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In search of coherence: A review of email research

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RUNNING HEAD: IN SEARCH OF COHERENCE: EMAIL IN REVIEW

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ABSTRACT

Email research encompasses a vast and diverse body of work that accumulated over the past 30 years. In this paper, we take a critical look at the research literature and ask two simple questions: What is email research? Can it help us reinvent email? Rather than defining an overarching framework, we survey the literature and identify three metaphors that have guided email research up to this day: email as a file cabinet extending human information processing capabilities, email as a production line and locus of work coordination, and finally email as a communication genre supporting social and organizational processes. We propose this taxonomy so that designers of future email systems can forge their own direction of research, with knowledge of other directions that have been explored in the past. As an illustration of the possible future work we want to encourage with this review, we conclude with a description of several guidelines for the reinvention of email inspired by our journey through the literature.

CONTENTS

1. EMAIL: A MULTI-FACETED RESEARCH OBJECT

Email is an evolving sociotechnical phenomenon. Whereas email was once restricted to a limited circle of technocrats, it has now become a part of everyday life for many people beyond the world of science and technology. From advertisements on the sides of buses to children's television programs, email is omnipresent. "Email" has officially passed into the English language, as both noun and verb (Pearsall, 2001):

n. the system of sending messages by electronic means from one computer user to one or more recipients via a network.

v. mail or send using email.
- DERIVATIVES emailer n.
- ORIGIN C20: abbrev. of electronic mail.

If someone said they would send you an email, in all probability you would know what they meant without a moment's hesitation. Yet for all the certainty that use of the term seems to imply, email has proved to be deceivingly simple as an object of research. Indeed, if we consider the above definition from the Oxford dictionary more carefully and try to unpack its meaning, the multi-faceted nature of email quickly becomes apparent. First, email is "a system": it presupposes the existence of a technological infrastructure, not only "a network" as mentioned above but also an email client and its interface to compose messages in the first place. These messages do not appear out of the blue either: they need to be composed, sent, received and eventually managed as more accrue over time. Human beings perform most of these tasks; as such, they are not taking place randomly but within a social context that gives meaning to and influences the act of communicating that is email. We could go into even more detail, but one thing is already clear: there is more to email than one may initially assume.

Probably as a result of this complexity, thirty years of research on email have not produced a unified set of results. Email research as a whole is a loosely interwoven body of findings, broadly divided into a collection of separate research fields. Each field brought its expertise to bear on a separate facet of email, generating important results but not assembling them into common threads that could define how the main issues relate to one another. Most importantly, email interfaces have remained surprisingly static: a great deal of this research has failed to influence the (re)design of email.

Therefore, we think it is worthwhile at this point to ask two simple questions: What is email research? Can it help us reinvent email? The body of work produced on email is so diverse and expansive that developing a unifying framework is, we think, probably beyond reach today: email has been looked at from such a variety of disciplines and theoretical perspectives that some gaps are simply impossible to bridge. However, we think it remains possible to organize email research into broad categories that could be useful to future researchers. In this paper, we describe such a categorization of email research. Our hope is that anyone interested in the design of future email systems can use

our review to forge their own direction of research, with knowledge of other directions that have been explored in the past.

In the remaining sections of this paper our survey of the literature traces the emergence of three themes in email research over time. While our coverage is as exhaustive as possible, we acknowledge that our taxonomy is but one particular path through the literature. Other classification schemes could fruitfully have been used and, in fact, we invite our readers to think about their own. Our approach has been to identify metaphors reflecting the "collective imagination" of different disciplinary fields regarding email. The three metaphors we propose are:

Email as a *file cabinet*. In this literature, the research focus has been essentially on cognitive aspects of information organization and retrieval in email. Filters, folders, inbox organization and their possible substitutes have been examined in great depth, and innovative interfaces have been developed to try and alleviate some of the problems that have been identified. There is, however, little discussion of how messages relate to email users' work activities and practices. A great majority of this research comes from two research fields: Human-Computer Interaction (HCI) and Artificial Intelligence (AI).

Email as a *production facility*. This line of research has been concerned with the efficiency and effectiveness of organizational communication, adopting a viewpoint on email that focuses on collective effort, workflow and its situated articulation. A great deal of the email research in Computer-Supported Cooperative Work (CSCW) adheres to this view.

Email as a *communication genre*. Years of research on the impacts of electronic mail on organizational effectiveness initially took email to be a rigidly constrained medium with invariant properties. Research considered how email could fit into chains of business communication by substituting for other meeting media. It is now focusing on the malleability of the medium, in terms of its features and use, for allowing appropriation for various organizational purposes. This section of the literature is essentially contained within the fields of organizational studies and information systems research.

We conclude our paper with a description of how the above survey of the literature influenced our own thinking about reinventing email. In particular, we propose a possible design framework cutting across the three levels of analysis reflected in our metaphors: individual, communicative, and socio-organizational. Far from being a definitive answer, it simply highlights how our survey could be used to inform the design of future email clients.

We begin below with the first email metaphor: email as a file cabinet.

2. EMAIL AS A FILE CABINET

2.1. Human cognition and message handling

Many email studies have focused on the way email users store and organize the messages they receive over time. This is due in great part to the strong influence of cognitive science and psychology on the design of human-computer interfaces. The concept of cognition concerns the set of mental processes responsible for the acquisition, storage, retrieval and use of information. Consequently, it has been a topic of enquiry that encompasses perception, learning, memory and reasoning. It is premised on the idea that these processes are fundamental and universal to all people (Neisser, 1976). They are the result of an evolutionary, species-wide set of influences that have defined an information processing architecture for dealing with the environments that people encounter. Based on this premise and drawing on early studies of information organization in the office (Kidd, 1994; Landsdale, 1988; T. W. Malone, 1983), a line of research portrayed email as a *file cabinet*: it is a means of storage for individuals to use, organize and manipulate messages in terms of their informative content. Its effectiveness depends upon its compliance with the constraints of human learning, reasoning and memory.

2.2. Early studies of information organization in the office

For Malone (1983), who studied how office workers organize their desks, people who had neat offices and used structured filing systems had fewer difficulties in information retrieval, overlooked fewer things they had to do, and were better at finding specific documents than those who had messier offices. Many of Malone's interviewees arranged information in piles on their desks. The purpose of these piles was not only to store information for later retrieval, but also to remind the subjects that they had something to do. Malone sees the latter as a crucial feature of desk organization, and suggests that failure to support this function may seriously impair the usefulness of "electronic office systems" (such as email), while explicitly facilitating it may provide an important advantage for automated office systems over their non-automated predecessors.

Another important point in this study is that the cognitive difficulty of categorizing information is an important factor in explaining how people organize their desks. Therefore, it is suggested that computer-based systems may help with this difficulty by doing as much automatic classification as possible, and including untitled 'piles' of information arranged by physical location as well as explicitly titled and logically arranged 'files.' Following the first of these principles (facilitate/automate classification as much as possible), Malone, Grant & Turbak (1986) later developed the Information Lens, a system to help people share and filter information communicated by computer-based messaging systems. It provides users with a set of semi-structured message templates, used by the senders of the messages to facilitate composing messages. This later helps people filter, sort, and prioritize messages that are addressed to them, and it also helps them find useful messages they would not otherwise have received by searching for certain keywords in a central repository of messages. A subsequent 18 months investigation of the use of Information Lens (W. E. Mackay et al., 1989) revealed

that people without significant computer experience were able to create and use the sorting, prioritizing and deleting rules offered by the system effectively. As we will see in the remainder of this section, the Information Lens's early emphasis on rules and classification of electronic messages is still prevalent in email research.

Landsdale (1988) also emphasized the cognitive difficulty of categorizing items. This task is doubly difficult, first in determining which categories to use and second in remembering these categories later, at the time of retrieval. Consequently, people are reluctant to file information away either because they cannot decide how to categorize it, or because they are not confident in their ability to retrieve it later. Moreover, we remember far more about documents such as email messages than is evident in retrieval facilities. Information is committed to memory through a selective encoding process, connecting it with a number of associative networks. Networks can be conceptual, historical or story-based (episodic memory), built around narrative constructs. This process is heavily constrained by the active mental models of the person who is committing information to memory. Later retrieval of information can depend on the circumstances in which people find themselves, since they can embed cues that reflect the original encoding strategy. So there is good reason to believe that what is remembered about email messages includes a number of potentially helpful attributes: the meaning of their content, contextual information such as what they look like, what one was doing at the time, associated concurrent events, the time of message receipt or composition in terms of message chains or "transactions" (see Section 3.1.). Email systems have not exploited this rich web of cues, instead relying on the user recalling filenames and categorization information unprompted. Landsdale argued that the sort of thing people were best at was being ignored in systems design. Information which is logically related to the required memory will not succeed in eliciting recall unless it is also related to the way in which that information was interpreted: we need a richer set of metadata.

Landsdale concludes that every attempt to retrieve information is based on two different psychological processes: 1) recall-directed search followed by 2) recognition-based scanning. Information retrieval systems should provide support for multiple categorizations and be sensitive to synonyms. Storing or categorizing information leads to a dilemma: the more time a user has to spend to categorize an item, the less likely it is that the categorization will be done at all. Moreover, the more we automate this process, the less the user will be able to recall due to fewer associative links in memory. Associations between items of information are constructed by active involvement on the part of the person for whom the email has significance. This suggests that automatic filing and message folders, two ubiquitous features in contemporary email software intended to help rationalize the information overload problem, do not match human cognitive processes very well.

In a study of 12 knowledge workers, Kidd (1994) reports the same 'piling' phenomenon as Malone's but offers an alternative explanation. Kidd found the knowledge workers' desks to be cluttered, and to seemingly function as a spatial holding pattern for current input and ideas. These workers, however, are changed by the information they process: once informed by some written material, they have no particular need to retain a copy of the informing source (e.g. they take a lot of notes, but

then discard them: the act of writing is more important than an external memory store). However, if a piece of written material has not yet informed them, then they cannot sensibly file it away because its subsequent use or role in their world is still undetermined, which is why they use piles and a spatial information organization scheme. Kidd concludes that computer support for knowledge work might be better targeted at the act of informing rather than on passively filing large quantities of information in a disembodied form.

2.3. Adapting email systems to users' cognitive processes

Moving from the physical desk to the virtual, Barreau and Nardi (1995) conducted two studies of the ways users organize and find files on their computers (including their email). They found that users preferred location-based finding because of its crucial reminding function. Users were seen placing files in locations where they were likely to notice them (e.g. inbox, upper-level directory). Users preferred browsing lists of files rather than using the search feature. They avoided elaborate filing schemes, and archived relatively little information. Every user indicated that their attempts to establish elaborate filing schemes for archived information failed because they required more time and effort than the information was worth. Finding and reminding are intimately linked in the practice of email use and should always be considered together.

Barreau and Nardi's findings generated a debate within the HCI community about the adequacy of current interfaces for information organization and retrieval. Fertig et al. (S. Fertig, Freeman, & Gelernter, 1996) believe that Barreau and Nardi's users preferred location-based search because it is the lesser of evils: if other search methods had been available, they would have been used. They think that location-based search is only possible when users don't archive, or give up using archived information. They argue it is a 'cart and horse' problem: if archiving were better supported, users would archive. In short, they see the use of location for reminding as a simple coping strategy for lack of anything better, and point to alternative solutions: dynamic queries, semantic file system, or Lifestreams (Scott Fertig, Freeman, & Gelernter, 1995), a system they developed shortly before Barreau and Nardi's study.

Lifestreams is an approach to organizing a user's personal files. It uses a simple metaphor, a time-ordered stream of documents, to replace conventional files and directories. Every document a user creates is stored in her lifestream, as are all the documents other people send her. Moving beyond the present and into the future, the stream also contains documents the user will need: reminders, meeting schedules, and to-do lists. The stream stores everything the user touches electronically, and can even be extended with phone call logs and URLs. The interest of the whole approach is to allow retrieval in context, since resources are surrounded by other resources accessed at the time. Fertig et al. see their system as the perfect counter-example to Barreau and Nardi's theory but both point to Lansdale's argument about the value of richly associated sets.

Another way to address the cognitive difficulty associated with information organization and retrieval in email is to automate the process. Using mostly techniques from natural language processing (NLP), some systems have followed this approach. One

example is Re:Agent (Boone, 1998). Using a variant of automatic feature extraction, Re:Agent groups similar emails and combines their common information into a feature. This is called the concept feature approach. To automatically define features, the user directs the agent to use the task training examples as feature examples (e.g. if you want to sort all messages for Nicolas into a folder called Nicolas, you first train the program on the content of the 'Nicolas' folder). Alternatively, the user can aid the agent by providing keywords and example messages that define concepts present in the email. Another system tries to automatically identify the speech-acts associated with a given message (Khosravi & Wilks, 1999). This could prove useful in certain contexts where roles and responsibilities are clearly defined, and actions are unambiguous.

It is worth noting, however, that users show little confidence in learned rules for text classification (Pazzani, 2000), which directly questions the validity of a completely automated approach to email filing. Taking a more moderate stance, MailCat (Segal & Kephart, 1999) encourages users to file their mail by simplifying the task but not completely automating it. Using an adaptive classifier, the system predicts and proposes the three existing folders that are most likely to be appropriate for a given message.

Finally the Information Tapestry (Terry, 1993) is an experimental system that combines a variant of collaborative filtering with content-based filtering and automatic appraising and highlighting. The intention of this battery of techniques is to tailor the delivery and presentation of information to each user's personal interests according to a network of relevance criteria. In this way, users should be able to cope with ever-increasing volumes of incoming electronic mail. Rather than automatically file a message, the Tapestry system uses 'appraisers' to assign it a priority ranging from 1 to 100. An appraiser is a predicate or query that is applied to each new message received (e.g. if it contains "St Marcellin" give it 100, if it contains "Monterey Jack" give it 5). Collaborative filtering is also implemented: a user can rate each message as 'LikeIt' or 'HateIt'; he can then write an appraiser saying, for instance, 'send me all the messages that X liked.' The user can then sort her messages in order of decreasing priority, processing only the most important ones. More recently, researchers have been applying techniques from the field of Artificial Intelligence to tackle the same problem. The Priorities system from Microsoft Research (Horvitz, Jacobs, & Hovel, 1999), for instance, infers the criticality of email messages using Bayesian networks.

2.4. Empirical studies of email use

Relatively few studies have investigated the specific strategies that email users have developed to handle their email in practice. The earliest is probably Mackay (1988): she interviewed 23 experienced email users at a research laboratory, and concluded her study with two principal claims. First, electronic mail is more than just a point-to-point communication system. It supports a variety of time and task management activities. The second claim is that use of electronic mail is strikingly diverse, suggesting that email designers should define flexible primitives that can be employed to various degrees by a wide range of users.

Whittaker & Sidner (1996) were also interested in email users' message management practices. They interviewed and logged the email traffic of 20 Lotus Notes users in several departments at Lotus Corporation. They reiterated one of Mackay's conclusions: although email was originally designed as a communication application, it is now being used for additional functions that it was not designed to support, such as task management and scheduling, as well as personal archiving. Email is a good candidate for schedule reminders because it has become an ever-present resource in the workspace (Ducheneaut & Bellotti, 2001). Strategies for managing email frequently leverage its salience and surfacing properties.

Whittaker and Sidner noted that email's success could very easily prove its own undoing. Email overload clutters inboxes with hundreds or thousands of messages, including outstanding tasks, partially read documents and conversational threads. The inbox operates as a kind of task manager, where people are reminded of current tasks, and where they can keep information relevant to those tasks accessible. Whittaker and Sidner emphasize the importance of a visual reminding function: users who tried to create dedicated "action" folders abandoned the strategy, because they had to explicitly remember to go to it and view its content, rather than being reminded by working with the whole set of messages. In this regard, Landsdale's (1988) and Malone's (1983) claims are confirmed: it is clear that successful filing is highly dependent on being able to imagine future retrieval requirements, and that it requires considerable effort. It is a cognitively involved task and, as a consequence, users either forget outstanding actions and/or create failed folders. Whittaker and Sidner also found striking individual differences in email management strategies. They divided their users into no filers, frequent filers, and spring cleaners depending on their usage of folders and frequency of cleaning. Frequent filers use folders and clean often, whereas spring cleaners use folders but clean only occasionally. Bälter later expanded this taxonomy in his Ph.D. thesis (Bälter, 1998), adding a fourth type: the folderless cleaners, characterized by their active deletion of messages from their inbox and an absence of folders. Although in principle there may be an optimal strategy, in practice management of messages and tasks varies considerably with experience and numbers of folders (Ducheneaut & Bellotti, 2001).

Takkinen and Shahmehri (1998a; 1998b; 1999) argue that users' construal of email is primarily as a task management tool rather than as a messaging system. They reach this conclusion on the basis of two studies of high-mail-traffic professionals who need to manage email in different organizational roles. The authors report that the advanced formatting features in email systems (e.g. using extra bold type, HTML, etc.) are rarely used because it takes time and because the messages are mostly short, and also because the receiving side cannot be presupposed to see the same layout; instead, documents are created in a word processor and attached to the message. Templates, other than signature files, are not widely employed because they are a hindrance and because most messages are short. Confirming the delivery of messages is generally cumbersome with Internet email and typically the telephone is used to confirm important messages. Furthermore, accessing one's email is often done from different computers using different email clients, and from the perspective of different roles depending on the communication context (social, work, educational etc.). Forwarding, in contrast, is very common as is the use of aliases and the address book. Messages can gather momentum in terms of those

who are subject to their circulation. New recipients can be added to an unfolding messaging thread so that groups of recipients can grow and become defined as a new receipt entity in a kind of "snowball" effect.

Takkinen & Shahmehri went on to examine three structural representations intended to help encapsulate the spontaneous organization of messages. Their findings highlight the inappropriateness of the general uniformity of facilities for the organization of messages and visualization of collections in contemporary email clients. Filtering, transfer to folders, and two or three-paned displays are not adequate to support classification, organization, and getting an overview of a set of messages, since the strategies for sorting and searching are not all covered. Takkinen & Shahmehri (1998a; 1999) are now extending their CAFE system (Categorization Assistant For Email) by defining three modes of usage: the busy mode for intermittent use at times of high stress; the cool mode for continuous use at the computer; and the curious mode for sporadic use when exploring and (re-)organizing messages when more time is at hand. Bellotti et al. (this issue) are also addressing the email overload problem with the TaskMaster system by moving away from the file cabinet metaphor to an activity-centered view of email.

2.5. Managing messages in the email file cabinet

A large number of email studies and proposals for technical improvement have been focused on techniques for message organization and retrieval. This viewpoint on email can be described as *a file cabinet*. According to the analysis presented in this section, all email activities can be thought of on one hand as primarily matters of storage or learning and on the other as matters of retrieval or memory.

As such, the debate around email in this research cluster is fundamentally divided by different conceptions of human memory and cognition, rather than a strong view of the dedicated functionalities email should provide. In fact, many of the findings reported in this section of the literature apply equally well to the design of other computer technologies where the management of personal information is prevalent. As a consequence, few of the systems based on the file cabinet metaphor differ strongly from the common email interface, itself an extension of the desktop metaphor (e.g. inbox, outbox, folders). Most of the advances have been around ways of interacting with such an interface more easily, but do not really challenge its basic design. Moreover, most of this literature focuses on the individual use of email at work. There is little or no mention of the larger context in which filing and sending messages takes place. More recent research within the storage and retrieval tradition has shifted the argument towards messaging that subserves task management. The cognitive demands of such work thus revolve around group-defined task-level operations and not individual-created message-level operations.

As a summary, Figure 1 below outlines the existing research body that is consistent with the file cabinet theme.

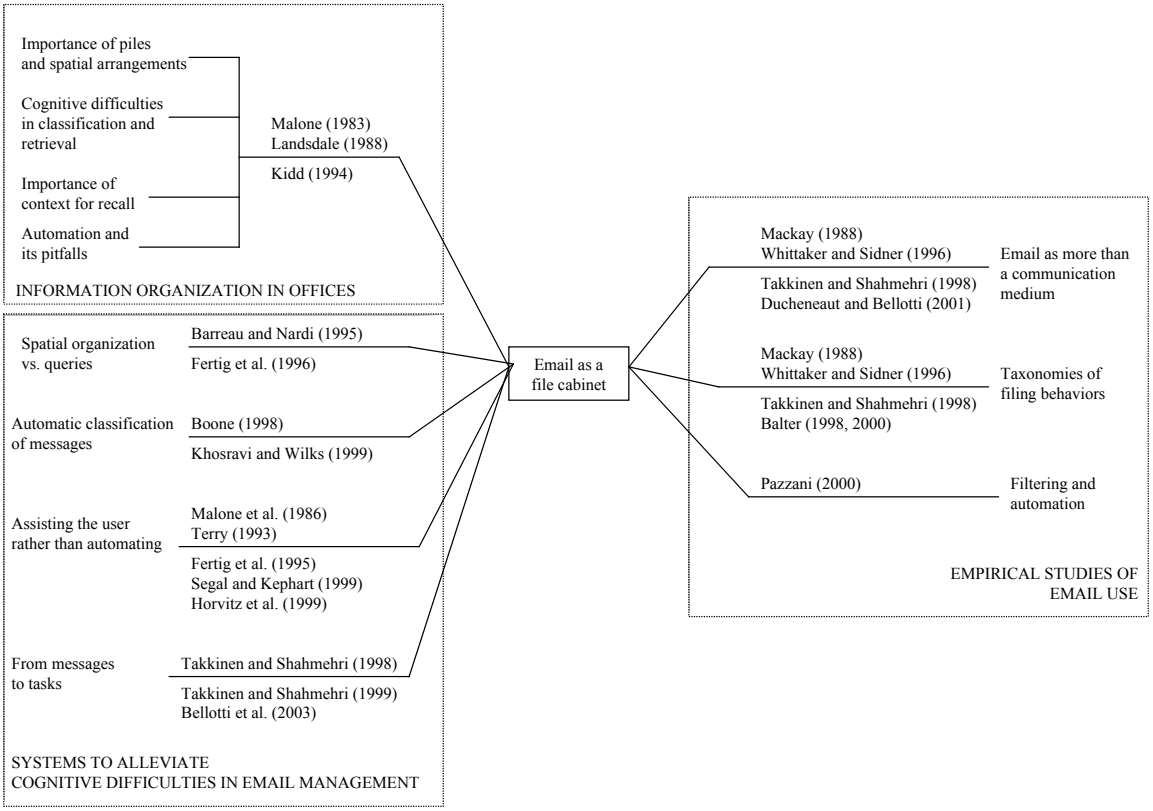

Figure 1 – The file cabinet theme and its associated literature

3. STRUCTURED MESSAGING SYSTEMS AND THE EMAIL PRODUCTION LINE

3.1. Email and collaboration

In the previous section, we characterized the file cabinet theme for email research as, in effect, revolving around operations carried out by a single user sitting at a terminal, at some remove from the social and organizational world around him. This is quite surprising considering that email is, first and foremost, a communication technology used to support interaction and coordination between groups of people. Another line of research, typically in the Computer-Supported Cooperative Work mould, has placed this consideration at the heart of its concerns. It proposes ways to support and improve email's role in collaboration.

Generally speaking, debates on the role and use of electronic communication technologies in collaboration have been characterized by a dialectic of two strategies. On the one hand, research has aimed at devising strategies for building coordination support to reduce the complexity of coordination through technologies for intra-group regulation. On the other hand, efforts have been made to devise strategies that aim at flexible means of interaction which do not regulate interaction but rather leave it to the users to cope

with the complexity of coordinating their activities (Bernstein, 2000; Kjeld Schmidt & Simone, 2000). The importance of wider and unregulated articulation cues is firmly established in the field, evidenced by for example the growth in awareness technology. These wider concerns, however, must all be related somehow to cooperative effort: they "refer to actors' taking heed of the context of their joint effort." (K. Schmidt, 2002, p. 280). This workflow-and-coordination approach has led to the emergence of another theme: email as a *production line*. The emphasis here began with concerns about discipline and control over the flow of communication. The most influential and controversial example of such work is certainly The Coordinator (Flores, Graves, Hartfield, & Winograd, 1988) although the EU COSMOS system followed a similar design philosophy (Bowers & Churcher, 1988).

3.2. Making sense of group transactions through linguistic structures

Winograd and Flores (Flores et al., 1988; Winograd & Flores, 1987) proposed that the design of a tool for communication and management in an organization should embody an orientation toward the management of action. They suggest that this ought to be done by understanding the role of background and language in setting the dimensions of the space in which people interpret and generate their possibilities for action. Language, providing the coordination between actions, is central: human beings are fundamentally linguistic beings, and action happens in language in a world constituted through language. This approach to the design of coordination technologies is known as the Language-Action Perspective. The subject of heated criticism (Suchman, 1994), The Coordinator served as the focus for an entire issue in the Journal of CSCW (Bannon, 1995). However, the Language-Action perspective is co-evolving with two other "post-cognitive" perspectives (Kaptelinin & Nardi, 2003), activity theory (Nardi, 1996) and Distributed Cognition (Hutchins, 1994), and so deserves special attention in this paper.

Winograd and Flores found in Speech Act Theory (Searle, 1969) a unified foundation for designing the support of interactive work in organizations. Speech Act Theory came about as a result of dissatisfaction with the logical positivistic view of language, which dealt with the meaning of a sentence just in terms of its internal verifiability. That is, language use was considered without external reference. Speech Acts represent a 'common-sense' approach to language that extends beyond the making of statements, and asserts that, for the most part, utterances cannot be said to be true or false. It underscores the importance of the distinction between language use and linguistic meaning.

Words can be used to accomplish many things, not only conveying information, and when information is conveyed it is often more than is directly encoded in words alone. A speech act consists of three elements: the speaker says something, the speaker signals an associated speech act, and the speech act causes an effect on the listeners or the participants. He called the first element a locutionary act (the act of saying something that makes sense in a language); the second, an illocutionary act (that is, the use to which language can be put in society); the third, a perlocutionary act (concerned with what follows an utterance, the effect of an illocutionary act). So speech is performative in that it is premised on the existence of a certain communicative intention and results in effects in the world: language is, in a certain sense, intentional action.

Flores et al.'s Coordinator provided facilities for generating, transmitting, storing, retrieving, and displaying records of moves in conversations based on this language/action theory. Instead of providing a uniform command to initiate a new message (as in standard e-mail), The Coordinator required its users to select from among a pre-defined and notionally objective set of linguistic actions. For example, a user could explicitly label her message as a request or an acknowledgement. A key design issue is that the content of the messages themselves is totally free-form: the designers let people interpret the natural language, and let the program deal with explicit declarations of structure. The Coordinator therefore applied a theory of language without attempting to automate language understanding. During later exchanges, a conversational state interpreter kept track of the current sate of the conversation, and automatically generated a list of those actions that could sensibly be taken by the next speaker.

A key premise of Flores et al.'s design was that by interpreting a situation as a network of requests and promises with certain logical and temporal structures, they could help bring order to an otherwise chaotic process. The Coordinator gave managers tools for anticipating and identifying breakdowns on the way to the completion of actions, simply because the kind of mechanisms identified in Austin's Speech Act Theory are made visible and explicit to the users. The nature of action itself is not intrinsically changed, but a tool for diagnosis is now available. This is especially important because electronic communication systems can struggle to convey the social context people normally rely upon to detect and address collaboration difficulties (see section 4). The Coordinator aimed at reconstructing some social commonality and providing shared interpretations albeit within organizations characterized by stable roles, obligations, and collaboration patterns.

3.3. The problem of tools that embody coordination structure

Researchers have been polarized over the role of structures for articulation work as they are embodied in tools, in relation to the structure of work in practice. Suchman (Suchman, 1994) denounced the 'hidden agenda' embedded in technologies such as The Coordinator, arguing that "the adoption of speech act theory as a foundation for system design carries with it an agenda of discipline and control over organization members' actions." All organizations exert control over their members but do so to differing degrees. Extreme examples are given by command and control structure of military groups, at one end of the spectrum, and artists' cooperatives at the other. Responsibilities, roles, accountability and freedom in decision-making are always at stake, as is discussed in Section 0. The objection has not concerned explicit organizational control structures *per se* so much as those control structures that become embedded in tools. When protocols are embedded in technologies, they can assume the guise of impartial mediators in the functioning of groups, where they could formerly be challenged and changed to meet situational demands.

Flores et al. argue that the typical office comprises a structure of recurrent conversation patterns associated with formally declared roles: group manager, assistant, programmer, etc. (Flores et al., 1988). The role structure is assumed to be stable and not under negotiation or change. Positions and power relations among the users are also

assumed to be stable. Moreover the customer/supplier metaphor, reified and objectified to a remarkable extent in the literature on business process reengineering (Hammer & Champy, 1993), is also prevalent in The Coordinator. Problems arise when this basic conceptualization is applied to any kind of role-declared activity since it does not permit changes in response to the influences that are exerted on a functional group that carries out the activity. Consequently, the view of work embedded in The Coordinator leads us to notions such as bureaucratization and control, and away from the more powerful view of organizations as networks of commitments. For example, Schael (1996) found that The Coordinator can be problematic for relations among persons at different levels in the organizational hierarchy (e.g. one subject said 'I try to avoid to make requests, especially for conversations with directors'). Carasik & Grantham (1988) showed early on that, by being overly restrictive, The Coordinator simply impoverished interactions or, in certain circumstances, forced violation of established norms of interaction. Other reasons advanced to explain The Coodinator's lack of success is that users are unwilling or unable to make structure, content, or procedures explicit (Shipman & Marshall, 1999). This is because the use of formal representations can serve to hinder articulation work by adding to its overhead of effort. Formalization also requires introspection to make tacit knowledge visible, and this process interrupts the task-at-hand and changes it.

Flores et al. understood the notion of role change within a group and role combination, depending on circumstance and membership changes. However, in devising The Coordinator, they seemed unprepared for the extent to which the structuring of exchanges in electronic conversation could propagate up to the political lives of the groups who used it. This could be an instance of a problem that will arise any time one imports a passive descriptive theory from another discipline for use as a basis for prescriptive design (Ljungberg & Holm, 1997).

3.4. Structural support for managing workflow

Numerous other attempts have been made in the past decade to develop message-based tools to support collaborative work activities, and correct some of the flaws of The Coordinator. They include, Strudel (Shepherd, Niels, & Kuchinsky, 1990), another example of a conversation-based model on top of email and Conversation Builder (Kaplan, Carroll, & MacGregor, 1991; Kaplan, Tolone, Bogia, & Bignoli, 1992) an attempt at a more flexible variant of Winograd and Flores's model. Other moves towards structural flexibility to improve the applicability of the Language Action Perspective for the design of communication systems include the Structure Definition Language from the COSMOS project (Bowers & Churcher, 1988) and the Milan Conversation Model (De Michelis & Grasso, 1994). From a more commercial groupware perspective, Lotus Notes (Lotus, 1996) integrates a database and platform for developing email-based workflow systems of a similar nature. In all of this work, there is a persistent view of email as an unruly flow that would benefit from the inclusion of structural support for conversations.

3.5. Other structured email systems

Soon after the inception of email, and in parallel to the efforts outlined above, other researchers started to wonder about the various technical improvements one could make

to the system. These people, mostly with a technocentric view of email, started experimenting with the capabilities of email and extended them to support new functionalities. These functionalities provided new opportunities for group collaboration which, one way or another, were also based on a structuring of the flow of email messages. Their mechanisms take two forms, following on from the collaborative nature of messaging: (1) establishing and defining the evolving conversational structure, and (2) tracking and modifying the content of the conversational record.

The earliest suggestion for technical improvement is probably computational mail (Anderson & Gillogly, 1976), in which programs are embedded in each message. When the message is opened, the program is executed. One frequently cited application of these embedded programs is collaborative decision making, such as asking a set of recipients questions about suitable times for a meeting and centrally collecting them.

Collaborative decision making through email places great strain on the participants' ability to maintain the thread of their arguments. In this respect, the use of quoting of prior messages and threading by sorting on subject or sender is a critical process for nearly all email users (Eklundh & Macdonald, 1994). Active Mail was devised to address the collaborative nature of email by supporting consistency between versions of messages and maintaining dialogue continuity (Goldberg, Safran, & Shapiro, 1992). It treated messages as a shared space that participants in a discussion can edit from within their own email client. MONA used a hypertext representation to try to maintain threading, inferring conversational context from message headers (Cockburn & Thimbleby, 1993). However, as Cockburn and Thimbleby themselves point out, participants' investment of meaning into their exchanges, and the evolution of a conversational thread, limit such attempts at automatic conversational structure extraction to the level of guidance at best.

Envoys (Gold, 1986) addressed the joint and consequential nature of messaging by actively automating the routing of messages in a round-trip from message senders. Observations about quoting in email exchanges make clear that, unlike many other forms of communication, email conversations keep statements alive and subject to continual modification. It included relevant recipients that were not specified, allowed modification as messages move from mailer to mailer, and returned messages to the original sender to inform her what actions have been taken. Borenstein's (1992) Atomicmail allowed its users to build collaborative applications on top of email with a LISP-based language. Atomicmail extended some ideas already present in an earlier multimedia-enabled system, the Andrew Message System (AMS) from Carnegie Mellon University (Borenstein & Thyberg, 1988). In AMS users could already send voting messages, return receipts requests, enclosures, or subscription invitations.

According to Milewski and Smith (1997), transactions are "a series of activities between two or more parties that follows through to the completion of some planned goal." They propose that two key characteristics of traditional electronic messaging are antithetical to transaction support. First, messages are traditionally treated as independent objects: there is no simple way of bundling together messages that are part of the same transaction. Secondly, once a message is sent, there is traditionally little or no control over its content, in the event, for example, that the sender wishes to change it.

Consequently, they implemented in their Action Mail system an approach towards structuring messages that is intended to help users carry out some of these transactions. Their approach has been to make message structure both general-purpose and optional. The message composition screen proposes a list of possible responses to each message received. The message itself is not sent, only a pointer to the message. The recipient sees the original message, with a list of interface elements (checkboxes) allowing easy reply to the options included in the original message.

3.6. Email as production through transaction

The functionality for sending and receiving electronic messages, available in many groupware products, has been shown to be by far the most heavily used and is universally acknowledged as the most critical facility (Bullen & Bennett, 1990; Farshchian & Divitini, 1999). It is no wonder then that some of the earliest work on electronic collaboration, such as The Coordinator, tried to build on this success. But widely deployed systems attempting to structure email exchanges in order to improve workflow have so far proved unsuccessful; other prototypes have not been deployed widely enough to get meaningful results.

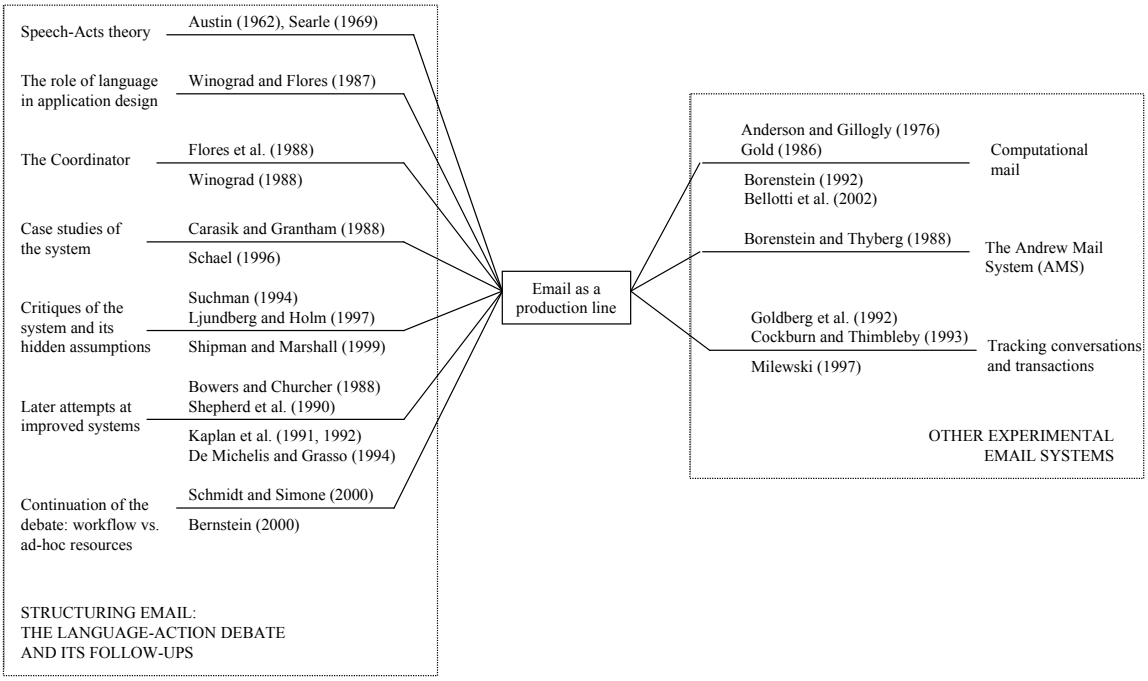

Figure 2 – The production line theme and its associated literature

The *email as a production line* theme examines messaging technology as a facility for work production within groups, across individuals in terms of their role as members of the group. This approach seems to be particularly useful in contexts where activities are fairly repetitive and well-defined, but it breaks down easily when more flexibility is required. As discussed above, the polymorphous nature of email (Ducheneaut & Bellotti, 2001; Whittaker & Sidner, 1996) only adds to the difficulty, as this communication technology is constantly repurposed for the needs of its users (see also section 4 below).

This casts serious doubt on the feasibility of developing a truly generic, structured email infrastructure and, in fact, research efforts in this direction seems to have been greatly reduced in recent years. It does however leave open the need for appropriate mechanisms for revealing and working with the structure of email message collections, and for treating the dual nature of email messages as both matters of record and as collaborative work in progress.

To summarize, Figure 2 above outlines the main contributors to this body of email research.

4. EMAIL AS A COMMUNICATION GENRE

4.1. Email and organizations

Communication and organization have a lot in common. Very early on, seminal works in organization theory recognized that communication was an essential ingredient in the creation and long-term survival of organizations. Barnard, for instance, proposed that '*an organization is born when there are individuals who are able to communicate*, and who are determined to engage in actions oriented towards a common goal' (Barnard, 1938, emphasis added). Email being a communication technology, it is therefore not surprising that its effects in organizations have been the subject of much scrutiny. Researchers have, for example, examined the relationship between electronic media, organizational behaviors and outcomes, such as intra-group interaction (Finholt & Sproull, 1990), communication patterns (Eveland & Bikson, 1988; Feldman, 1987), group decision behavior (e.g. Kiesler, Siegel, & McGuire, 1984; Kiesler & Sproull, 1992), socio-emotional discourse (Haythornthwaite & Wellman, 1998; Sproull & Kiesler, 1986; Walther, 1995), and managerial effectiveness (e.g. Daft & Lengel, 1986; Schmitz & Fulk, 1991; Trevino, Daft, & Lengel, 1990; Zack, 1994).

The view of email emerging from these studies has shifted dramatically over time. Initially, email was assumed to be a communication medium with well defined properties, leading to predictable effects. But research progressively recognized the malleability of email and this medium is now described more in terms of its local meaning, contingent on how users appropriate it and renegotiate the value of its features in the context of their organization. As such, we identify the third theme of email research cluster as *communication genre*. We begin below with the earliest research on email use in organizations.

4.2. Organizational communication

Discussions of media choice within organizations began by treating media choice as an objective, individual and voluntary act of matching tasks to media. It was assumed that inherent properties of media leant themselves to certain kinds of organizational function and that the goal of research was to show which media went with which organizational tasks. This idea is extensively articulated in Short, Williams and Christie's "Social Psychology of Telecommunications", a synthesis of work carried out by the Long Range Research Group of British Post Office in the early '70s, and formalized as Reid's

"Telecommunications Impact Model" (described in Chapter 3, Short, Williams, & Christie, 1976). The idea of inherent properties is also evident in Media Richness or Information Richness Theory (IRT), which proposes that the sum of the observable attributes (e.g. speed of transmission, range of transmissible cues) gives a net effect of information provision (Daft & Lengel, 1984, 1986). Depending on the degree of equivocality or ambiguity of a task, users can then select the most appropriate medium. Equivocality is an extremely important issue in organizational decision-making, since it identifies the need for judgment in the face of uncertainty and implies the need for consensus or clear authority to carry through from decision to action. Organizations, as collections of individuals, require a balance between autonomy to allow uncertain decisions to be made and accountability to contain their risk. Email, because of its textual and asynchronous nature, is placed at the lower extreme of the richness scale, and is said to be inappropriate for highly equivocal and/or ambiguous activities.

Researchers following this information-theoretic, rationalist approach paid less attention to the influence of organizational power, group perceptions, and social network relations on media adoption (see Rice & Shook, 1990). As telecommunications became ingrained in organizational processes (Sproull & Kiesler, 1991), studies began to expose the overriding role of these factors. Social networks, social influence, interpersonal relationships, and organizational power structures all affect how groups and individuals use email (Garton & Wellman, 1995). For instance El-Shinnawy and Markus (1998) found that users generally preferred electronic mail over voice mail for most communication purposes. These results do not support a hypothesis derived from IRT that technologies such as voice mail would be preferred to email for ambiguous and socially significant situations because they are intrinsically 'richer'.

As a result, social influence theories have gained considerable ground in the past years, at the expense of rational theories such as IRT. Interpretivism is one of these more recent attempts at understanding email adoption. From an hermeneutic perspective, Lee (1994) argued that richness or leanness is not an inherent property of the electronic mail medium, but rather an emergent property of the interaction of this medium with its organizational context, where the interaction is described in terms of distanciation, autonomization, social construction, appropriation, and enactment. In another study, Markus (1994) examined the literal and interpreted content of messages to examine what some managers themselves meant in the email messages they sent to one another. Managers were found to perceive various media in ways that were relatively consistent with information richness theory, but to use email more and differently than the theory predicted. In particular, effective senior managers were found to use email heavily and for precisely the kind of judgment-intensive, equivocal communications tasks that email was supposed to be poor at supporting. Through collective behaviors like answering messages as they arrived, email senders invested this medium with the speed and richness usually associated with the phone. It suggests that the adoption, use, and consequence of media in organizations can be powerfully shaped by social processes such as sponsorship, socialization, and social control, which require social perspectives to understand them.

Ngwenyama and Lee (1997) later reinterpreted Markus's data from the perspective of Habermas' (1979) critical social theory (CST). People, as actors in a social or

organizational context, themselves 'process' data into information and hence richness dimensions of email arise in association with the organizational processing units that are instituted over time, not just in the raw-data bandwidth terms of IRT. They clearly show that organizational members are more than just passive receptacles for data or meanings that are somehow transported or downloaded to them. When people communicate, they perform social acts that are regulated by organizational norms and thereby come to have meaning within their organizational context. Thus they simultaneously enact existing and new relationships with one another as they communicate over email, a phenomenon completely overlooked by theories such as IRT.

So email often serves to support socially loaded decision making, where processes that convey authority, autonomy and accountability all need to be supported. The degree to which each of these is exploited in practice will depend upon a combination of factors within the organization, including the various organizational functions into which it is recruited.

4.3. Email and participation in group work

Another issue addressed in great length by the organizational literature on email is that this technology provides fewer cues than face-to-face communication about interactions, physical context or social roles. Since most of the early research on the effects of email in organizations was conducted by people with a strong background in social psychology, this particular emphasis on the role of cues to support social attribution in electronic group work is not surprising. The results coming out of this 'cues filtered out' approach are, however, less than conclusive.

Email's lack of cues can make it easier for group members to contribute to group discussions. As "status equalization" (Dubrovsky, Kiesler, & Sethna, 1991), the reduction of information about group members' expertise, organizational niche and power, and characteristics such as age and gender, can change interpersonal perception and with it feelings about ability to participate. It can encourage contributions from those who would normally wish to remain silent and reduce the ability of those who would normally dominate from disproportionate contribution. However, status differentials seem to be much more robust than initially thought when electronic tools are used in organizations (Saunders, Robey, & Vaverek, 1994; Sherblom, 1988). It is very difficult to draw conclusions about communications shared between people who have no relationship outside the medium and then to apply these conclusions to those whose relationships span media and map onto identified, persistent organizational roles.

Many studies have also found that, as a corollary of the equalization effect, people can be less inhibited, non-conformist and combative when using email (Adrianson & Hjelmquist, 1991; Hiltz, Johnson, & Turoff, 1986; Kiesler & Sproull, 1992; Kiesler, Zubrow, Moses, & Geller, 1985; Siegal, Dubrovsky, Kiesler, & McGuire, 1986). It has been suggested that since it is more difficult to interpret the intentions of the sender, misunderstandings are more likely to emerge and will be more difficult to resolve. Email groups tend to be more polarized, and are slower to develop leaders and reach consensus (see for instance Kiesler & Sproull, 1992), which is somewhat balanced by the fact that

their greater range of ideas may also produce more innovative and better decisions (Valacich, Paranka, George, & Nunamaker Jr., 1993). However, meta-analyses (Walther, 1992, 1995) have shown that uninhibited behavior is quite infrequent when email is used in organizations, and decreases with time, group history, and anticipated future interaction. Email can also be used to create and maintain friendship ties at work (Haythornthwaite & Wellman, 1998), despite its low 'socio-emotional bandwidth'. Again, this hints at the fallacy that email entirely describes the social milieu within which people know one another. Although this may well be true outside of organizational relationships, for example on Newsnet bulletin boards, within organizations it is rare indeed. Even if members never meet beyond the medium, their responsibilities to one another exist within a socioeconomic world that requires them to understand the consequences of their dealings through email.

Overall it seems much attention has been focused on incidents and the problematic nature of email for decision making in organizations, rather than the countless rewarding and routine non-problematic interactions also happening (Baym, 1995). One simply cannot discount the organizational context in which the technology is used, the history of past interactions built over time and anticipations of consequences for future interactions. This does not mean that such effects as have been noted are spurious; rather that they should be taken within the wider context of the social networks to which they refer. Indeed, the anonymity effects of email that underlie deindividuation and polarization (R. Spears, Lee, & Lea, 1990) seem to be among the most powerful within groups compared to other media (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). Social Identity Theory places them into just such a framework of social relations, whereby group members reflect on their group membership, its values and their simultaneous and competitive relationship with other groups (Tajfel & Turner, 1986). Applied to email, Social Identity Theory suggests that it is the relative balance of individual and group information in evidence at the interface that governs such effects, but always against the backdrop of persistent relations (R. Spears, Lea, & Postmes, 2000; Watts, Nugroho, & Lea, 2003).

4.4. Email in formal and informal structural relationships

At the very least, the structure of an organization is the embodiment of its functional constitution, chains of command and inter-functional interaction. Email has the potential to allow various strategic and political manipulations of information in organizations, thereby affecting the organization's structure in terms of power and control (for analysis of the problem dealing with more technologies than simply email see Zmud, 1990). Zuboff (1988), for instance, reported early on the case of a manager spying on email exchanges in his company. Other studies have shown that some managers distrust email because they cannot control communication channels as easily as before (Perrin, 1991). Using email, employees could discover more about their company than their management would like them to know and subvert controls for their own individual benefit (Sproull & Kiesler, 1991), threatening traditional pyramidal control structures. Although email can be used to give a large group of people access to quality information, this potential can backfire and email can as easily become a rumor mill (Finholt & Sproull, 1990).

Illustrating the applicability of these concepts, Romm (1999) shows in a series of case studies how email has been used to organize concerted political actions against a variety of organizational groups or members.

Most of the work on email's impact on organizational structure has examined the tension between the value of being informed and the threat to authority posed by underlings having possession of too much information. The threat side of the equation has been in terms of dilution of boundaries set in place by management through the new cross-functional and cross-organizational linkages created by electronic communication tools. It has been proposed that electronic mail creates new connections between individuals, and that its users can therefore get access to information they would not have received otherwise (Finholt, Sproull, & Kiesler, 1990), for instance by finding organizationally distant people with whom they have shared interests (Feldman, 1987). The value side of the equation resides in cost, speed and flexibility. Email reduces the cost of communicating with a large number of people, some of whom are completely unknown. Therefore, email serves as a vehicle for broadening the process of socialization in an organization by facilitating the creation of weak ties. In other studies email users have also reported a better sense of connection to others after using the tool, as well as a feeling of getting better quality information than before (Rice & Steinfeld, 1994). In fact, some users join a great number of email lists just because they don't want to miss anything (Finholt & Sproull, 1990; Rice & Steinfeld, 1994).

By facilitating informal interactions, email also reinforces the linkages between core and periphery in organizations (Eveland & Bikson, 1988; Huff, Sproull, & Kiesler, 1989; Sproull & Kiesler, 1991). Peripheral workers can increase their participation in the organization, and in return feel more positively oriented towards the group. Low status individuals can use email to gain more information and power. By being a potential source of emotional support, email can also reinforce the cohesion of a group, especially during times of crisis (Haythornthwaite & Wellman, 1998; Steinfield, 1985). The traditional frontiers between these groups, however, are blurred by email (Bikson & Eveland, 1990; Eveland & Bikson, 1988), because email can support in-groups without out-groups: expertise in-groups can form via one-to-one computer mail, but via all-group mail that expertise can be shared (Finholt et al., 1990).

4.5. Email as a communication genre

As discussed in this section, studies of email use in organizations have followed a historical progression that is typical of emerging technologies. Although early research was concerned with factors that contributed to or hindered the integration of the technology with existing practice, later research looked at email as a social phenomenon with much broader, transformative organizational implications. The later research, however, still fails to show where and how in general email will be used to good effect in organizations – if anything, it seems to imply that such guidance is impossible. Despite a great deal of published work, the breadth of the field gives it a piecemeal rather than integrated nature (Rudy, 1996). Moreover, many of the published studies are based upon questionable assumptions about the limited reach of social relations among email users. Most of the work has concentrated on how individual users interface with their

computers, how two persons interact online, or how small groups function on-line (Garton & Wellman, 1995); much less attention has been devoted to the effects at a larger organizational or social level. In this respect, email research in this mould could be subject to the same criticism Wellman and Gulia (1999) level at Computer-Mediated Communication (CMC) research in general: it is often Manichean, presentist, and parochial, assuming that individuals use the electronic medium exclusively, that this is done in a social/organizational vacuum, and without consideration of one's history of past interactions.

Studies of email illustrate a common problem in studies of information and communication technologies. As Markus and Robey (1988) and later Orlikowski (1992) pointed out, the state of knowledge about technology in organizations is ambiguous and conflicting. Early research assumed technology to be an objective, external force that would have determined impacts on organizational properties such as structure. Later researchers focused on the human aspect of technology, seeing it as the outcome of strategic choice and social action. Either view, however, is incomplete, and email studies have been no exception to this rule. As a consequence, recent developments in this area have tried to articulate a theoretical framework in which technology is presented as the product of, as well as the medium for, the interactions of its users (Orlikowski, 1992; Orlikowski & Robey, 1991). Researchers are actively trying to explain the incredible variety in the effects email has in organizations depending on each organization's culture, its members frames of reference, and structural properties of the organization (Orlikowski, 1996).

Because its meaning and use always seems to be contingent on the social and organizational factors surrounding it, the email theme of this research cluster is that of a *communication genre* (Agre, 1998). This reflects the view that, when a new medium comes to be used, people will try to define its place in their relationships, to ultimately reach a 'relatively stable, expectable form of communication' (Agre, 1998). The changes 'will express latent potentials in the local social system, and they will be influenced heavily by the participants' own (shared or conflicting) understandings of the situation' (ibid). This theme can be identified in recent studies of the use of email (and other communication media) in organizations (See for instance Ducheneaut, 2002; Orlikowski & Yates, 1994; Yates, Orlikowski, & Okamura, 1999). Such studies reflect the new direction organizational research is taking with email. Initially, email was portrayed as a *substitutable communication medium with predictable effects* in relation to the various organizational functions into which it could be recruited. The variability of deployment has recast email as *a communication genre that is constructed and adjusted over time* from the interaction between the technology and its context of organizational deployment. Figure 3 below summarizes this body of research.

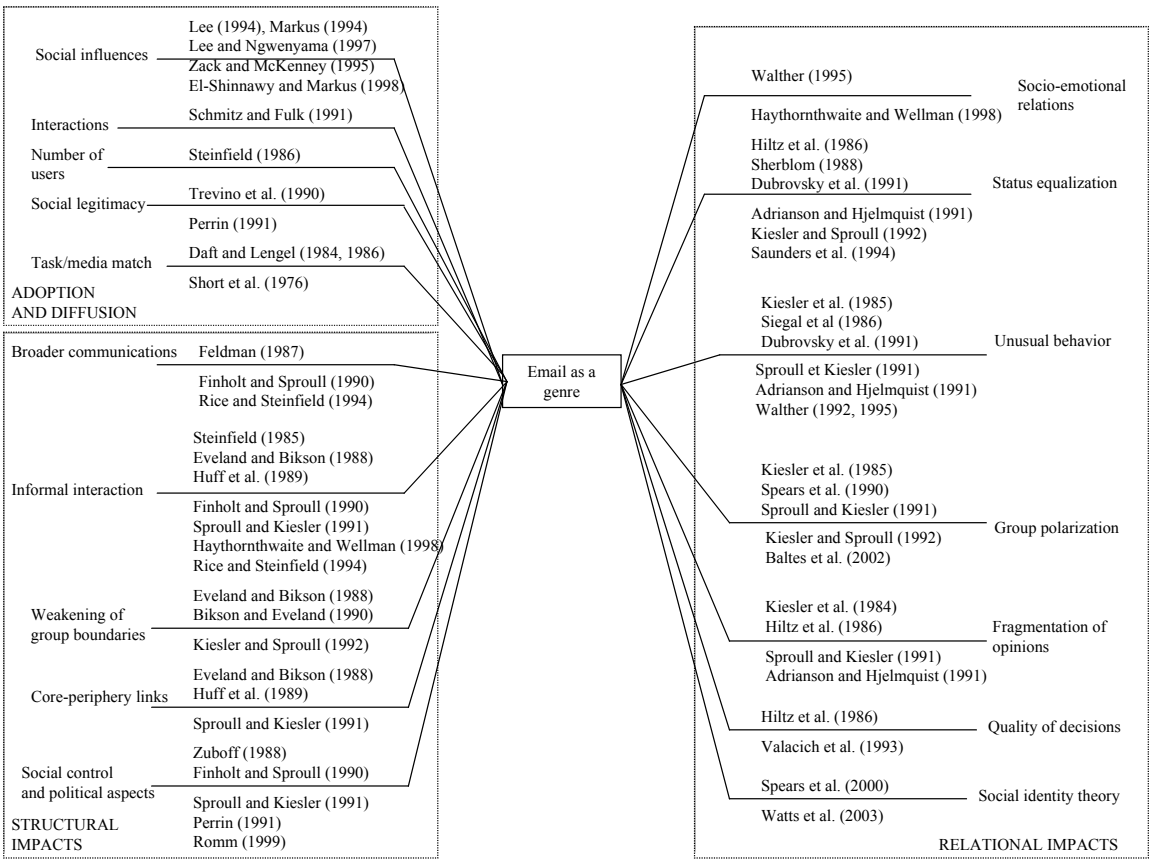

Figure 3 – Email as a communication genre and its associated literature

5. MOVING FORWARD: A POSSIBLE DESIGN FRAMEWORK

In the sections above we have journeyed through more than thirty years of email research and proposed three metaphors that, we think, can help organize this vast and diverse body of work. It is clear email has been considered from so many different angles that researchers can be hard-pressed to find any commonality between some of the existing findings. While our survey's organization is certainly not without flaws, we think it brings a minimum of order to this body of work that makes it more tractable and, therefore, more useful as a point of departure for future research.

Indeed, as stated earlier, our hope with this review was to delineate was had been said about email so that future researchers could use some or all of this early work as stepping-stones. In the interest of starting a debate that would be particularly appropriate to this special issue, we would now like to illustrate how previous research influenced our own thinking. Based on this discussion, we then propose one tentative avenue for reinventing email.

In our view, the most problematic issue with past email research is that it failed to connect the three levels at which email operates: namely the individual, communicative,

and socio-organizational. Our metaphors reflect these divisions. For instance, the notion of email as a file cabinet rightly draws our attention to the central role of individual users in managing their electronic communication, but often forgets about the conversational and situated nature of email. At the other extreme the characterization of email as a communication genre highlights the fluidity of email as a medium and the importance of the socio-organizational context of its use – perhaps with a tendency to forget about the user simply manipulating an email client. In the middle, the idea of email as a production line emphasizes the communicative act, the exchange of information and work between several parties.

We think each of these themes point at several components that should all be considered for inclusion in any new email interface. In other words, even though many of the *theoretical* gaps in email research probably cannot be bridged, we think this does not prevent all perspectives to simultaneously affect the *design* of future email clients. In our scheme each of the design components either connects two previously isolated analytical levels, or offers more detailed information about a single level. Moreover, each component offers a dynamic view of the processes it relates too – in other words, it incorporates a model of time. Put together, these components are an attempt at blending together in an artifact some of the most high-level concerns of email researchers over the past three decades. Figure 4 illustrates this potential design framework:

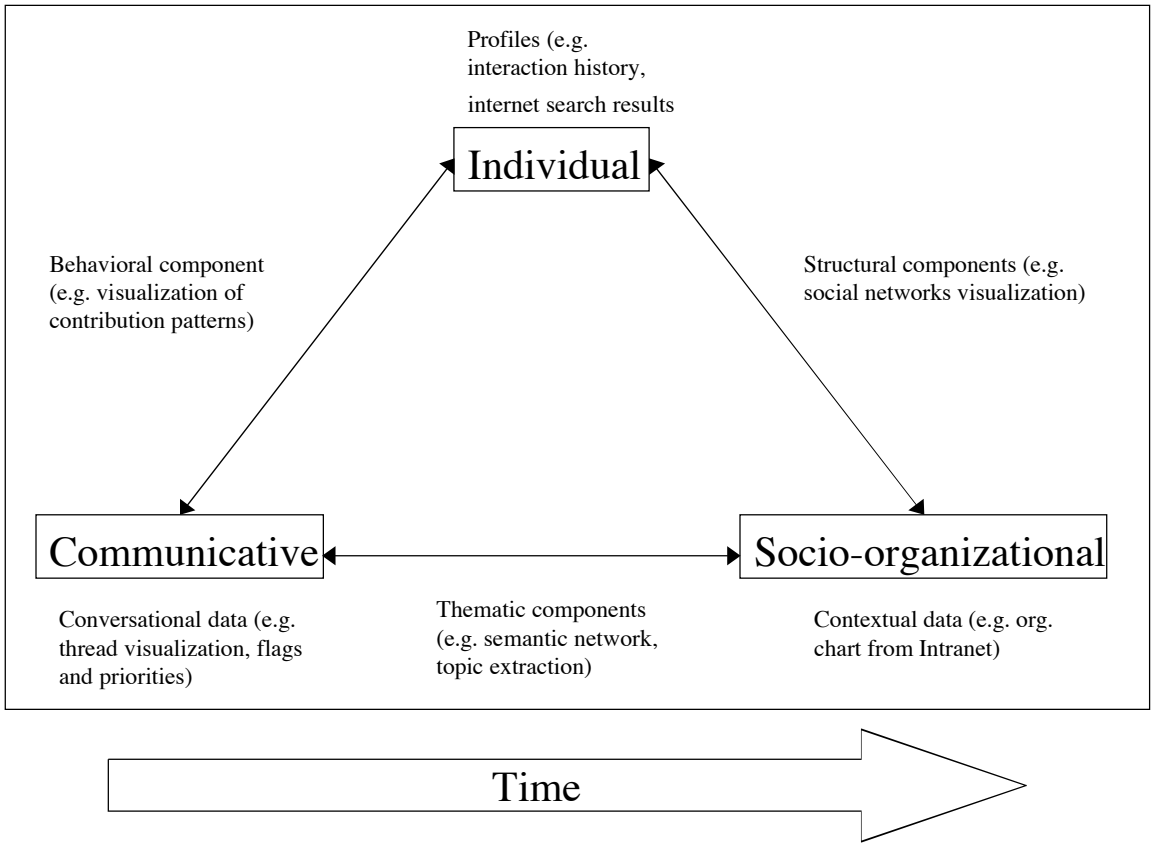

Figure 4 – A possible framework for reinventing email

Let us describe the components of this design framework in more detail:

Profiles can offer in-depth information about each individual an email user is corresponding with. For now, the only indicator of a correspondent's identity is an email address and signature file, but it would be possible to do more. Simple strategies, like automatically querying an Internet search engine with an unknown correspondent's name, could enrich email users' understanding of who they are dealing with. Interaction histories and rhythms would also provide a useful context. Indeed email, like any communication activity, is about face management (Goffman, 1959; Tyler & Tang, 2003). It is therefore quite important to have access to resources allowing an evaluation of the identity projected by someone through their email. It is equally important to ensure that control of such profiles rests firmly in the hands of the individuals to whom the information pertains.

Structural components connect the individual and the socio-organizational levels. Up to now, there is no way to connect email correspondents to the larger social and organizational structures to which they belong. Yet this information can be valuable: when it becomes visible, email users can start reasoning about how they partition their social relationships and which set of identities they present to the world through their messages (Viegas, Boyd, Nguyen, Potter, & Donath, 2004); it also reveals the roles of each correspondent and the attention that should be given to them (Sack, 2001; Smith & Fiore, 2001). Existing research proposes several social network visualization techniques that could be fruitfully imported into new email interfaces.

Behavioral components connect the individual and the communicative levels. Intuitively, we all know that people do not communicate the same way over email. Some are more vociferous than others; some start more conversations, while others are content to simply reply to contacts they have not initiated. All these factors affect the interaction strategies an email user can adopt, and yet none of these behavioral aspects transpire in current email interface. Again, recent research has proposed some ways of making this information more accessible (Donath, Karahalios, & Viegas, 1999; Viegas & Smith, 2004), but it is clearly in its infancy. Much more could be done to give email users a better sense of how to interact with their correspondents.

Improved **information about each individual conversation** would be greatly beneficial. At the communicative level, current email interfaces mostly consider conversations as sets of atomic messages. It is only recently that some commercial email clients have started offering crude threading mechanisms, in a form very similar to those available in Usenet reader for many years. Yet email conversations can be quite involved and hard to track. Mechanisms to help the user deal with entire conversations are needed, to help them get a better sense of how conversational turns are unfolding and how they relate to each other. Efforts have been started in this direction (Bellotti, Ducheneaut, Howard, & Smith, 2003; Venolia & Neustaedter, 2003) but there is still much space left for improvements.

Contextual data could be fruitfully integrated into email. The profiles we have discussed earlier help email users evaluate the identity of their correspondents and to manage the basis upon which they themselves are being evaluated. Contextual data offers a similar benefit, but at the larger socio-organizational level. When email is used in a

corporation, for instance, a wealth of data is frequently available about how work is (or should be) organized. Company intranets can be repositories for organizational charts and documents. All of these could be made accessible from within one's email, as a context for the interpretation of email exchanges. One effort has already been made in this direction, relating email conversations to the organizational chart of the corporation it is used into (Heckel & Hamann, 1997).

Thematic components connect the communicative and socio-organizational levels. Each email conversation takes place in a socio-organizational context. In particular, topics and themes reflect which part of this context a conversation is concerned with. However, there is currently no way in email to get a sense of what is being talked about. Sorting messages by subject line is crude and inefficient, since many conversations drift away from their initial subject (Ducheneaut & Bellotti, 2003). Better ways of visualizing themes of conversation could be imported into email (Sack, 2001), or entirely new ones developed. Both would help contextualize conversations more easily.

Finally, each of these components should include **a model of time**. Email exchanges are inherently dynamic, connecting shifting constellations of individuals depending on the purpose and context of the communication. For now however, time is poorly represented in email interfaces: sorting by date, or searching for messages over a specific date range, are often the only two possibilities. This limits the potential reuse of content accumulating in one's email, since the user is often constrained to focus only on the present state of his affairs reflected in a monolithic inbox. Time in email also does not have to be only represented as present and past: recent systems show that email interfaces can also be used to project into the future, to reason about upcoming activities and commitments (Bellotti et al., 2003).

As a concluding remark for this section, note that all of the components we proposed automate very few email activities. Instead, they point the user at potentially interesting information patterns that they can interpret as they see fit. This is an important requirement: as we have discussed earlier, automated approaches to email management have rarely been successful (see section 2 in particular), and attempts at imposing structure have not fared much better (see section 3). We view email users as human beings able to reason about their activities, not passive recipients of pre-analyzed data. Email interfaces should encourage active sensemaking as much as possible.

6. CONCLUSION

In this paper, we have surveyed a range of research carried out on email over the last thirty years. Our hope is that this survey will prove useful to future researchers and help them forge their own direction of research, with knowledge of what has been attempted in the past. We found it impossible to cast email research into a single mould since the idea of email has manifested itself in significantly different ways in the various research communities to have tackled it. Instead, our approach has been to propose three metaphors reflecting, as best as possible, the "collective imagination" of several disciplinary fields regarding email. With this we have made an attempt at answering the first question we started with: What is email research?

It is clear that we know a lot about email as a communication medium, its usage and its users, the way it interacts with its social and organizational contexts of use. Yet email remains a moving target that has evolved from a simple electronic letter writing system to a business and social communication genre, and keeps evolving as new generations of users adopt it. Perhaps because it is so hard to pin down, academic research has had surprisingly little effect on the design of new email interfaces. We think it is time to put some of this knowledge to use and reinvent email so that its interface reflects the diverse range of practices it is used to support.

Informed by our journey through the literature, we proposed a way to put theory into action by suggesting design guidelines for the reinvention of email. Our view is that, despite the incommensurable theoretical gaps between most published works on email, it is still possible to merge many of these seemingly incompatible ideas into a new email interface. Our particular approach, meant more as an illustration of the possible avenues to explore than a definitive answer, has been to blend the three analytical levels cutting across three email metaphors in one place. We therefore suggest ways for future email interfaces to simultaneously support activities in three contexts: individual, communicative, and socio-organizational.

However we are persuaded there can be many alternative readings of email research that could be as, if not more, informative for the reinvention of email. Our co-contributors to this special issue will no doubt propose other challenging and exciting approaches. The second question we asked remains very much open: How can we reinvent email? We look forward to the discussion generated by the possibilities described in the remaining articles.

NOTES

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