Towards the use of user-centric meta-knowledge in applying organizational memory to email communications

David G. Schwartz
Graduate School of Business Administration
Bar-Ilan University, Israel
dschwar@mail.biu.ac.il

ABSTRACT

The communicative act in a learning organization is subject to a number of threats to its validity (Habermas 1981), in particular the comprehensibility, truth, trustworthiness, and appropriateness of a given message. Organizational Memories can be used to address these threats. Our focus is on email communications which suffers from the same threats identified by Habermas. The integration of email with an Organizational Memory can improve the quality of communication by applying people-centric meta-knowledge to appropriately link a given message to the OM. In this paper we expand upon the direction taken by earlier work of Abecker et al. (1997) with respect to the importance of the object-meta relationship and the use of meta-knowledge to manage (or rather to complete) an OM. We suggest that the focus of the meta-knowledge in an email application, should be on the roles, perspectives, and characteristics of the people in an organization rather than on knowledge description. This, we argue, will effectively insure that knowledge will not be disassociated from the people and the situation (Sierhuis and Clancey 1997). We present the HyperMail architecture and sample application to illustrate how formal meta-knowledge is used to re-associate informal email communications to an Organizational Memory.

1 Introduction

Complex organizations are composed of many diverse, interdependent work groups such as product development teams, manufacturing planning, and marketing, all of which have unique decision domains. Managers act autonomously within their domains, yet they are affected by each others' actions. A *learning organization* or *organization of the future* (Huber 1991, Malone et al 1987, Simon 1991) is a decentralized organization with differentiated sub-units that requires some mechanisms of integration. Organizational sub-units develop unique perspectives in response to the different tasks, goals, and environments they face and these different perspectives reveal ambiguity, paradox, and conflict. (Pondy et al. 1987). Integration is not achieved by a straightforward summation of different perspectives, but it has traditionally been found through dialogue in which conflicts are recognized and discussed.

Learning and empowerment, often accompanied by dispersion, are characteristic of many of today's successful organizations. A learning organization relies on complex thinking and ongoing dialog (Schein, 1993). Decentralized and dispersed organizations rely on distributed information processing, communication and cooperation (Bartlett & Ghoshal, 1990). But these require complex information processing and rich communication because today's diverse environments create a state of high uncertainty and high novelty that requires thoughtful rather than routine information processing and rich rather than lean communication (Daft & Lengel, 1984).

Rich communication is needed not only because of higher complexity in the message communicated, but also because of the knowledge differences between the communicating parties. For example, communication between different organizational cultures, e.g., engineers versus managers, requires elaborate messages and descriptions of context (Schein, 1997). International communication and cooperation introduce further idiosyncrasies to the communicative act (Hofstede, et al., 1990).

Organizational memories (OM) provide a mechanism to preserve, distribute, and reuse the knowledge accrued by an organization. Using organizational memory as a basis, we are investigating and developing different mechanisms that, leveraging the OM, add richness to electronic communications throughout an individual organization, and potentially between multiple, distinct organizations. This latter point deals with extending the use of organizational memories from an in-house tool to an inter-organizational tool. By combining organizational memories with electronic mail communications, we can achieve richer communications which serves as the foundation for integration between differentiated sub-units. Combining OM and email in an effective manner involves many tasks and central to the success of such a combination is the collection and use of meta-knowledge.

1.1 The Organizational Memory Problem

The Organizational Memory Problem has been defined (Dworman, Kimbrough et al. 1997) as follows:

> *"Information pertinent to the task at hand has passed through the organization. Was this information captured? If so, how can it be efficiently retrieved and brought to bear on the present task?".*

We take this intentionally (on the part of Dworman et al.) broad definition and focus it on a number of specific aspects of the OM problem. In particular, the "present task" is email-based business communication between managers in an organization; and "brought to bear" in terms of using OM means to directly aid in the relevant interpretation of such communications. As such, we can rewrite the above definition as follows:

> *Information pertinent to organizational communication has passed through the organization. Was this information captured? If so, how can we use this information to help managers properly interpret email received from a colleague?*

Of course a definition that focuses on the OM *Problem* - a procedural or applicative issue - begs the question of the particular type of OM we are addressing. Within this conceptualization of the Organizational Memory Problem, we further define an Organizational Memory as follows:

An Organizational Memory consists of a (semi-formal) organizational knowledge base and a (formal) set of meta-knowledge that can be applied to that knowledge base.

Thus there are two key components here: (1) a knowledge base, which has been the subject of decades of AI research; and (2) a well-defined set of meta-knowledge - another well-worn AI technique, yet one that has yet to be fully leveraged in the context of Organizational Memories. Neither, in and of itself, should be considered an OM. It is through the combination of the two that OM can be applied in the industrial setting to which we refer.

This paper begins by analyzing the need for an organizational memory to support non-routine and non-structured communications. We then present a framework for applying OM to the problem intra-organizational communications . A number of issues are brought to the fore, including the integration of formal and informal organizational knowledge through a meta-level architecture, and a people-centric approach to the use of meta-knowledge (as opposed to the knowledge-centric approach taken by Abecker at al 1997). To illustrate, we report on the development of the HyperMail system. The development of HyperMail, shown conceptually in Figure 1, follows suggestions by Kantor (1994), that similar to other problems that have been dealt with by AI, the field of OM requires solutions that are domain-specific, not unlike the need for domain-specific intelligence found in expert systems and other AI technologies. This approach becomes apparent in our use of management-specific meta-knowledge as a facilitator to improve on more traditional information retrieval and ranking techniques. The use of meta-knowledge as a facilitator in integrating the knowledge of multiple participants has been the focus of much DAI research (see, for example, Schwartz 1995) in a two-tiered object-meta architecture, and more recently in a three-layer architecture (Abecker et al. 1997) for Organizational Memory applications.

What's the big question here? In essence, OM research is at a crossroads. Do we focus our efforts on shaking and baking the individual knowledge entries to generate knowledge descriptions? Or do we let the people speak (so to speak), and combine domain-specific knowledge entries with user-centric meta-knowledge that can guide us to the relevant organizational memory? The goal of this paper is not to advocate the latter at the expense of the former, (odds are we'll end up needing both!) but rather to suggest that for an application such as electronic communications, where there are two, if not more, active human participants in the process, a user-centric approach will result in effective use of the organizational memory.

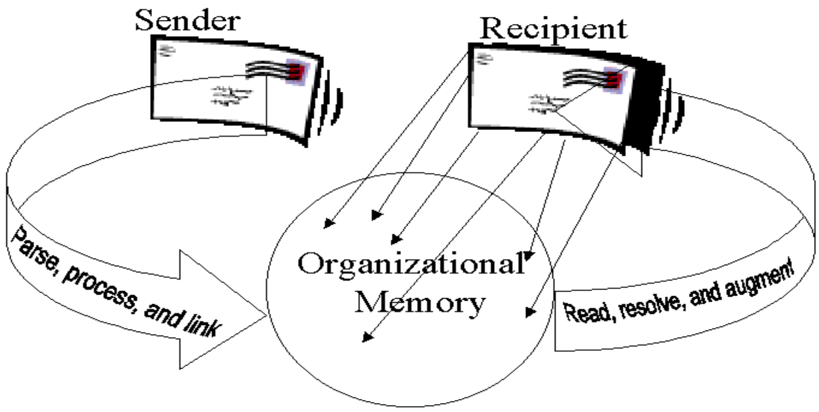

Figure 1: Conceptual overview of applying Organizational Memory to email communications

2 On The Relationship between communication and organizational memory

Sierhuis and Clancey (1997), emphasize the centrality of people to the task of knowledge management in an organization - not only while constructing the OM, but in properly using it as well. Sierhuis and Clancey are most explicit in this regard "knowledge cannot be disembodied from the people and the situation". The importance of "situatedness", while rooted in the understanding of plans and actions (Suchman 1987), must be brought to bear on the fragile task of interpersonal communications. No matter how complex the knowledge being stored or the message being communicated, we contend that properly situating a communicative act requires a user-centric approach and user-centric meta-knowledge.

Assumptions about what others know and what is mutually known are necessarily tentative. Assumptions made are based on a variety of information sources with varying levels of credibility and relevance. At any point in time, the perspective (and resulting interpretation) taken by a participant in communication can be viewed as a tentative hypothesis that participants modify and amend based on additional information (Mead 1934). The task of assessing the knowledge held in common by members of a community of communicators, be they branch managers in a chain of department stores, or clothing designers and sewing production managers in a textile manufacturer, is complex and involves a variety of knowledge structures and judgmental processes.

2.1 Heuristics for determining common knowledge in communications

Many heuristics have been proposed to provide a basis for determining common knowledge between communicating individuals - all of which assume the ongoing participation of both communicators.

2.1.1 Linguistic co-presence heuristic

The linguistic co-presence heuristic, proposed by Clark and Marshall (1981) suggests that the determination of common knowledge be based on a simple temporal relationship. Anything said at time T can be assumed to be known at time T+1. This theory, in reference to face-to-face communications, assumes total recall and perfect associative skills in human memory. While those assumptions may even be unreasonable in a human context, supporting electronic communications on the basis of the linguistic co-presence heuristic, deals with only part of the problem. The validity of this theory in human communications is based in part on a continuous yet limited time period – i.e. the course of a telephone conversation. It is not necessarily valid in different-time different-place communications such as email.

2.1.2 Explicit exclusion and implicit inclusion

Steedman and Johnson-Laird (1980) have proposed that "the speaker assumes that the hearer knows everything that the speaker knows about the world and about the conversation, unless there is some evidence to the contrary". Questionable even in the context of face-to-face communications (to which the theory refers), this approach quickly loses ground when applied to email communications.

2.1.3 Availability Heuristic

The availability heuristic is a form of ego-centric greedy algorithm in which on assumes that the most readily available interpretation will also be available to others. Using the availability heuristic to assess what others know results in an overestimation of the likelihood that a perspective or interpretation be shared by others. The ready availability of one's own perspective results in a false consensus effect in which subjects assume that others are more similar to themselves than is actually the case (Ross et al. 1977).

Each of the above heuristics assumes the luxury (limitation?) of maintaining an association between the knowledge, and the people and situation in question. But communication in a modern organization of necessity often disassociates the communicating parties, resulting in difficulties far beyond those of establishing common knowledge.

2.2 Why is communication difficult?

Communication does not come easy because people tend to simplify and adopt only one perspective of reality, hold on to their own views, refuse opposite views, and tend to converge on a solution prematurely (Janis, 1989). Like any communication that is not face to face, computer supported communication suffers from lack of verbal and nonverbal feedback, limitations of written language, limitations on form and other limitations of the particular technology used.

Habermas (1981) defined four threats to validity in the communicative act: comprehensibility, truth, trustworthiness, and appropriateness. The lack of each of these may cause breakdowns in communication yet each can be mitigated by applying organizational memories to the communicative process. Habermas claims that a communicative act assumes four conditions to be valid:

1) it is comprehensible so that the receiver can understand the sender,
2) it is true so that the receiver can share the sender's knowledge,
3) intentions are expressed truthfully so that the receiver can trust the sender, and
4) the communication is appropriate within some normative context so that the receiver can agree with the sender within his or her value system.

As presented in Table 1, each threat to valid communications can be diffused to varying degrees through the use of organizational memories. Comprehensibility problems may be supported by translations, explanations and structure. Truth or accuracy problems can be supported by more details or explanations. Problems of trust need to be addressed by explaining intentions and the context of actions. Problems of appropriateness need to be addressed by discussing norms and shared values.

Table 1: Diffusing threats to valid communications

Threat to Validity in Communications	**Role of OM in Diffusing the Threat**	**Necessary Component of Organizational Memory**
Comprehensibility	Provide supporting and background materials in context	Primary OM content
Truth	Indicate consensus and similar interpretations across the organization	Shared Semantics indications
Trustworthiness	Provide supporting and background materials in context of sender and recipient	User-specific meta-knowledge
Appropriateness	Provide supporting and background materials in context	User-specific meta-knowledge and shared semantics indications.

There have been efforts to address the interpretation of email messages through highly structured and formalized email mechanisms (see, for example, Kimbrough and Moore 1997, and Kimbrough and Thornburg 1989). However these attempts involve replacing English with some theoretically sound formal language - achieving semantic accessibility at the expense of semantic richness - and are thus not relevant to this discussion.

3 Accessing the Organizational Memory Through User-centric Meta-Knowledge

3.1 The need to combine formal and informal knowledge

Electronic mail, like any other free-text documents, represents informal knowledge, yet it does include some useable formal knowledge, namely the identification of the sender, the identification of the recipient, and a timeframe reference. Our goal at this stage is not to treat the email message as part of the organizational memory, but rather use it as the informal launching point for entry into the organizational memory.

3.2 Formal knowledge

The identification of the sender and recipient of an email message is of paramount importance. Knowing this allows us to access a wealth of user-specific meta-knowledge that can be used in focusing access to the organizational memory.

3.2.1 Meta Knowledge

The meta-knowledge used by HyperMail consists of two main components - user profile information and shared semantics information. Both of these reside in a highly-structured relational database. There are clearly other mechanisms and methods that can be used to handle the meta-knowledge (higher order logics come to mind), however the relational database mechanisms provide both sufficient expressiveness and acceptable performance for the queries necessary to support our particular use of the Organizational Memory. The (formal) meta-knowledge serves as the link between the (informal) email communications and the (semiformal) HTML-based organizational knowledge base.

3.2.2 Shared semantics

Storing and maintaining information regarding the shared semantics of a given concept is a fundamental requirement of any OM system. Our implementation of shared semantics provides a mechanism by which a member of the organization, upon viewing a knowledge item relevant to a given concept, can either ascribe to or disassociate himself from the association presented by the system. By ascribing to a given knowledge association, the user is indicating that he shares the semantic representation of that item with whomever else has ascribed to that representation. Once a semantics has been ascribed to by a user, that semantics will receive a significantly higher ranking by the system when the same term is used by this person in the future. Since ascribing to a given semantics requires an explicit act on the part of the user, it is the strongest possible indication of both comprehensibility and appropriateness as defined above. The data definition for storing and accessing shared semantics information is a straightforward relation as shown in Table 2. If the user finds that there is no suitable link to the OM (or no link at all), they can define a link to some existing OM entry, or make a new entry into the OM.

Shared Semantics Table Definition joins associates a concept (ConceptID) with an entry in the OM (MemoryID) and an ascribing user (PersonID). The sample data shown indicates that users p7 and p12 share the same representation of concept c3 but differ in their expected use of concept c18.

Table 2: Shared Semantics

ConceptID	MemoryID	PersonID
C3	M344	P7
C3	M344	P12
C18	M186	P7
C18	M13	P12
C18	M13	P8

Other tables required include:

Concepts

ConceptID	ConceptName	ConceptDescription

Memory-URL

MemoryID	MemoryURL

The concept table and memory-url table are normalized apart to allow for multiple concepts to share the same memory and have a single concept associated with multiple memories (a many-to-many relationship). Note that in the shared semantics table PersonID is not a required field.

3.2.3 User profiling

The use of user profiles for relevance ranking has been the subject of much effort in the Information Retrieval community. Our approach to user profiling is architecturally similar to Abecker et al's (1997) use of knowledge description attributes. But rather than following their focus on describing the knowledge (knowledge-centric), our investment in meta-knowledge is in describing the people involved in communication and knowledge creation (user-centric). We believe that this approach will be able to more effectively implement the notion of "situatedness" as espoused by Sierhuis and Clancey (1997). Table 3 presents a representative piece of the database definition of the user profile information being used.

Table 3: People-profile (unnormalized)

PersonID	DepartmentID	RoleID	CurrentProject	SupervisorID
P7	MKT	ProjLead	SupreFlange	P3
P8	FIN	DeptHead	MaxiWidget	P3
P9	FIN	Bookkeeper	SupreFlange	P8
P10	HR	DeptHead	MaxiWidget	P3
P11	MKT	AcctMgr	SupreFlange	P7
P12	MKT	AcctMgr	MaxiWidget	P7

Additional tables keep track of previous projects, educational backgrounds, and similar user-centric information that can be used to evaluate and match the profiles of the communicating parties.

3.3 Informal knowledge

The corporate knowledge bases being used by HyperMail consist of both semiformal and informal knowledge. The informal knowledge exists in the form of Word documents and files from other computing applications (such as spreadsheets), text documents, and graphical images. Semiformal knowledge exists in the form of tagged HTML documents and historical email messages (whose semiformal aspect was described above). These documents are indexed and searched using an industry-standard mechanism (Verity within the ColdFusion environment (Allair 1998)).

4 Hypermail architecture

4.1 The HyperMail Architecture

Figures 2 and 3 present an overview of the HyperMail architecture, and a sample session

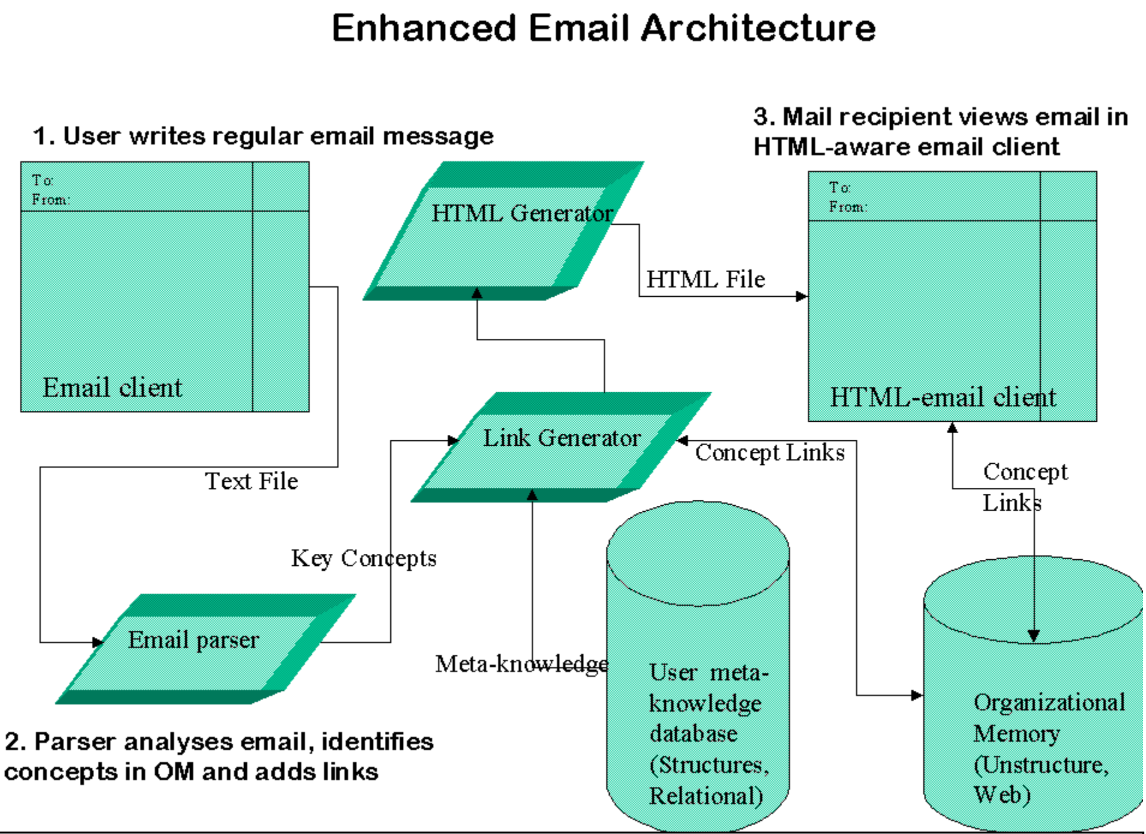

Figure 2 Enhance Email Architecture

respectively. The main software components of the system, aside from the Organizational Memory itself, are: an email client; a parser that analyses the email text; a relational representation of meta-knowledge; an indexing and search engine; and an

HTML generator that recomposes the email message with embedded links into the OM. The recipient of an email message uses a standard Web browser to view and interact with the email message.

There are three types of actors involved in any use of HyperMail: (1) the email author; (2) the email recipient (which may actually be a set of recipients); and (3) the contributor of any portion of the Organizational Memory referred to by the enhanced email. We refer to these three respectively as: Author, Recipient, and Contributor.

Each type of actor encounters different functionality and a different interface when interacting with HyperMail. The following scenario describes a typical use of HyperMail illustrating the roles of Author and Recipient.

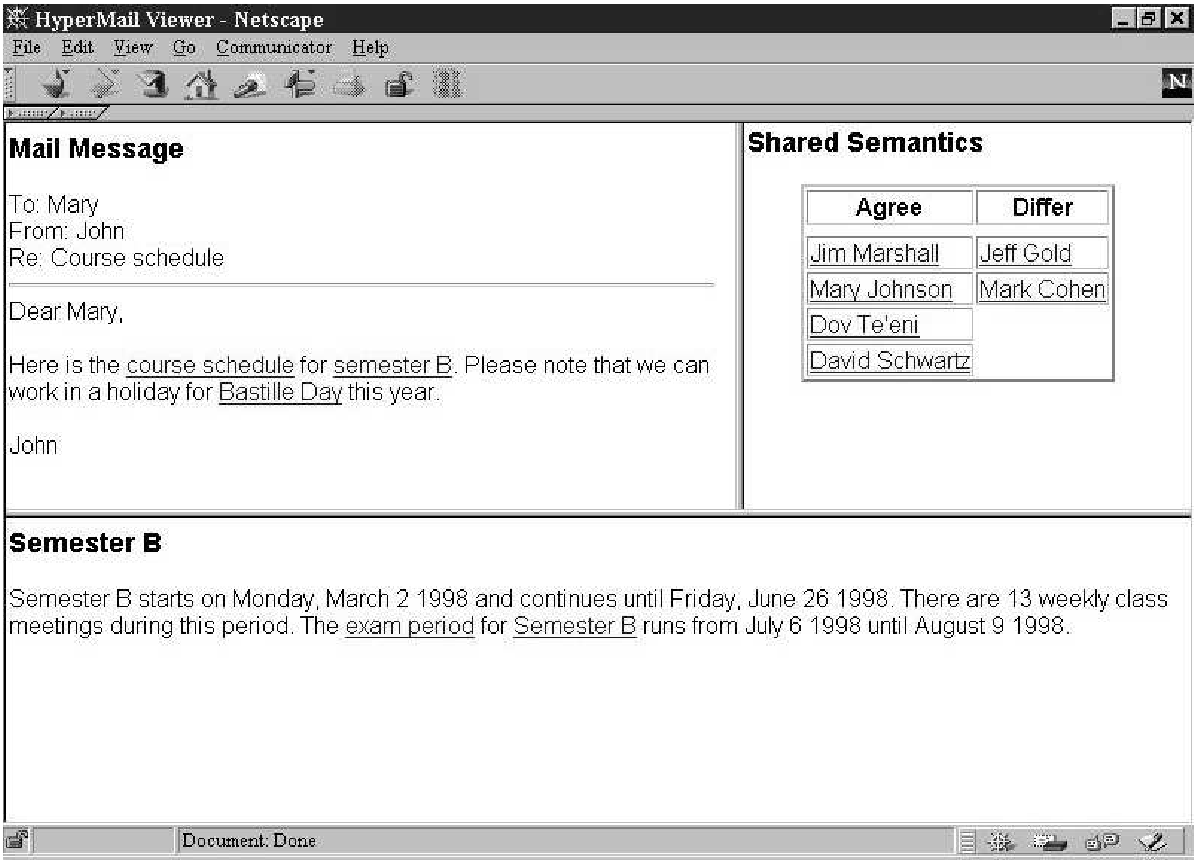

Figure 3: HyperMail Viewer

4.1.1 Author Scenario

- Using a regular email client editor, John wants to send email to Mary.
- When John presses SEND, a dialog appears asking him if he wants to "Enhance" his email.
- The dialog presents three choices: Enhance and Send; Enhance and Preview; Just Send It.

- The process of enhancing the email parses the email text to identify any concepts located in the Organizational Memory. The selection and ranking of the identified concepts is based on a correlation between the user-specific meta-knowledge about the sender, and similar knowledge about the recipient. The identified text is augmented with a link to the appropriate spot in the OM. An HTML version of the email message is created wherein the OM entries are presented as links.

4.1.2 Recipient Scenario

- Mary receives the email as an HTML file, and views it in a Web browser. Every key concept identified by HyperMail appears as a link in the email text. When Mary encounters a term in John's email that requires clarification, such as *semester B*, she clicks on the link and views the appropriate page(s) in the OM. Mary can simply read the email and ignore the links.
- The process of resolving links in the email does not simply bring up a static concept page from the Organizational Memory, but rather an interface that combines the presentation of the email message, a window into the OM, and a window showing shared semantic information. Figure 3 shows the recipient interface.
- In addition to viewing concept information related to the email being read, Mary can choose to ascribe to a given meaning, disassociate herself from that explanation, or view the representations of other participants who do not ascribe to the given meaning or add a new entry to the Organizational Memory to represent her understanding of a concept.

HyperMail is a server-based email system that uses a web browser as its primary interface. Mail authoring, mail viewing, and knowledge base management are all handled through the same browser interface.

5 Future Work - Field studies

The HyperMail system is being tested in two "low-tech" environments. The initial, albeit anecdotal, evidence from our field studies indicate that for "low tech" organizations there is neither an existing digital corpus of information, nor are there the necessary resources and expertise to provide a knowledge analyst role. This means that we expect a considerable part of the OM to evolve through use with minimal upfront knowledge engineering. The first site, S, is a national chain of department stores in which store managers use email to communicate with each other and with the head office to discuss issues related to purchasing, policy, specials, and general managerial support. The second site, D, is a multinational textile manufacturer. In this environment, HyperMail is being applied to communication between factories located in two different countries. Managers communicate on a variety of topics including financial reporting, production management and technical support for production.

Addressing email communications is really only a first step. Other elements of electronic communication, including email attachments of documents, spreadsheets etc. are all valid candidates for the type of analysis and augmentation we are attempting with HyperMail. There are many other forms of business and technical communications to which these same techniques can be applied and ample room for future research.

6 Conclusions

In this paper we have intentionally ignored the task of creating the organizational memory. Likewise we have not dealt with the design or efficiency of the information retrieval algorithms that are necessary to search the OM in order for a system such as HyperMail to be effective, or the parsing algorithms which must include stemming and synonym mechanisms. Our focus has been on the nature of communications, the threats to valid communications, and how Organizational Memories can be integrated with email through the use people-centric meta-knowledge thereby addressing these threats.

We agree with the direction taken by earlier work of Abecker et al. (1997) with respect to the importance of the object-meta relationship and the use of meta-knowledge to manage (or rather to complete) an OM. However, we suggest that the focus of the meta-knowledge should be on the roles, perspectives, and characteristics of the people in an organization rather than on knowledge description. This, we have argued, will effectively ensure that knowledge will not be disassociated from the people and the situation and is particularly important in applying OM to email communications.

A presentation of the HyperMail architecture and sample application was used to illustrate how formal meta-knowledge is used to re-associate informal email communications to an Organizational Memory.

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