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ABSTRACT

A panel session on e-mail management was organized at ICIS 2005 in Las Vegas, Nev. The panelists provided perspectives from industry as well as academia and discussed various problems in e-mail management, research methodologies to address these problems, various research opportunities, and an integrative framework for research on e-mail management. This paper succinctly summarizes the presentations made by the panelists during the session and issues raised by the audience. A rich bibliography and Web links are provided at the end for researchers interested in this area of research.

Keywords: e-mail management, performance, knowledge worker, collaboration, communication, information overload

I. INTRODUCTION

E-mail has become the most ubiquitous medium for communication within organizations. Knowledge workers within these organizations are all aware of the bright side of e-mail. Only recently, however, have they started to look at the dark side of e-mail. Many problems can be associated with state-of-art e-mail technology and its use within organizations. The reasons that have led to the popularity and widespread adoption of e-mail have also become the root causes of several problems such as e-mail overload, stress, interruptions, prolonged work hours, and lost productivity. Although the time spent on e-mail may represent as much as 25 percent to 60 percent of a knowledge worker's daily time, IS journals and researchers have paid relatively little attention to e-mail research. More effort has been focused on spam control than on the management of e-mail. In a recent *MIS Quarterly* editorial, Weber (2004) called for more research on the use of e-mail by knowledge workers. For example, the concept of e-mail overload

has not been defined clearly in the literature; therefore, there is a need to develop a metric for this phenomenon.

In this panel, both technical and empirical perspectives were examined to better understand the problem of e-mail management. The panel comprised speakers from academia (Ramesh Sharda from Oklahoma State University, Ashish Gupta from Oklahoma State University, J. Leon Zhao from the University of Arizona, and Ron Weber from Monash University) as well as industry (Nicolas Ducheneaut from Palo Alto Research Center). It focused on several important issues related to e-mail management, such as patterns of e-mail usage in the workplace, problems associated with current e-mail usage, predictors and consequences of these problems, problematic behaviors related to e-mails, and techniques to minimize adverse effects. The goals of this panel were to share recent research by the panelists in academia and industry and to identify mutually beneficial research opportunities for managing e-mails.

The session began with an introduction of panelists by the panel's chair, Ramesh Sharda. He described various problems associated with e-mails and discussed the relevance and importance of studying these problems in an academic-industry setting. This was followed by presentations on three representative studies conducted by panelists (Ashish Gupta, J. Leon Zhao and Nicolas Ducheneaut). Finally, Ron Weber examined some impacts of e-mail on face-to-face (physical) meetings, discussed several behavioral issues, and presented an integrative framework for e-mail research. Each panelist identified major research opportunities for working in the area. The panel and the audience discussion also helped identify additional research opportunities.

The rest of this paper is divided into seven sections. The following section identifies several problems under study by researchers in the e-mail domain. The subsequent three sections describe three representative studies. Section Six identifies various research opportunities and presents a framework for research on e-mails. It also gives a brief summary of the question-and-answer session that the audience had with the panelists. Section Seven provides concluding remarks from the panel, as well as a summary of an online discussion among the panelists, a bibliography, and a list of online resources for readers interested in pursuing research in this area.

II. THE PROBLEMS OF E-MAILS[1]

During the last few years, e-mail has become the most prevalent mode of communication and information exchange within organizations. It is one application that has stood the test of time and can be considered as a mature technology. With time, however, work environment of knowledge workers has evolved dynamically, but e-mail technology has not kept pace. As a result, fault lines have started to surface. It is time to recognize these problems and increase research efforts to address them. Several email related problems are briefly described below:

E-mail Overload - The E-Policy Institute (2004) has predicted that the annual rate of e-mail growth is approximately 66 percent. A recently conducted survey of 840 organizations revealed that 47 percent of workers spend one to two hours and 34 percent spend more than two hours in a workday on e-mail processing (American Management Association, 2004). These statistics suggest that e-mail overload is a problem for knowledge workers. This phenomenon is not well-understood and needs to be researched further.

E-mail Retention and Archiving - The recent Sarbanes-Oxley 2002 compliance act has forced managers to focus on e-mail archiving and retention policies. Business-related e-mails can no longer be deleted before a certain period of time has elapsed. This requirement has created various storage- and caching-related problems that require research. Moreover, compliance acts such as HIPAA (Health Insurance Portability and Accountability Act) also pose several legal

[1] This presentation was based on a study conducted by Ramesh Sharda and Ashish Gupta.

challenges. Access to archived e-mails now needs to be restricted to various employees because the information contained within the e-mails could be sensitive and confidential. More research is needed to establish better access control mechanisms.

E-mail Phishing - The word "phishing" first appeared in hacker newsletter "2600 Magazine" (1996). It was coined by some crackers attempting to steal accounts from unsuspecting AOL members. The term really refers to online imposters who use various social engineering methods and technical subterfuge to steal user's information (http://www.antiphishing.org/). Webster's dictionary also provides a more detailed definition - "The practice of luring unsuspecting Internet users to a fake Web site by using authentic-looking e-mail with the real organization's logo, in an attempt to steal passwords, financial or personal information, or introduce a virus attack; the creation of a Web site replica for fooling unsuspecting Internet users into submitting personal or financial information or passwords" (*Webster's New Millennium Dictionary of English, Preview Edition (v 0.9.6)*). Phishing reports received from antiphishing.org reveal that such activities have more than doubled since last year. More research is needed in the area of fraud and deception detection to better understand the problem.

Pharming, Virus and Spam - Pharming is a crime that misdirects users to fraudulent sites or proxy servers, typically through DNS hijacking, DNS poisoning, or malware (http://www.antiphishing.org/). It has been reported that spam, although increasing, is now substantially under control due to effective filters. Nonetheless, a relatively new phenomenon is starting to take place, which is called SPIM (spam in instant messaging). Little research has been done on SPIM. Also, viruses spread through e-mails offer several opportunities for research. For example, it is worth studying the pace at which e-mail viruses propagate through networks.

E-mail Use - In addition to these problems, e-mail has several other drawbacks. For example, e-mails are cheap to use and open to everyone. Senders incur no cost other than composing the e-mails. Receivers, on the other hand, pay a price in terms of the time they must spend reading, dealing with, and responding to e-mails. Imposition of some sort of monetary charge, similar to the concept of stamps, is one of several possible solutions to the problem. However, the impact of a monetary charge on e-mail communications needs to be studied before implementation. One example of an organization that has started to implement this idea is Goodmail, which charges senders (not receivers).

Multicasting – Anyone can send e-mails to any individual and many individuals at one time, contributing further toward receivers' overload. This problem is compounded when individuals send multiple reminders and queries (simply because they can) that are often unnecessary. The result is redundant information and multiple interruptions, ultimately causing receivers' overload.

E-mail Addiction – Osterman Research recently conducted a survey to find how often workers check their e-mail for new messages when at work. Results confirmed that 67 percent of the workers check continually, and 17 percent check a few times each hour. Findings from a recently conducted survey have also confirmed a similar disturbing pattern in e-mail use, suggesting the presence of irrational behavior and attention-deficit disorders in workers dealing with e-mails (Gupta et al., 2006). In fact, an NPR (National Public Radio) story on e-mail describes the analogy between e-mail processing and smoking a cigarette. They also refer to Blackberry as Crackberry.

Language Degradation – E-mails are also contributing toward the degradation of communication lingua. For example, numerous short notations and acronyms for sentences have been developed (e.g., c u l8r, Hw r u, missing salutations, etc.). A prime reason for this phenomenon is e-mail overload. Workers have to process too many e-mails in a timely manner, which forces them to develop short-cut ways to convey messages.

E-mail Privacy and Security - It is important to securely preserve the information held in e-mails, as it may be required to satisfy auditors, especially in industries such as the health care industry.

More research needs to be focused on privacy-preserving methods such as authentication and cryptographic techniques.

The next three sections describe three representative studies conducted by panelists in this area.

III. QUALITY VS. QUANTITY: DEFINING AND SOLVING E-MAIL OVERLOAD

E-MAIL AS HABITAT[2]

Knowledge workers spend a large amount of time processing e-mail. They literally "live in their e-mail." It has become the main computer tool used to support project management and informal workflow.

Ducheneaut reported the results of extensive research that he and his colleagues conducted over three years in which they sought to better understand e-mail overload and what it means to manage tasks in e-mail. The availability of data is a major challenge to pursue research in this area (due to various privacy issues). Also, the data captured may not have information about deleted e-mails.

E-mail overload is a somewhat diffuse and ill-defined concept. Ducheneaut and his colleagues' goals were to find whether quantity or quality of e-mails caused e-mail overload and whether something can be done to control e-mail overload. Their findings have led to an alternative conceptualization of e-mail overload.

Ducheneaut and his colleagues' literature review helped identify three metaphors that have guided e-mail research: e-mail as a file cabinet extending human information processing capabilities, e-mail as a production line and locus of work coordination, and e-mail as a communication genre supporting social and organizational processes. Past research on e-mail task management has portrayed e-mail as a filing cabinet: messages are discrete units put, on a more or less regular basis, into user- or machine-defined "buckets." The biggest challenge identified from this type of research is e-mail volume. Rather than considering e-mail as a file cabinet, with quantity-management driving design thinking, Ducheneaut and his colleagues also considered the quality of e-mail-centric task and project management, and particularly interdependent tasks, in a new philosophy for e-mail – namely, that of a task- or project-management tool. They conducted an investigation of task management in two phases (as described below).

STUDY I: INTERVIEWS AND OBSERVATIONS

To understand the kinds of task-related processes taking place through e-mail, Ducheneaut and his colleagues conducted 28 interviews in three professional organizations: their own research organization (at the time, 400 employees, and part of an 80,000-employee corporation using a variety of e-mail clients), a rapidly growing multimedia production start-up (150 employees, using Eudora), and a small design consulting company (six employees, mainly using Microsoft Outlook Express). After their analysis, they were able to assume that people in their organization use e-mail in ways that make them fairly representative of knowledge-work professionals.

During this phase of the study, Ducheneaut and his colleagues explored the question of whether the myriad features in popular e-mail clients provide appropriate resources to manage the kinds of tasks and project activities they saw in their preliminary empirical work. They conducted an in-depth study in their own organization and two other organizations to examine task and project management in e-mail from a variety of e-mail users' information management perspectives.

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[2] This presentation was based upon a study conducted by Nicolas Ducheneaut and his colleagues (Belloti et al., 2005).

Ducheneaut and his colleagues used several means to gain understanding of e-mail processing such as "think aloud" protocol, video recordings, and reconstruction of threads from current messages. They conducted more than 40 exploratory interviews that showed managers are most likely to feel overloaded and unable to track the many concurrent processes for which they are responsible. These findings led them to develop a set of six key challenges of task management in e-mail: 1) Keeping track of many concurrent actions, 2) Marking things as important or outstanding, 3) Managing activity extending over time, 4) Managing deadlines and reminders, 5) Collating related items (such as documents) with e-mails, and 6) Getting task-oriented overview through email inspection without having to browse multiple folders.

Ducheneaut and his colleagues found that two kinds of tasks are mainly prompted by e-mail, with only one requiring significant task management resources:

1. *Rapid-Response Tasks* - These are obligations that can be dispatched quickly in a "fire-and-forget" fashion using available resources on one's machine or on the intranet or Internet – for example, receive message, find information, respond, done. These tasks are entirely under the recipient's control, and they are the type of task that e-mail was designed to handle. Here, overload is simply linked to volume.

2. *Extended-Response Tasks* - These are obligations that take time to handle, requiring extra task management strategies in terms of preservation of ongoing work status, possibly with a need to make "to-do" notes so that ideas on how to handle the task are not forgotten. Examples include receiving message, beginning to reply, starting parallel message asking data from colleague, waiting for response, and updating draft message based on phone conversation with manager. These types of tasks have several dependencies, and often the need to "manage" the activities of other e-mail users exists. They impose a much-higher cognitive load (multitasking, interleaving). Here, overload is linked to complexity.

STUDY II: CONFIRMING THE RELATIONSHIP BETWEEN TASK STRUCTURE AND OVERLOAD

To understand these challenges in more detail, Ducheneaut and his colleagues conducted the second phase of the study. In this phase, they used a data mining approach to help them examine how extensively people conduct task management in e-mail and how much task management needs to occur before e-mail users begin to feel overloaded.

For seven participants of different work profiles: three researchers (R1, R2, and R3), two process managers (PR- public relations, IP-intellectual property), and two group managers (M1, M2). Ducheneaut and his colleagues installed e-mail filters for a number of weeks to capture all participants' incoming and outgoing e-mails. Participants were aware their e-mails would most likely be read by researchers, and they had several privacy concerns. Two to three weeks' worth of data was then analyzed to determine whether e-mails were sent to individuals or groups and to identify the threading pattern.

Table 1 summarizes the analysis of the e-mails sent and received by the seven study participants. The picture that emerges from e-mail logging and thread-tracking is suggestive rather than being statistically significant. Note that a very small proportion of e-mail is sent to distribution lists (DL), indicating that most work conducted by the participants in e-mail takes place in messages addressed to individuals. Based on their data, Ducheneaut and his colleagues computed a metric of e-mail-based task-tracking difficulty, which can be related to e-mail overload. The tracking difficulty score is shown on the bottom row of Table 1: The average number of days (*D*) per thread by the average number of steps in threads (*S*) for each participant, giving *D*/*S* which was then multiplied by the average number of threads per day (*TD*). The last column gives the row averages (*Av*)

Table 1. Direct Link between Overload and Task Structure, *not* Volume of Messages

Role	R1	R2	R3	**PR**	**IP**	**M1**	**M2**	*Av*
Messages received per weekday	33.4	25.6	14.3	34.1	**39.2**	**83.2**	**38.1**	*38.3*
Messages sent per weekday	12	5.5	4.2	**23**	**13.8**	**15.6**	10.6	*12.1*
Uniquely addressed msgs received/day (1:1)	8.9	2.6	2.0	**11.9**	5.4	**11.4**	**11**	*7.6*
Uniquely addressed msgs sent/day (1:1)	6.6	2.3	2.0	**12.5**	7.7	**8.2**	**8.7**	*6.9*
Multiply addressed msgs received/day (1:N)	3.3	2	2.4	**5.5**	5.3	**6.2**	**9.6**	*4.9*
Multiply addressed messages sent/day (1:N)	1	**0.9**	0.6	**3.5**	1.2	0.8	**1.5**	*1.4*
DL addressed messages received/day (1:DL)	13.6	9.1	5.8	11.3	**14.1**	**45.3**	**15.6**	*16.4*
DL addressed messages sent/day (1:DL)	0.3	**0.8**	0.3	**2.7**	0.1	**1.5**	0.1	*0.8*
Threads per weekday (TD)	13.3	5.7	6.5	**18.7**	14.6	**25.7**	**19.4**	*14.8*
Steps per thread average (S)	4.0	3.8	**4.8**	4.3	3.9	**7**	**4.8**	*4.7*
Days per thread average (D)	2.9	2.9	**5**	2.4	3.1	**8.8**	**3.9**	*4.1*
*Metric of tracking difficulty (D/S)*TD*	6.9	3.8	6.0	8.9	**10.7**	**30.2**	**14.3**	*11.1*

WHAT CAN BE DONE?

Current e-mail clients need to be redesigned to manage complex, interdependent tasks. There are four main requirements:

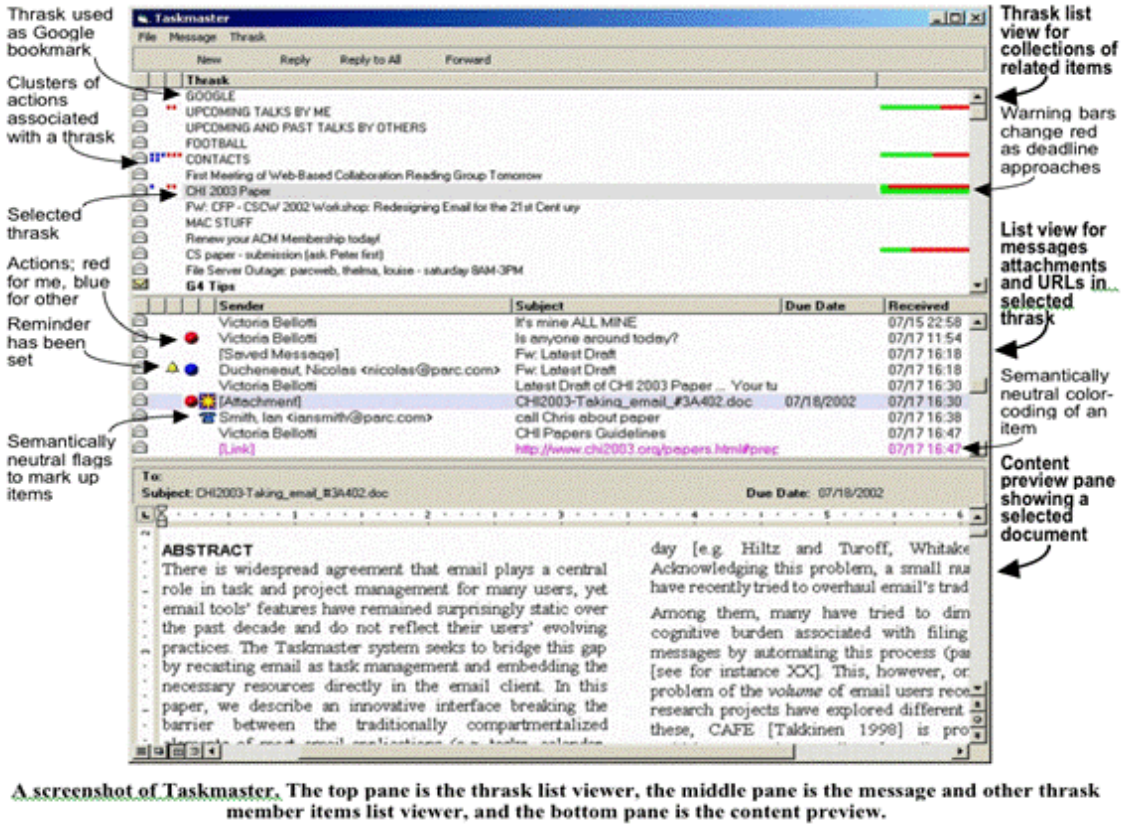
1. *Break the messaging-system metaphor* - The principle for achieving this outcome is 'task-centric collections.' Interest should be on the task and not on the individual messages when arranging them. Individual messages can represent tasks, but interdependent tasks comprise threads of message files, links, and drafts. The incoming messages (replies in a thread, with any attendant files or links) should be grouped automatically by analyzing the message data. Attachments become "first-class citizens" - they are often more important than the message itself. Attachments and links must take precedence over the message.

2. *Application Neutrality* – E-mail is like a habitat, and thus, application switching while working on e-mails should be minimized.

3. *Task-centric meta-information for items within e-mail* - Information such as deadlines, reminders, and actions within e-mails should be assigned meta-information so that concurrent activities can be tracked.

4. *Aggregation of information for an overview* - This will allow the state of all tasks to be assessed at-a-glance instead of scrolling through folders.

Ducheneaut and his colleagues combined all six challenges and four principles mentioned above for efficiently and effectively managing the tasks within e-mails by developing an entirely new e-mail client called "TaskMaster (Figure 1). Taskmaster repositions e-mail as task management, and it provides resources to reduce the time-consuming work of overloaded multitaskers. TaskMaster is only a proof-of-concept prototype, however, and thus it needs to be developed further before professional implementation and use can occur.



A screenshot of Taskmaster. The top pane is the thrask list viewer, the middle pane is the message and other thrask member items list viewer, and the bottom pane is the content preview.

Figure 1. A First Attempt: TaskMaster

CONCLUSION

On the basis of their studies, Ducheneaut and his colleagues reached four main conclusions. First, e-mail overload is influenced more by the quality of tasks than the raw number of messages. Second, current e-mail clients are poorly suited to managing complex, interdependent activities. Third, e-mail needs to be re-invented as a task-management environment. Finally, their initial attempts in this domain are promising and were well-received by e-mail users, but the involvement of a major e-mail client provider will be needed for further progress to occur (e.g. Microsoft Outlook ® is so widespread that users adapt their practices to the limitations of the tool).

IV. MITIGATING E-MAIL'S INTERRUPTIVE EFFECTS[3]

In this study, the focus was on two separate but related problems that knowledge workers are currently facing with e-mail – the problems of e-mail overload and interruptions.

E-mails can create interruptions if checked continuously, and e-mail overload is further aggravated as a result of frequent interruptions that occur in the work environment. Interruptions, in general, consume about 28 percent of a knowledge worker's day, which leads to 28 billion lost hours per year in the United States (Spira and Feintuch, 2005). At an average cost of $21 per hour (U.S. Department of Labor Bureau of Labor Statistics, June 2005), this translates into an

[3] This presentation was based on a study conducted by Ashish Gupta, Ramesh Sharda, and their colleagues.

annual cost of $588 billion to U.S. companies (Spira, 2005). The typical business e-mail user today is interrupted about six to eight times per hour. This figure is supported by a survey of 800 knowledge workers conducted by Pitney Bowes, which found that a knowledge worker experiences at least six interruptions per hour. The problem is being aggravated by always-on mobile devices.

Figure 2 describes the process of interruptions (adopted from Trafton et al., 2003). The main components of time wasted due to interruptions are Switching time or Interruption Lag (IL) and Recall time or Resumption Lag (RL) (Trafton et al., 2003). IL is the time a knowledge worker takes to react to a new e-mail notification by activating the e-mail application. RL is the time taken to get back to the work being done prior to the e-mail disruption. Jackson et al. (2003) suggest that in the case of e-mails, the average IL is 1 minute and 44 seconds, and the average RL is 60 seconds. Although this time may appear to be small, due to the large number of messages arriving every day, the cumulative interruption and resumption lags become large. Hence, they increase the non-value-added time of a knowledge worker (Jackson et al, 2003) and decrease the knowledge worker's efficiency. Clearly, when people process many e-mails, this time is substantial. Organizational losses due to the practice of responding to messages as soon as they arrive could be substantial too.

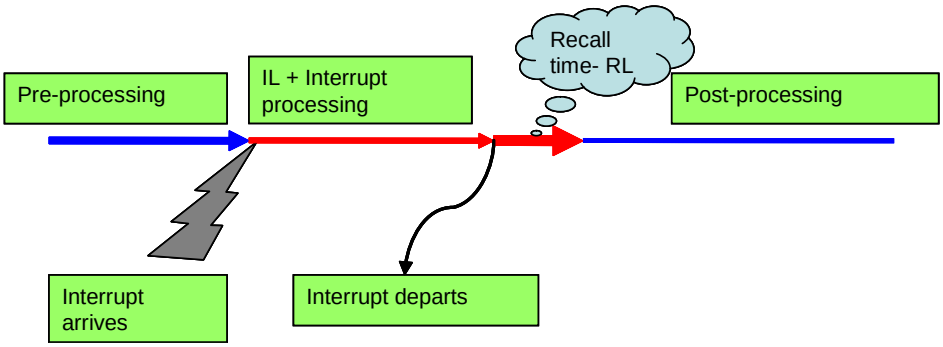


Figure 2. The Process of Interruptions (Trafton et al., 2003)

Gupta, Sharda, and their colleagues developed rigorous, large-scale simulations. The simulations represented different e-mail processing strategies and different work environments. In particular, they compared processing e-mail once per day, twice per day, four times per day, eight times per day, and as soon as it arrives. The research question they set out to explore in the study was: What is the optimal e-mail processing strategy in terms of timing and frequency?

CONCLUDING REMARKS

Gupta, Sharda and their colleagues found that the best e-mail processing strategy is to process e-mails two to four times (C2 to C4) per day (Figure 3). This reduces the number of interruptions as well as workload. Processing e-mails twice to four times per day result in minimum worker distraction due to interruptions while keeping the balance between e-mail response time and primary task completion time.

These findings are theoretically important for several reasons. First, they suggest that previous results may be incorrect. This study suggests that processing e-mails two to four times per day is the best strategy, while earlier studies suggest that processing e-mails eight times per day is best (Jackson et al., 2003). The practical importance of the finding is also important. Use of a C2 or C4 policy can potentially save approximately 17 minutes per day per knowledge worker, which is the equivalent of saving 3.5 to 4 percent of the eight-hour workday. This saving is significant when the organization as a whole is considered. For example, with the use of a C2 or C4 policy, the overall saving per year for a mid-sized organization having 1,000 knowledge workers earning an average salary of $5,000 per month is over 2 million dollars.

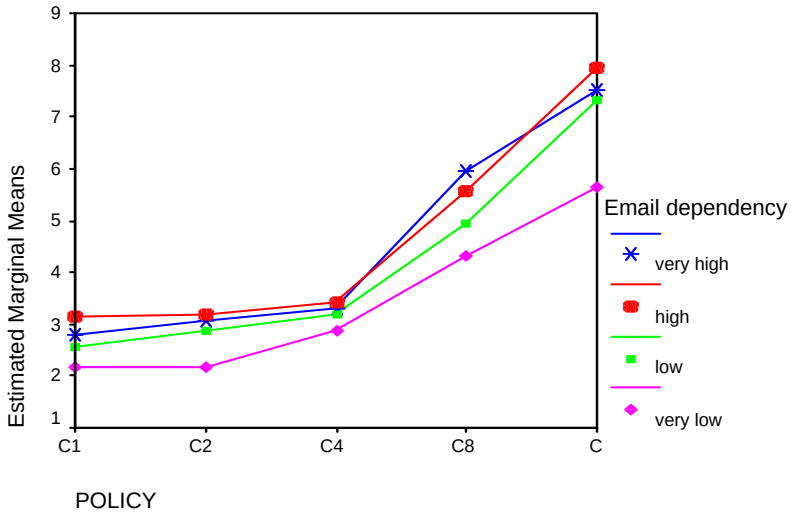


Figure 3. Effect of Policy on knowledge Worker Utilization

V. ADVANCED E-MAIL MANAGEMENT: BEYOND USER-MANAGED FILTERING[4]

While e-mail has made the distribution of information cheaper and faster, the side effect is information overload. Current e-mail systems are essentially uncontrolled, bi-directional pipes of text. The ease with which information can be distributed electronically encourages overuse of e-mail in general and of mailing lists in particular. Some ways in which e-mail overload can be controlled are:

- *Reduce Irrelevant E-mails* - It is important to direct employees' attention to work-relevant e-mails. However, irrelevant e-mail messages are more difficult to identify than junk e-mail messages.
- *Categorize and Prioritize E-mails* - Various categorization and prioritization techniques will help direct employees' attention to more urgent and more useful e-mails, thereby reducing the cognitive load of knowledge workers and improving their productivity.
- *Make E-mail Networks Secure* – Junk e-mail is a major problem for e-mail users and can often lead to significant time overhead. Developing more secure e-mail networks can lead to a large reduction in e-mail clutter and facilitate the processing of relevant e-mails.

Zhao and his colleagues have identified four principles for effective e-mail system design:

- Minimize e-mail overload
- Enable e-mail usage monitoring
- Provide customized services for varying e-mail needs
- Apply AI techniques to enable smart e-mails

Several advanced techniques potentially could be used to improve the management of e-mails at work. Techniques such as smart mailing lists, automatic matching of e-mails and users, automatic e-mail categorization and prioritization, and secure e-mail networks are just a few examples.

[4] This presentation was based upon a study conducted by J. Leon Zhao and his colleagues.

These techniques incorporate several aspects of the above-mentioned design principles. Following are a few selected ones in more detail.

ADVANCED MAILING LISTS

Mailing lists within organizations are extensively used as a means of sharing and enhancing organizational information such as seminar announcements. However, the traditional approach to information distribution using mailing lists has several drawbacks such as junk e-mail, irrelevant e-mail, and e-mail overload.

Currently, companies use static mailing lists that involve little process automation. All messages to a mailing list will go to all of the users on the list. However, all users on a particular mailing list are not uniformly interested in the same issues and things, and only a fraction of e-mails to the list are relevant to a particular user. As a result, users must perform their own e-mail filtering work, which is overloading, boring, and tedious. Furthermore, e-mail senders often resend the same e-mail repeatedly to solicit responses, which further increases information overload.

Zhao and his colleagues have proposed a workflow approach to automatically match information supply and demand (Zhao, Kumar, and Stohr, 2000/2001). Workflow management systems can be used to support the automatic routing of e-mails. This new workflow design adds automatic profile matching between seminars and mailing lists and between seminars and interested users. As a result, abusive uses of mailing lists are now controlled by the server's matching algorithm. The matching is done in two stages: the mailing list match and the user match. The advantage of the two-stage matching method is to reduce computational cost by making use of dynamic mailing lists. The main feature of the new workflow is that it attempts to send a message only to relevant mailing lists and only to interested users within the relevant mailing lists.

E-MAIL CATEGORIZATION AND PRIORITIZATION

While mailing lists help users distribute messages to other users based on user groups, they create information overload. The advanced mailing lists help reduce information overload by filtering irrelevant e-mails based on the message content, but when users have too many relevant e-mails, advanced mailing lists cannot help further. In this scenario, users can benefit by categorizing the e-mails so they can be prioritized according to the user's information patterns. For example, e-mails can be categorized into the following types:

- *By the source of e-mail*. E-mails may be from different types of sources, e.g., internal sources, external sources. Among the internal sources, one can further categorize the e-mails into immediate authorities, immediate subordinates, and so on. Among the external sources, one can further categorize the e-mails into old partners, new partners, potential partners, and so on.
- *By the thread of e-mail*. An e-mail may be a derivative of an ongoing e-mail thread. The thread may have been categorized as critical, moderate, and unimportant. The e-mail could be categorized according to the category of its thread.
- *By the relationship with the sender*. E-mails might come from senders that have an existing relationship. For instance, existing senders may be categorized as friend, boss, and family.
- *By the type of work*. E-mails may be sent by a workflow system that routes the work to the e-mail receiver, or by a human that communicates work-related issues. Workflow e-mails should receive immediate attention because a deadline might be associated with the task, whereas e-mails from co-workers might be less urgent because urgent matters might be communicated by the e-mail sender via a phone call.

By categorizing e-mails into various types, e-mails can be prioritized to attract the user's attention to more urgent e-mails. Current e-mail tools can only order the e-mails using one attribute such

as sender, date, and size, and therefore do not help much with e-mail prioritization. Future e-mail tools should provide more advanced categorization and prioritization facilities as proposed here.

It is also important to understand that not all e-mails have equal priority. As a result, knowledge workers need to implement different prioritization schemes depending upon their roles within their organizations. Business workflow relevant e-mails should always be given top priority. Next priority should be given to more-generic, business-related e-mails, and the lowest priority should be rendered to personal messages. Furthermore, different types of knowledge workers, depending upon their roles, deal with different types of e-mails. For example, executives typically receive few workflow-related e-mails but get more-generic e-mails, whereas managers may receive a mix of balanced workflow-related e-mails and general e-mails. On the other hand, clerks deal with mostly workflow-related e-mails and few generic e-mails.

SECURE E-MAIL SERVICES

While e-mail categorization and prioritization are useful for directing users' attention to more-important e-mails when overload occurs, thus reducing the impact of junk e-mails, they cannot eliminate junk e-mails, primarily because spammers who generate them can fake e-mail addresses. Most e-mail management research has focused on e-mail filtering (Dittrich et al., 2005) and accountability (Diaz and Preneel, 2005). To filter junk e-mails from spammers, innovative e-mail services such as secure e-mail networks, e-mail registration services, and e-mail firewalls can be considered and are outlined below.

- *Secure e-mail network.* Each company should maintain its own secure e-mail network that specifies the valid e-mail servers that have a valid business reason to communicate with its own server. The network should specify the server names, server IDs, server URLs, and their valid server users. By maintaining this secure e-mail network, e-mails originating from sources outside the secure e-mail network will be placed in a separate category for further scrutiny.
- *E-mail registration service.* Senders of e-mails outside the secure e-mail network will be offered the opportunity to register their e-mail addresses, which must be verified before their e-mails are allowed to proceed to the receivers' mailboxes. Essentially, the e-mail registration service will ask the e-mail senders to enter basic company information and assign the senders a valid identifier to use in their e-mails.
- *E-mail firewall*. The e-mail firewall will first verify whether the e-mail is from a server that belongs to the secure e-mail network and then verify whether the e-mail is from a registered user if the e-mail did not originate within the secure e-mail network. Other e-mails will be diverted to a pool of e-mails that are potentially junk e-mails.

The proposed secure e-mail services stem from a philosophy that the e-mail server should block the junk e-mails instead of asking the users to filter them, thereby reducing information overload. To implement the proposed services, more advanced e-mail tools are needed because asking e-mail senders to register and to use sender identifier can be time-consuming if the e-mail tools do not support those features. However, as junk e-mails pile up and decrease corporate productivity, these secure e-mail services might be the only effective way to eliminate junk e-mails. In other words, secure e-mail services will install a valve on the receiving end of the uncontrolled, bi-directional e-mail pipes at the server level.

VI. RESEARCH OPPORTUNITIES AND FRAMEWORKS

The problems mentioned above provide rich interdisciplinary opportunities for research on e-mail management. Methodologies applicable to these research opportunities can be broadly categorized into four types - operations research and management science, Human-Computer interface, system development, and organization science (Figure 4). Researchers may choose to work in either one of four quadrants or at the interface of two or more quadrants. For example, the REMS (Research on E-mail Management Strategies) group at Oklahoma State University has

focused mainly on ORMS approaches such as modeling knowledge worker attention, modeling interruptions, studying e-mail routing within contact centers using queuing theory approach, simulation, Markov decision process approach to e-mail processing, and stochastic programming with recourse approach to e-mail management.

Operations Research and Management Science e.g. economic modeling, workflow modeling, queuing, simulation, etc.	**Systems Development** e.g. new clients, intelligent agents, additional features, etc.
Human Computer Interaction e.g. visualization, clustering, mining, etc.	**Organizational Science Approaches** e.g. organizational policies, choices and impacts, etc.

Figure 4. Research Opportunities

Based upon the previous research presentations, a framework for research on e-mails was developed and presented. This framework comprises several interactions among individuals and groups while considering the influence of context and time on these interactions (Figure 5). Following subsections describe this framework in more detail. Portions of this framework have been described by Ron Weber in one of the *MISQ* Editorial columns (Weber, 2004).

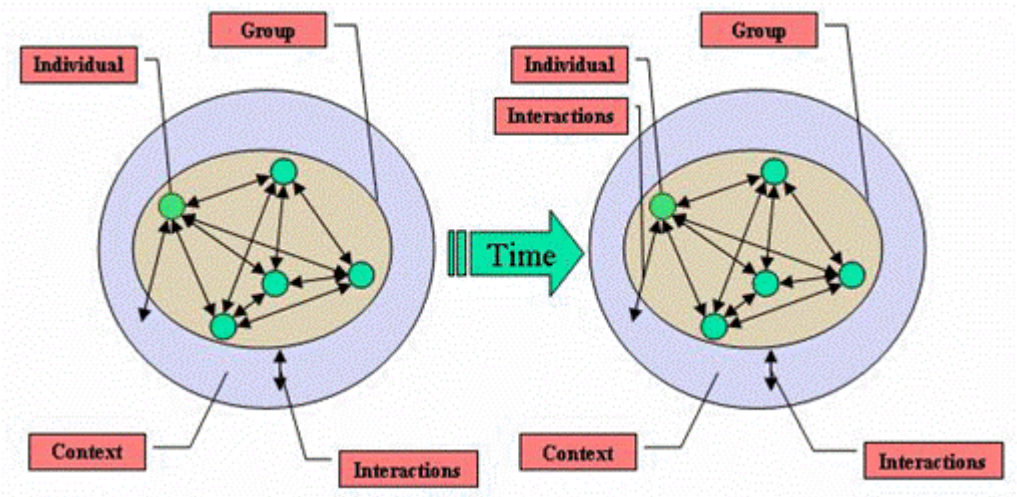


Figure 5. A Framework for Research on E-mails

E-MAIL USERS

There are several types of e-mail users:

- *Individuals* - These are stand-alone e-mail users, and they exhibit behaviors that are independent of groups to which they belong.
- *Formal groups* - These groups may be either work groups or organizations. Work groups are formed because they may be engaged in similar activities, working on the same project, or be a part of the same department. Organizational groups are formed because of a sense of belonging to a particular firm (centralized or decentralized).
- *Informal groups* - Such groups most likely are not related to work and may come into existence due to common interests or hobbies.

- *Permanent versus temporary groups* - Some groups are permanent and time-tested, whereas in certain types of groups, membership keeps changing.
- *Tightly coupled versus loosely coupled* - These groups vary based on the degree of cohesion among group members. Often, the frequency of e-mail exchange can be considered a measure of cohesion within an e-mail group.

Different behaviors are shown by these individuals and groups. Several of these behaviors are described below.

Individual Behavior

E-mail has several task-related uses such as composing and sending messages, receiving, interpreting and responding to messages, archiving, task management, document delivery, communication, and contact management. There is a need to better understand such task-related e-mail uses. Following are some pathological uses of e-mails related to individual behaviors:

- *E-OCD-ADD (obsessive compulsive disorder, attention deficit disorder)* – This behavior is manifested when individuals feel they must always deal with e-mail and act as though it is absolutely imperative they deal with it now. Upon hearing the alarm, they feel compelled to process the e-mail. They cease whatever task they are undertaking to attend to the newly arrived message. The problems of interruptions are predominant in such cases.
- *BFD (brain-finger disconnect)* - With this syndrome, a person's fingers somehow seem to be able to type a response to a message with little engagement on the part of the person's brain.
- *WMD (weapons of mail destruction)* - These behaviors are exhibited when someone uses e-mail as a weapon to launch an agenda against another person or to show their disagreement in relation to a decision. Such e-mails are often a steady, frequent stream of angry, abusive messages.
- *Alter ego behaviors* - Some workers, who are otherwise friendly, take on another personality when they compose and send e-mails. They are more aggressive and rude in the messages they send via their e-mails.
- *Signaling behaviors* - Some workers use e-mails to send certain signals to the receivers. For example, some workers especially like to respond to messages quickly when they are sent at odd hours of the day or night or at weekends. It shows they are always "on the job." Some exhibit these behaviors by frequently sending messages to a list-server to signal their expertise or presence in the community.

Group Behavior

Just like individual behaviors, workers affiliated to a group use e-mails for various task-related purposes. In addition, issues such as patterns of e-mail exchange, source and destination of messages, frequency of exchange, and nature of messages become important to explore as well. Following are some pathological uses of e-mails related to group behaviors, which tend to undermine the effectiveness of groups and organizations.

- *See-See (carbon copy)* - A message is sent from one individual to another individual with copies sent to a number of other individuals. As a result of this syndrome, the carbon-copy list attached to e-mails can grow quickly, sometimes exponentially.
- *Blind see-see (blind carbon copy)* - This syndrome is mainly driven by the Machiavellian tendencies of the sender. Carbon copies of e-mail messages have been sent to others, but the receiver is unaware that this situation has occurred.
- *The "general"* - These individuals use e-mails to give instructions or orders to their colleagues.
- *The "bouncer"* - Rather than undertake basic, straightforward work themselves, some colleagues simply have a habit of broadcasting a message to others, seeking a solution to the problem they are facing, thus adding to e-mail overload.

- *Flame wars* - Someone sends an aggressive or abusive message. A receiver takes offense and responds in kind. The original sender again responds, this time with an even more aggressive or more abusive message. Others might then be drawn into the exchange. They, too, may begin to send aggressive or abusive messages. All this contributes toward wasted time, increased overload, and damaged relationships.

E-MAIL CONTEXT

It is also important to understand various influences of and impacts on different contexts within e-mail work environments. Some of the main influences of context that are worth exploring are history of prior interactions, cultural context in which e-mail is used, and stakeholder expectations in relation to e-mail use. Some of the major impacts on context that should be studied in more detail are work impacts (e.g., group productivity) and social impacts (e.g., effects on family life).

ALIGNED VS. NON-ALIGNED USE OF E-MAIL

E-mails have resulted in increased interaction with the outer world. If this is enriching in some sense, then it is very costly in another sense. The costs associated with e-mails are growing, and there is a need to better understand how e-mail is undermining the effectiveness and efficiency of knowledge workers. The deluge of e-mails is often the reason for it being called “the killer application.” Receiving somewhere between 50-100 e-mails per day is not atypical.

The motivation for wanting to cover this topic comes from the experience of one of the panelist (Ron Weber) and the experience of one of his colleague who is a full-time consultant (she works primarily in the mergers and acquisitions area). The behavior of concern is the use of laptops or PDAs during face-to-face meetings where participants are physically present in the same room. If participants use a device (a laptop or PDA), then use might be of two kinds: (a) meeting-aligned use (e.g., making notes about the meeting), or (b) non-aligned use (e.g., playing games, answering e-mail, writing a paper). When a participant uses a device in a meeting, it is sometimes difficult to know whether the use is meeting-aligned or non-aligned. Other participants begin to form a view on what a device user is doing (through verbal cues, non-verbal cues, body language, and so on). If participants perceive that the device user is engaged in non-aligned use, then the effectiveness and efficiency of the meeting declines (gradually at first, and then sharply).

From a research perspective, there are many interesting issues to investigate in relation to non-aligned use. First, one could try to categorize the different types of non-aligned uses (e.g., answering e-mail that is irrelevant to the meeting, cleaning one's diary, making a to-do list for the remainder of the day).

Next, it would be interesting to develop and test theories that account for the different categories of non-aligned uses such as passive or disinterested behaviors, avoidance behaviors, and resistance or aggression behaviors. In this regard, in the panel session, Weber briefly recounted an experience of one of his consultant colleagues. She was involved in a large merger, and increasingly she became frustrated by management's use of cell phones, PDAs, etc. in face-to-face meetings. It was clear they were not attending to critical issues that were being discussed in the meetings. Moreover, the managers were continuing this behavior when she met with them individually. Finally, she raised the issue with the CEO, and he too had become extremely frustrated with the behavior of his managers. The consultant found the managers were using the devices as a means of avoiding the very difficult issues the merger was surfacing. They were not coping well with the stress of the changes that were occurring. The result was that she came to an agreement with the managers whereby she collected cell phones, PDAs, laptops, and so on, before a meeting started and took them out of the room. Another interesting story relates to how the managers then had to develop coping mechanisms for the stress they experienced when they could not turn to their cell phones, PDAs, and so on.

Still another topic would be to document meeting outcomes and behaviors when participants use devices for non-aligned purposes. A number of pathological outcomes may occur, including a breakdown in trust and respect among participants, annoyance and anger, breakdown in meeting

processes, and an overall exponential decline in meeting effectiveness and efficiency. Again, there is a place for theory building to account for meeting outcomes and behaviors.

A few important questions that all MIS researchers need to explore with respect to the e-mail use and design science are:

- What capabilities would improve the effectiveness and efficiency of e-mail users?
- What capabilities would inhibit pathological behaviors among e-mail users?
- How can the e-mail "marketplace" be improved?

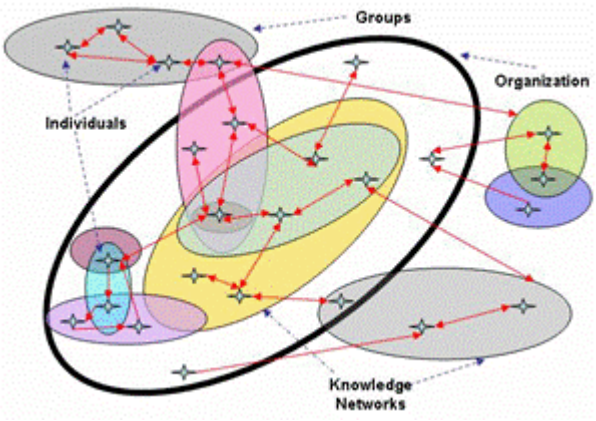


Figure 6. E-mail Knowledge Network

Most e-mail-based studies conducted have focused on the individual level. Because e-mail communication always involves, at a minimum, two individuals, it is important to analyze the problem at a higher level, such as the group or organization level, to be able to obtain a holistic view. One way is to look at the problem from a social network perspective. A worker usually belongs to several knowledge networks and has different types of relationships with members of different groups (Figure 6). Complex e-mail interactions with numerous network members can often lead to results that are hard to anticipate otherwise. Simulation and network analysis approaches are well-suited for handling such problems.

E-MAIL-RELATED QUESTIONS FROM THE PANEL AUDIENCE

The audience asked some research-related questions. These are listed below, with responses from the panelists/authors.

Q1. Is there an instrument that has been developed to capture e-mail overload?

There is no available instrument meant specifically for capturing e-mail overload. However, there are a few instruments that have been developed in other disciplines such as cognitive psychology to tap subjective mental workload. One such popular instrument that has been developed by NASA is called NASA-TLX (Task Load Index) (Hart and Staveland, 1988), which is a six-dimensional instrument. Another instrument is SWAT (Subjective Mental Workload Assessment Technique) (Reid and Nygren, 1988).

Q2. How does one collect data about e-mails in light of all the security and privacy-related issues that are being raised?

Data collection is indeed a challenge because of security- and privacy-related concerns. Student subjects are often not appropriate for research purposes because their experience with e-mails may differ from the experiences of knowledge workers within organizations. Researchers will need to rely on working professionals to pursue e-mail research. However, some free e-mail

databases are available, such as Enron e-mail corpus (Klimt & Yang, 2004), that has been used by a few researchers for e-mail mining and categorization studies.

Q3. Instant messaging is used more than e-mails at work in some Asian countries. Did you study the impact of instant messaging on interruptions?

Short messaging services and instant text messaging have recently gained more popularity among younger people and those who reside outside of the United States. Its acceptance in the corporate sector in the U.S. is still limited but is fast picking up. This technology is more intrusive as it is relatively less asynchronous than e-mail, so it would be worthwhile to add this research question to the interruptions study stream.

Q4. Not all e-mails are interruptive. In your models, did you consider the influence of different types of e-mails?

An ongoing study is examining the impact of e-mails in a network setting, and is looking at several different types of e-mails: interruptive e-mail as well as non-interruptive e-mail. Much more research needs to be done in this area.

VII. PANEL CONCLUSION

This panel session helped bring together industry and academic research from various disciplines on an important problem that has received relatively little attention in the IS literature. All panelists agreed there are several research opportunities with e-mail. They believe that research on e-mail has high practical significance and that e-mail management is an area where IS research can make a significant, measurable impact.

ONLINE FORUM DISCUSSIONS AND RESOURCES

An online discussion forum was also organized to create a dialog among the panelists and other interested parties at http://groups.google.com/group/ REMSOSU. Some of these discussions helped panelists to share interesting research being done in the area and to craft future research directions. Many of those topics that were discussed have been blended throughout the paper. Some of the topics that were not integrated elsewhere in the text are accessible through the Web site link given above. Many interesting statistics on e-mail usage are available from this discussion link. Also available are links to relevant Web sites and other resources on e-mail research.

ONLINE RESOURCES

http://www.iris.okstate.edu/rems/

http://groups.google.com/group/REMSOSU

http://www.emailresearch.org/

ISworld endnote resource on e-mails: http://post.queensu.ca/~ss32/endnotelibs/

ARTICLES / NEWS LINKS

Please note that these links were active when they were accessed by the panelist group. Authors do not guarantee they will be active in the future and for any particular amount of time.

http://www.cnn.com/2005/TECH/internet/12/07/internet.scams.study.ap/index.html (Dec 7th, 2005)

"Got 2 Extra Hours for Your E-Mail?" http://www.nytimes.com/2005/11/10/fashion/thursdaystyles/10EMAIL.html (Nov, 11th 2005) - Requires registration to access

http://www.cnn.com/2005/TECH/10/17/wireless.overview/index.html (Oct 18th, 2005)

http://www.businessweek.com/magazine/content/05_40/b3953601.htm (Oct 3rd, 2005)

http://www.npr.org/templates/story/story.php?storyId=4279486 (Jan 12th, 2005)

http://hbswk.hbs.edu/tools/print_item.jhtml?id=4438&t=globalization

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1. these links existed as of the date of publication but are not guaranteed to be working thereafter.

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3. the authors of the Web pages, not CAIS, are responsible for the accuracy of their content.

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