Dissertation Proposal

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This dissertation proposal consists of an overview of my current research interests, abstracts of four essays that explore questions and propose hypotheses raised during my previous research, a strategy for collecting additional case study data to further develop the ideas in these essays, a dissertation outline, and a schedule.

Research Interests

I am interested in how to make people more productive. Two strategies for accomplishing this are to provide better methods of accessing information in forms that meet the needs of the user and to provide users with the ability to customize their working environment to meet specialized needs. The wide-spread use of computers, both as stand-alone productivity tools and as a communication network, offer many possibilities for improving productivity. However, there are many things we don't understand and blind application of technology to organizations may cause as many problems as it solves.

My specific research interests began with the observation that users are often unable to successfully use the information that is "readily available" to them. Most information is not designed to fit the users' problems, nor is it clear that prepackaged information can be. This observation led to my interest in electronic communication networks, in which the source of the information is sometimes another person, who may be better at presenting information in the terms that the user can understand.

I have thus focused on the role of electronic communication systems in work and learning. I have been fascinated by the dynamic interplay between people and the software they use. Software does not occur in isolation; it must be examined in the context of a constantly changing work environment. Electronic communication systems are especially interesting because their use often reflects the dynamic nature of the organizations in which they exist. Electronic mail both affects the communication patterns within an organization, e.g. by changing communication costs, and is affected by the existing work and social patterns of the organization. It is used to coordinate activities and allocate tasks, prioritize work, and provides a record of useful information. Electronic mail also provides an additional mechanism for accessing a wide variety of technical and political information within an organization.

People in organizations adapt electronic mail to meet their needs, often using it in ways unanticipated by the designer or even changing the software to meet specialized needs. This makes it a useful test case for studying user innovation. We can explore the circumstances under which users innovate and whether or not these innovations can be predicted by the developer of the software. If they cannot be predicted, it may be possible to change the software development process to identify the areas most susceptible to user innovation.

One often overlooked benefit of introducing new technologies is that they can expose underlying assumptions about human behavior that turn out to be wrong. Many new tools have been introduced that do not work as expected, because the designers were unaware of the kinds of activities actually performed by users, their needs, or the causes of their behavior. Observing where new technology breaks down can thus provide important insights into our understanding of human behavior. Networks of computers have proven too valuable for them to go away. It makes sense then to use them as a method of learning more about user behavior and then feeding that information back into the design of more useful systems.

The following essays are an attempt to develop a theoretical understanding of users' communication strategies and to gain insights that will allow me to increase the effectiveness of electronic communication systems.

Abstracts of Proposed Essays

The following are abstracts of the four essays I would like to write. Each essay derives from one or more observations of user behavior that surprised or intrigued me. I view these essays as an opportunity to explore the underlying theoretical issues and to identify, perhaps, principals of human communication and/or problem solving.

Factors that influence choice of communication channel:

I am interested in how electronic mail fits into an overall work pattern, what it is useful for and why. I have begun to explore this by asking users to describe the reasons for their choices of one communication medium over another. Subjects were asked which activities caused them to prefer face-to-face meetings, phone calls or electronic mail. I also asked how they go about obtaining technical information or finding previously stored information. Users consistently identified a particular characteristic of the communication channel as the overriding reason for their choice. Other features of the channel were accepted as necessary limitations.

My hypothesis is that we can identify characteristics of communication channels independently of the forms in which they are actually presented to users (e.g. phone and electronic mail). If the key characteristics can be isolated, it should be possible to identify the kinds of activities for which each is most useful and then improve the user's access to the most useful features.

In order to examine this systematically, I would like to interview some of the users I have already studied and observe their choices of communication channels. The questions about preferred features will be derived from the previous interviews. (Examples of needs that cause people to choose one channel over another include: the ability to keep a record of the conversation, avoidance of disturbing the user by leaving a message, the need to have a rapid interchange, the need to hear the intonation of someone's voice or see facial expressions, and the desire to carefully compose a message.)

I will ask each individual to provide a recent example of each type of activity, and what they chose to do, whether or not it was typical, and why they did it (cf. critical incident theory). This will provide a method of cross-checking user's answers to the general question about preferences of communication channel. The derived list of information needs should be mapped to features of different communication channels.

The next question is what is the optimal way to present these features to users. One solution is to simply add functionality to existing channels (e.g. adding answering machines to telephones). Another is to repackage the features into new devices that serve the most commonly identified collections of user needs. A third possibility is to create a general-purpose, flexible communication system that allows users to control these features themselves. (Of course this leaves many remaining design questions. Refer to the essay on "barriers to the use of productivity tools" for a discussion of why simply adding flexibility may not solve the user's needs.)

Pygmalion is an inititial attempt to provide the third type of flexibility. It allows users to choose the communication medium (text, video or audio), whether or not the transaction will be synchronous or asynchronous, whether the sender or the receiver has primary control over access to messages, and changing the users perspective from passively receiving a stream of messages (and managing) or actively seeking them from an existing body of messages. Pygmalion represents my suggestions for the design of future systems -- it now remains to be tested.

The predictability of user innovation:

The pilot work has raised a number of questions that would benefit from further study of the users in the previous studies. Just when exactly *do* users innovate? What influences the choices they make? Are there general patterns that would lead us to predict when users are more likely to innovate?

Several kinds of situations increased the probability of user innovation. A major change in the user's work situation may cause reassessment of work patterns. Examples include leaving for an extended trip, the sudden introduction of a major new task, or a change in job. Simply examining one's own behavior, as in the course of my interviews or seeing data from the mail study, also caused people to try new things. Crisis situations often had the opposite effect, paralyzing users and causing them to keep "tried and true" methods.[1]

I found a number examples of user innovation in the course of the pilot studies. Some of these innovations followed the lines expected by the designer of the software; others did not. An example of the latter stemmed from the refusal of a number of potential users to use Lens. They articulated the problem as "not wanting to have someone or some machine pre-read their mail." However, one user stumbled on to a way to run rules *after* he had read his mail. This completely changed the kinds of rules he wrote. Other users then decided that it would be useful to use the system in this way, significantly increasing the total pool of users. The software was then redesigned to let users control when to run rules. It seemed useful to allow users to have more than one ruleset. The net effect of this change was more innovations -- and a different (and more generalized) way of thinking about how users want to manage electronic information. (It turned out that some of the people who originally protested that they did not want to have software pre-read their mail ended up finding it useful.) This series of incidents caused me to reassess my own assumptions about what users really do and why. I also came to the conclusion that it is difficult to predict user innovation, simply because the range of needs are complex and changing, and users are often unable to articulate their needs.

What implications do these observations have on the design of systems? One might argue that completely rigid software is useful if it completely and exactly meets the needs of the user. One can imagine, perhaps, such situations, but certainly managing work and communication networks in an organization is not such a situation. The opposite extreme, making a system completely flexible, is

[1] A man in a car pulled up to a boy running as fast as he could, pushing a bicycle. "Why don't you get on your bike?", he called out. "I don't have time!", replied the boy. Many people have trouble getting on the bicycle.

impractical as well. In some sense, programming in assembly language is completely flexible -- but most users do not have the skills or time to use it effectively. Higher level languages have built-in constraints, which make them easier to use both by collecting together low-level features and by providing models of use. The tradeoff is that, while they are more flexible along some dimensions, they are by definition more rigid along others. The software is likely to be more useful to the extent that user's needs match the dimensions along which the software has been made to be flexible.

I would like to collect additional examples of user innovations in the context of electronic mail and rules for filtering it. I plan to ask users to provide examples and attempt to determine the situation and potential triggers for the innovation, the effect of the innovation on work patterns, and any new innovations (or new insights about the user's own behavior) that may have occurred. I am also interested in how these innovations are shared and how other users modify the innovations to meet their own needs. I will describe how some of these innovations have led to major changes in the designs of Argus, Pygmalion, and EVA, and the preliminary results of those changes.

Barriers to using productivity tools:

Why do people resist organizing their activities, managing their time, and using tools that will help them be more productive in the long run? My hypothesis is that the long-term benefits are outweighed by the short-term costs of finding out the necessary information and applying it to the current problem.

Electronic mail is itself a productivity tool and the variants of Lens provide tools for increasing the productivity of electronic mail. However, users do not use either of these tools particularly efficiently. Some of the potential reasons include: the high cost of being explicit about behavior, the inequities in costs and benefits to senders and receivers of messages, the user's lack of awareness of their own usage patterns and inability to predict what future needs, and the mismatch between the form in which information is available and the user's needs.

Most software developers concentrate on adding features, which improves potential long-term benefits, but has little or no effect on lowering the threshold for using the software at all. A disturbing example appeared in a study I conducted with "experienced editor users", i.e. professional secretaries with 1-1/2 or more years of experience with a text editor *and* a word processor. I discovered that half of them did not know how to use the very basic "cut and paste" function. At the time, the developers of the text editor were "improving" the software by adding rarely-used esoteric features that required a great deal of time to learn. Worse, the addition of these features made it more difficult to use the most common, "simple" features. (Examples of this abound. Apple's Hypercard was extremely easy to use and dramatically lowered the cost of entry, allowing users to customize their work environments. A successor program, Supercard, has far more features but is much harder for a newcomer to use.)

Clearly there are trade-offs between ease of use and power or flexibility. In many of these cases, there may be a cross-over point, beyond which it simply is not a productive use of time to further customize the software or learn to use more advanced features. I suspect that this cross-over point is rarely reached. Certainly the secretaries would have been more productive if they had learned "cut and paste". Electronic mail users who become overwhelmed to the point of missing meetings and losing important information could clearly benefitd from more efficient message management tools. The solution must involve lowering the short-term costs of learning or using these tools.

This essay will describe examples of each barrier listed above and explore how those barriers might be lowered. For example, I observed that some users resisted using rules and message types because they had difficulty articulating their current mail sorting behavior. This may be because creating a rule requires to user to be explicit about their own behavior. An alternative might be to observe what users actually do and allow them to replay those activities automatically. Designers of neural nets use this approach to identify patterns of behavior (cite example of Wecker's neural net mail sorter.) Another possibility is to use a tutor to periodically interrupt users with information, based on the tutor's perception of the user's needs. Each of these approaches has other problems; solutions may involve combinations of these approachs.

I would like to ask a set of additional questions to attempt to get a deeper understanding of what these barriers actually are, and develop suggestions for lowering them. I will begin by asking if the user is satisfied with his or her current level of productivity. If answers differ for different work areas, I'll try to identify the factors that cause the differences. I will ask them about their own time management techniques and how effective they are. I will describe how Argus has been modified to lower certain costs in the use of message types and providing methods for end users to annotate their messages for future processing. Also, the results of allowing users to specify when to run rules.

The importance of the user's work context.

People's message management activities are not based on the content of the messages alone, but on the content of those messages in the context in which the messages are viewed. The context is constantly changing, so a static system for handling them is likely to cause unexpected problems.

For example, if the user has been on vacation, the criterion for deciding which messages to delete immediately changes. Similarly, the same message passes through different states, depending upon whether or not the user has seen it (there's something enticing about a new message...especially if it's one of 10, rather than 1 of 100.), whether or not the user has responded to it, whether or not the user feels guilty about not handling it, and whether or not it has been saved in 'permanent' storage.

My hypothesis is that tools that allow users to incorporate the changing context of their work environment will be more effective, especially if these tools do not require the user to articulate what has changed. An example would be to allow users to create different rulesets that can be run at different times, in different circumstances. Note that this is where use of rules may be an improvement over neural networks, because the recording of the patterns must include recording of changes in context.

Another example is the observation that receivers of messages do not always use categories sent by the sender. It is often not possible for the sender to know which categories are useful and the fact that the user's relationship to any message changes over time makes it impossible for the sender to be completely successful in annotating messages. Thus, it makes sense to also allow users to annotate their own messages and use that information for processing rules. The EVA software is an attempt to provide very flexible, and interactive annotation capabilities.

Proposed Dissertation Outline

The dissertation will comprise seven chapters:

1. **Introduction and Literature Review:** Discuss why it is important to understand how people use, modify, and are affected by electronic communication systems. Explain why this work can have implications for the understanding of communication and user innovation? Cite literature from relevant areas: information access, electronic communication, cooperative work, user interface and technological innovation. Discuss research methodology issues and explain why it's important to study a small sample of subjects in-depth, over a period of time.

2. **Essays:** Four original essays will discuss issues raised in the course of the pilot research. Each essay will describe the research activity and observations that lead to the insight and suggest a hypothesis to explain the user's behavior. Implications for the design of software systems (or the design process) will be discussed, and the results of implementation of actual software will be described. Additional interview questions and user behavior to record will be proposed. The topics of the following essays are described more fully in the next section.

    a. **Factors that influence the choice of communication channel:**

       Identify the characteristics of different communication options and which cause users to choose one channel over another. Examine how these characteristics affect user choices of communication channel and suggest a design for electronic communication that makes these characteristics explicitly controllable by users.

    b. **Factors that influence user innovation:**

       Present examples of user innovations and try to identify the situations in which such innovations are most likely to occur. Explain why developing completely flexible and completely rigid software is inappropriate, and then discuss why it is difficult to predict the ways in which users will innovate. Can we predict what kinds of innovations users are likely to make?

    c. **Barriers to the use of productivity tools:**

Why do users resist organizing their activities, managing their time, and using tools that will help them be more productive in the long run. Explore some of the barriers identified in this research: the cost of being explicit, the cost balance between sender and receiver, the user's lack of awareness of their own usage patterns, the over-effect of short-term cost vs. long-term benefit, the user's inability to predict future use.

d. **The effect of the user's work context on behavior:**

Message management activities are not based solely on the content of the message, but on how those messages relate to the current work context. Since this context is constantly changing, a static system for handling them is likely to be less useful and cause unexpected problems.

3. **Case Studies:**

   Subjects: 13 experienced electronic mail users at Xerox PARC and MIT, each of whom have used a version of a rule-based mail filter: Information Lens, Common Lens, Argus.

   Pilot data: Pre- and post Lens interviews. Snapshots of email use. Rule use records. Evaluations of features of Lens.

   Procededure: Conduct a set of final interviews, based on questions raised in the four essays. Observe and record actual user behavior. Develop case studies based on previous and new data. Attempt to identify the key elements that influence the ways in which the user communicates with others and the factors that encourage user innovation.

4. **Analysis and Conclusions:** Re-examine the questions raised in the four essays from the perspective of the case studies. Suggest implications for design of future systems and suggest directions and strategies for future research.

Proposed Schedule

September	Write 3-5 page abstracts of each essay. Identify a set of questions and behavior to observe, which will be included in the case study interviews.
October	Develop a set of in-depth case studies, based on further interviews and observation. Continue to expand essays.
November	Develop the essays with respect the new data and begin work

	on final chapter.
December	Complete final essay and literature review.
January	Revisions.

Users have varying incentives and abilities to improve how particular software packages affect their work patterns. Even software explicitly designed to be customized by users can only be customizable along certain dimensions. Explore the extent to which designers can predict these dimensions along which users innovate, and strategies for identifying profitable innovation areas (learning by doing, iterative design).

Patterns of electronic mail use are dictated by that environment and affected by changes in the user's personal situation and work assignments.

Users may innovate, sometimes along lines intended by the designer of the software and sometimes in unanticipated ways. These innovations, in turn, affect the work done by users, the communication patterns, and they ways in which they work with others in the organization.

Introductions of new software and the user's customizations of existing software not only changes how effective the user is accomplishing work, but also what the user does and how that work is defined.

From a user's perspective, the system is only the set of available functionality, which can be used in the ways intended by the designer or in completely different ways.

Software tools that reveal information to the user about his/her own work patterns, may fundamentally change the ways in which the user works. The changes in the tool itself may also change the way the user works. Changes in one user may affect other users, which in turn affects the first user. (System dynamics model here...)

Software developers often develop software as if it will be used in isolation, in a static environment.

Most software is designed as though it is static -- at least temporarily, during a particular release. Software designers are generally unaware of how users will use their software and how it will be used in conjunction with other tools in the work environment. Although software is increasingly likely to be designed to be flexible, it is not clear how designers can know which dimensions are most likely to be useful? Is it possible to predict?

Change this ... presentation strategy that this is my pilot data, tell the story of how I've come to these ideas...then propose the case studies as a way of looking for new data. Don't say, "I've already done it". Explain findings, citing papers where appropriate, and then describe questions and hypotheses.

Sort of like my letter to the admissions committee...

Or a series of essays...observations about people and the barriers to communication.

Started with an interest in why people have such difficulty getting the technical information they need and successfully applying it to their current problems. Discovered that:

Training provides a lot of information, but not when it's needed. if provided before user knows there's a need, won't be remembered.

Documentation is organized based on the structure of the software, not the ways it is used, making it hard to answer questions

There are time costs in figuring out how to do something more efficiently, so people tend to avoid it. (Same as coordination costs, or time management. Organizing for future efficiency, especially when that future efficiency isn't guaranteed, is not likely to occur.

Other people (peers and experts) are really good sources of information, because they understand the problem in the user's terms and can provide information in a useful format. (BUT -- Tom Allen's findings that there's a cost associated with getting information from internal friends -- you only have so many points and can use them up. Does electronic mail lower the cost of these interactions, making it easier to get this information? Postings to bulletin boards, Athena's OLC with commonly answered questions. Reorganize the information in terms that users can understand. Then there's a trade-off between customized information and general purpose ... when do you need a special answer? How do you hook up people and answers? Need to let user be involved in the process (just as with a human tutor who probes for information as well as providing answers.)

I then moved to MIT and got interested in one form of access to information: electronic mail. Email lowers costs of certain kinds of information exchange, and is actually preferred to face-to-face communication for a number of things. I got interested in what things email can support, and what it can't. What are the characteristics of different forms of communication (ftf, phone, email), which are important for which communication tasks, causing the user to prefer one over another? Could you build an electronic communication system that allows users to repackage the information in different ways, so that they don't have to choose one medium (say email) because keeping a record is of most importance, when voice is actually preferred over text.

I also got interested in the ways in which people integrate email into their overall work activities and how it changes over time. The "simple" process of managing one's own electronic mail is subject to many different constraints, affected by a very dynamic work environment, as well as changes in the user him/herself. Note that people aren't good at identifying their own behavior (implications back for why they don't learn new information in text editors and other software...) and aren't good at predicting their own use of the software. (Note that this has important implications for data collection...must be sure to collect BOTH user's perception of what they do and what user actually does.)

then got interested in how users modify their work environments -- both along the dimensions expected by the designers of a flexible system and in directions not anticipated.

Information Access observations

I began with an interest in how people get the information they need, in the form in which they need it. Users had nominal access to large amounts of information about the work and software environment, but used only a tiny part of it. I wanted to understand why. So I looked at what people actually use and don't use in software ... e.g. editors ... people who use it every day for years are incredibly inefficient. Our CBI presents information clearly -- but not at a point at which it is useful (it's too early, chunks are too large. Doesn't relate to what they're doing.) Reference material is organized to serve a subset of needs ...

Information Context observations

CHI panel observations

CHI panel: what form of communication do you choose when you can choose face-to-face, phone or email.

Coordination Perspective:

Certain characteristics of electronic communication are ideally suited to helping people coordinate their activities. Identify these characteristics, compare role of Formal vs. informal message types and explicit vs implicit specification of rules.

Discussion about why people don't use message types...must prethink them. Must be explicit.

Can coordination of activities really work if people have to explicitly name what they're doing, as in the coordinator?

Can use electronic mail to study what makes users innovate. They have changing needs, many of which can be measured, and we can examine the results of the innovations and compare them to the kinds of modifications expected by the designers.

Can use electronic mail to identify communication patterns within an organization. (Particularly if you also look at off-line communication, such as phone and face-to-face.)

Can use electronic mail to study how people coordinate their activities.

Independently of all this, can look at users and start to understand what provides the most efficient strategy for giving them access to the information they need.

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let it be customizable along useful dimensions

easy to change in the face of changing work conditions

informative to user about own work patterns (learn by doing)

Why study electronic mail? Helps us to understand communication patterns in organizations and their relationship to organizational behavior. Helps us to look at work patterns and see how they evolve, especially in reaction to changes in technology. Provides a way to explore how users innovate.

several perspectives: the effect of electronic mail on communication patterns in organizations, the role of electronic mail in supporting cooperative work and as a mechanism for studying user innovation of software.

The members of my committee represent three related sets of interests that may be summarized briefly as: user innovation (Von Hippel), communication flow (Allen), and cooperative work (Malone). Electronic communication provides a testbed for all three perspectives.

My research interests have been driven by a desire to better understand the role of electronic communication in work and learning.

Previous Data

Electronic communication systems evolve and are adapted by users to meet individual and group needs. These adaptations affect the kinds of messages sent and reflect the evolving needs of the organization. Many users become overwhelmed and find it difficult to manage the increasing volume of information. Tools such as the Information Lens are designed to help users manage large quantities information. However, they are utilized far less than the benefits would suggest.

Because the benefits are so great, some users (lead users) will create customized tools to address individual problems. However, the majority of users do not have the technical skills, even if they have the need, to successfully manage their on-line interactions. To increase the usefulness of such systems, we need to understand how to lower the short-term costs of managing the information.

Barriers that increase the cost of managing electronic information:

1. Users who manage their own messages often do not have clearly articulated rules for how they do it. Most people, except those with extreme needs, will resist articulating these rules.

2. Users have misconceptions about what they actually do with electronic mail (Mackay, 1988, others), which makes articulating effective rules even more difficult. Observing user behavior and either operating directly as a result (Weckler, neural net work) or providing feedback to users (Mackay, others, tutoring work) will be more effective.

3. Pre-categorization of messages by senders will be most helpful in situations in which communication patterns are highly regular or the content of the message is the major indicator of how the message should be processed. The information lens should prove useful here.

4. Recipients of messages react to the same message differently, depending upon previous interactions with the message, changes in the external environment, and changes in the user’s interests. Providing flexible annotation (categorization) mechanisms to recipients, that can be used differently when the user’s state changes, will prove more effective than fixed annotation schemes.

Look at how communication has evolved. (Remember conversation with person from Tech review. Draw on the CHI panel data and add new questions to the questionnaire.

I have conducted research in several areas over the past three years at MIT. I have worked on theoretical issues related to electronic communication, specifically user access to and control over multi-media information. I have conducted empirical studies of electronic mail use and have explored how users filter and annotate messages. I have developed tools and a methodology for analysis of video data of software users. I have managed the design and iterative development of two major software projects, Pygmalion and Argus, which reflect the theoretical work and empirical findings. Much of the work has already been published. A complete list of publications can be found in my curriculum vitae.

========================== information access, communication patterns, and user innovation, barriers, user context ==========================

junk:Users change. They perform different tasks with email, which reflects the overall organization. Ho -- email/lens as a diagnostic tool for learning about what the organization "really does".

Different kinds of uses of email: work, time, info management. Diversity is not predicted by job title alone. Hypothesis: users will modify the communication system to reflect the patterns of work in the organization -- but it will not capture everything that's on-line.

Software implications:

Technical solutions: distributed video -- causes us to divorce the message from the access to the message (shared information, with multiple pointers) -- permits far more flexible message systems that users can recombine in any way they like.

I have developed hypotheses and, in some cases tested them in the design software development projects. , with implications for the design of systems and the processes required for designing those systems.

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