of work, namely the articulation of work. This implies that a technology supporting management of communication deficiency must enable the participants to articulate which modes of interaction is applied when and how. This is exactly articulating cooperative work with the articulation of work being the field of work, or put another way, coordinating coordination work.

The concept of interdependence in cooperative work has been promoted as a way of analyzing cooperative settings without subscribing to the assumption that the common fixture collaborating is a small homogenous group with a shared goal. Schmidt & Bannon argue that the notion of 'shared goal' is murky and dubious, and that cooperative ensembles are either large or embedded within larger ensembles with no omniscient agents; they are often transient formations where membership often is unstable or nondeterminable. 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 [33]. 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 communication overflow and deficiency. 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 communication patterns. There is a need for the design of coordination mechanisms [34], reducing the complexity of coordinating and negotiating who is using which communication technology, and when.

Acknowledgments

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