1-1-1998

Computer Supported Cooperative Work: An Annotated Bibliography

Kathy J. Merck

WPI-CS-TR-98-1 January 1998

Computer Supported Cooperative Work: An Annotated Bibliography

by

Kathy J. Merck

Computer Science Technical Report Series

WORCESTER POLYTECHNIC INSTITUTE

Computer Science Department
100 Institute Road, Worcester, Massachusetts 01609-2280

INTRODUCTION

Computer supported cooperative work (CSCW) research is quite broad in its scope, encompassing work in many different disciplines and on many different topics. Researchers in the fields of computer science (including systems developers, software engineers, and those studying human computer interaction), social science, and management contribute to the field, with contributions ranging from development of CSCW systems (often termed "groupware") to analysis of user interaction with such systems, and of the effects of these technological systems on user-user communication ("computer mediated communication") and coordination of this communication, on group dynamics, and on organizations and organizational change. In each of these areas, there is both empirical analysis of actual groupware systems and their effects (as studied in practice in the field and/or in testing in the laboratory) and theoretical investigation.

Among these varied subareas of exploration, there are many questions; many have been explored at least to some extent, some have not been researched at all, and few have been answered definitively. In the computer mediated communication sphere, much work has been done analyzing the differences in the content of communication via different modes, but there is not clear agreement on the findings. For instance, many early studies of computer mediated communication seem to clearly differentiate the media richness and/or social cues available in face-to-face versus computer mediated communication (particularly electronic mail systems), yet several more recent studies counteract these findings and new theories provide new explanations for these results. Most of this CMC research has focused on the medium of electronic mail; less has been done to study other groupware products in this area.

In the study of user-user coordination of computer based communication, much attention is beginning to be paid to the coordination mechanisms which are taken for granted in face-to-face workplace situations but may not be automatically paralleled in computer supported environments. Awareness of others and their engagement in and transitions between various levels of task work may be necessary for smooth work coordination between individuals. Studies on how groupware tools can provide for this "workspace awareness" and ways that tools can provide for other aids to work coordination (such as the need, in some applications, for the presence of shared physical materials to effectively communicate ideas and descriptions) are gaining attention; this research is still in the early stages, with many specific systems and prototypes being developed in an attempt to both determine and meet these needs. Other researchers argue that imitating physically proximate communication patterns should not be the goal of groupware design, but that, rather, we must discover and build on those aspects of the technological media which may meet certain communication needs not currently met by face-to-face venues.

Group study has mostly focused on the use of group decision support systems (GDSSs) and electronic tools for meeting facilitation, analyzing both specific groupware tools for these purposes and the relative performance of technology-supported groups and more traditional face-to-face groups in terms of quality of decisions reached, satisfaction of participants, amount of time taken to reach consensus, and whether each of these different media better support different

types of task resolution. Less attention has been paid to the effects of technology on group development stages or how such measures as a group's cohesiveness, conflict resolution ability, sense of purpose, or effectiveness are related to the use of technology.

Progress has been made in the study of technology adaptation by organizations, in that common obstacles have been identified which tend to hinder the effective implementation of technological systems in organizations. Each organizational culture/technology mix is unique, however, and thus these somewhat general findings do not necessarily make all integrations and transitions smooth. Less work has been done on analyzing the larger issue of whether the often highly anticipated organizational change expected with technology introduction can or will occur and how to predict and/or control this change.

Because there is such a wide body of research based in a number of different disciplines and therefore published in quite diverse sources, it is a large, time consuming task to find and read a sufficient number of articles to gain an adequate introduction to the field. This annotated bibliography provides an alternative initial approach in that it identifies and summarizes much of the major research that has been done on computer supported cooperative work, allowing the reader to both gain an overview of some of the important work in the area and also to provide a mechanism for deciding which specific research might match one's own focus of interest and identifying jump-off points of articles, authors, and/or publications with which to begin one's own search. The sheer number of sources and breadth of the research in the area make any number of different organizations of such a bibliography possible; this annotated bibliography covers the areas of research outlined above with a focus on studies and theories of the *effects* of computer technology as it is used for communication, coordination, group support, and organizational change, rather than on specific groupware products or general underlying principles of human-human or human-computer interaction. Even with this focus on effects, the inclusion of all four areas of communication, coordination, group support and organizational change leaves the area of coverage quite broad. This serves the purpose of providing a fairly comprehensive overview of the research, but results in none of these areas being exhaustively covered; for each, major studies (which are often cited in other articles, for instance) have entries as well as many other representative publications in the area. Bibliographic entries for other work which has been found but not annotated have been listed in a separate section.

The citations are organized into several sections according to the areas of focus. Section 1 cites readings which are general in nature, providing definitions, categories, or overviews of the area. Sections 2 -5 contain entries that are more specific in their focus. Section 2, Communication, cites those readings which study "what" is communicated in computer mediated settings and how this communication may differ from other communication media such as face-to-face. This includes studies and theories on social context cues, media richness, status cues, and mutual knowledge. Section 3, Coordination, addresses issues of "how" communication interactions take place. This area includes readings on informal interactions, workspace awareness, and the need for material tools in the communication process. Section 4, Group Process Support, includes readings on group development and group dynamics issues relative to technology. Finally, Section 5, Organizational Implications, cites sources which analyze factors in the success and failure of integrating computer communication technology into the workplace and discuss the types of change that are possible through such an integration. Within sections, entries are arranged alphabetically by author. There are two types of entries, those that describe field or

laboratory study and those that present a theoretical discussion. For those of the first type, there are three components to the entry: 1) purpose; 2) description of the study, including size, duration, type (experimental laboratory study, quasi-experimental laboratory study, experimental field study, quasi-experimental field study, correlational field study or case study), group history, data collection methods, design methodology, and technology used; and 3) summary of findings. For theoretical papers, only two of these components are included: 1) purpose and 2) summary.

Section 6 contains a full list of bibliographic entries for each of these citations with the section in which the citation appears noted for each. Section 7 contains a list of bibliographic entries of the collections in which the articles of Section 6 appear. Finally, Section 8 contains a list of bibliographic entries for a number of sources which were reviewed but not included as annotated entries, either because they were outside of the direct focus of this collection, because they described and reviewed specific groupware systems rather than the effects of these systems, or because their content was already addressed in some way by other included articles.

1. GENERAL

Bostram, R., R. Watson, and S.T. Kinney (eds.) (1992). *Computer Augmented Teamwork: A Guided Tour,* Van Nostrand Reinhold, New York.

Purpose:
to provide an introduction to computer augmented teamwork technologies through a survey of a number of research sites and their work

Summary:
Generally, technology can support group work in four ways: structuring group processes, supporting communication, providing enhanced information processing, or providing modeling capabilities. Research can be categorized along several different parameters, including communication versus task support, high time and place synchronization versus low time and place synchronization, and electronic participant input versus input by technology support person. Each chapter of the book is a survey of how these categories apply at a particular research site; each contains a description of the research infrastructure (history, status and future growth), technology the researchers have developed and/or acquired for use at the site, planned future development efforts and other insights or summary information about the research program at that site.

Ellis, C.A., S.J. Gibbs, and G.L. Rein (1991)."Groupware: Some Issues and Experiences," *Communications of the ACM,* 34(1):38-58. [also in Marca and Bock 1992]

Purpose:
to explore groupware, to provide a definition and goals description, a taxonomy of groupware systems, and examples of groupware, and to "delineate classes of design issues facing groupware developers." (p. 39)

Summary:
Groupware systems can be viewed through two taxonomies; one groups systems based on time and space (same time/same place, same time/different place, etc.), the other on their application level functionalities (message systems, multiuser editors, group decision support systems and electronic meeting rooms, computer conferencing, intelligent agents, and coordination systems). Real-time groupware, such as the GROVE text editing system, have many features that are different from face-to-face sessions: they can increase information, encourage parallel work within a group, make discussions more difficult, make group focus more difficult, cut down on social interaction, be confusing, unfocused and chaotic, have infrequent collisions, be efficient, help prevent information loss, lead to a tangible group process, and make learning a natural aspect of

tool use. Technical design issues that need to be addressed in groupware systems include group interface issues (WYSIWIS issues, group focus and distraction issues, issues related to group dynamics, issues related to screen space management, and issues related to group interface toolkits), group process issues (group protocols, group operations, organizational and social factors, exceptions and coordination, and integration of activity support), concurrency control "to resolve conflicts between participants' simultaneous operations," (p. 52), and other system implementation issues (communication protocols, access control, and notification).

Grudin, Jonathan (1994). "Computer Supported Cooperative Work: History and Focus," *Computer*, 27(5), 19-26.

Purpose:
to summarize the history of computer-supported cooperative work and highlight distinctions in approaches based on this historical context.

Summary:
A model is presented of research and software development contexts for computer supported cooperative work and groupware which relates target user level (organization, project, small group, or individual) and systems which support these groups with development contexts and types of research. Groupware encompasses those systems within the project and small group realms (based on networks and including group decision support systems, workflow tools, and computer mediated communication tools) and has origins in both organizational and individual systems and research. Computer supported cooperative work research spans all of these user levels in various forms. The author compares CSCW focus in the US and Japan (where research tends to be more focused on small group applications) and Europe (where research tends to stress organizational and large project issues), describes the difficulty of defining groupware's scope, and presents a 3x3 matrix typology of groupware based on time and space categorizations (along each of the two dimensions the options are: same, different but predictable, and different and unpredictable). Finally he discusses the history of group support systems as it relates to the concepts considered above.

Holmes, Michael E. (1995). "Don't Blink Or You'll Miss It: Issues in Electronic Mail Research," *Communication Yearbook,* 18: 454-463.

Purpose:
to suggest an alternate grouping of email research based on underlying concepts of email rather than the more traditional division which is based on the outcomes of email use.

Summary:
In reaction to the Garton and Wellman (1995) summary of research on electronic mail, the author instead suggests that email can be viewed as a tool for accomplishing tasks, an object with social

meaning, a message delivery system, and a genre of written communication. For each of these, the author suggests where current research areas might fit in, as well as presenting future directions for research in each of the areas.

Santoro, G.M. (1995). "What is Computer Mediated Communication?" in *Computer Mediated Communication and the Online Classroom. Vol 1: Overview and Perspectives,* Z.L. Berge and M.P. Collins (eds.), Hampton, Cresskill, NJ, pp. 11-28.

Purpose:
to provide a categorization of computer mediated communication areas and briefly describe each category and applications within it.

Summary:
Computer mediated communication, "the use of computer systems and networks for the transfer, storage, and retrieval of information among humans," (p. 11) can be divided into three categories based on the function of the role of the computer in mediating human to human communication. These three areas are: 1) computer based conferencing "involves direct human-human communication, with the computer acting simply as a transaction router, or providing simple storage and retrieval functions. ... This category includes such functions as electronic mail, interactive messaging, and group conference support systems," (p. 14) and includes applications such as email exploder systems (listserv), bulletin board systems (usenet) and conference management systems; 2) informatics, where "the computer has a more active role as the repository or maintainer of organized information, which originates with human contributors and is utilized by human retrievers ... Including online public access catalogs (OPACs), interactive remote databases, and program/data archive sites." (p. 15); and 3) computer assisted instruction, with "the computer structuring and managing of both the presentation of information and the possible choices available to human user. ... This is the realm of computers as teachers or guides." (p. 15)

Seibold, D.R., M.A. Heller, and N.S. Contractor (1994). "Group Decision Support Systems (GDSS): Review, Taxonomy, and Research Agenda," in *New Approaches to Organizational Communication,* B. Kovacic (ed.), SUNY Press, Albany, NY, pp. 143-168.

Purpose:
to "review recent research on GDSSs with primary attention to major reviews in the area, ... To propose a taxonomy of contextual contingencies for interpreting and anticipating GDSS effects ..., [and to discuss] "new perspectives and promising directions for the future of GDSS research." (p. 145)

Summary:
Different reviews of GDSS literature have based their categorizations of studies along different lines: “some reviews organize the GDSS effects literature in terms of technological sophistication, or capabilities of the GDSS, and the level of decision-making support that the system provides. ... Other reviews have assayed studies in terms of physical arrangements or attribute of GDSS systems such as whether GDSS users are dispersed or face-to-face; or whether communication support is synchronous or asynchronous. ... Third, some reviewers have argued that experimental design manipulations and operational definitions of process and outcome variables need to be mapped more precisely. ... Finally, others have attempted to illustrate task differences in terms of the complexity, characteristics, completion time, and type of task existing between studies ... As well as how different systems support environments appropriately ‘fit’ with certain tasks.” (p. 146) Using any one of these categorizations is limiting in terms of power to accurately describe GDSS use; instead multiple interacting factors should be combined. Such a combination may also be helpful in explaining the inconsistencies between study findings when only looked at one-dimensionally, as it would allow for the fact that a single factor may not always give consistent results across all groups (since it may in fact be found in different combinations with other variables in different groups or contexts). “Effects should be viewed in terms of a combination of contextual contingencies.” (p. 150) A framework for representing these contingencies identifies three distinct sets of global level characteristics of GDSS within which study findings may vary. The first, system characteristics, refers to “those technical attributes associated with a particular GDSS and the character of support they provide.” (p. 151) These characteristics include the system’s physical configuration, adaptability or appropriateness of support, level of user friendliness, and who drives the system. The second set of characteristics, use characteristics, “can be defined as conditions, manipulations, and constraints associated with the use of a particular GDSS in a particular setting for a particular task.” (p. 155), and include experimental manipulations and designs, task differences, time constraints, channel selection, and training. Lastly, user characteristics are “the various attributes that individual members or groups bring to GDSS meetings that have implications for how the GDSS might be used. These include sample differences, group size, group structure, history of interacting together, training, attitude/degree of respect toward use of new technology, level of computer expertise, and past experience adapting to new technologies. Fitting in with an emergent perspective, the authors argue that combinations of these factors are key; “perhaps the most significant implication of this essay is to reconsider the assumption surrounding previous work: that uniform effects should obtain within and across studies.” (p. 160)

2. COMMUNICATION

Carlson, John R. and Robert W. Zmud (1994). "Channel Expansion Theory: A Dynamic View of Media and Information Richness Perceptions," *Academy of Management Best Papers Proceedings 1994.*

Purpose:
to present "a reformulated model which attempts to explain the inconsistencies in current media richness theory research" (p. 280) which describes the effects of "experience and familiarity with the medium, experience and knowledge concerning the message topic, as well as experience with communication 'co-participants'." (p. 280)

Summary:
In addition to objective characteristics of media as described by media richness theory ("nominal richness") and subjective characteristics as described by social influence models of technology use ("communication richness"), the model presented also includes three dynamic "experimental constructs" (p. 281) which affect the relationship between these two and thereby affect perceived media richness and information richness. "Participants develop histories of communication, with each other, with the channel-in-use, and with the messaging topic. Through this history, participants develop a level of knowledge concerning their co-participants, as well as a level of expertise with the channel-in-use. In addition, through previous communication events, individuals have acquired organization and task-specific knowledge upon which they will draw in order to facilitate both the encoding and decoding of future messages. Each of these factors is seen to moderate the relationship between nominal richness and communication richness." (p. 282) "As communication participants overcome the experiential limitations imposed by the moderating variables, the communication richness for the channel-in-use will increase, and so too will the corresponding perceptions concerning media and information richness. That is, with usage, participants will view a given channel (e.g., email) as possessing increasing media richness, and will view communication events conducted with the medium to possess increasing average levels of information richness. This is the channel expansion effect." (p. 283) "Channel expansion theory describes the process through which individuals overcome the limiting effects of the moderating variables, enabling messages to be encoded in an effective manner specific to the context. This encoding, … in effect broadens the channel's bandwidth by enriching the message in a way that conforms to the technical limitations of the channel." (p. 284)

Hiltz, Starr Roxanne and Barry Wellman (1997). "Asynchronous Learning Networks as a Virtual Classroom," *Communications of the ACM*, 40(9): 44-49.

Purpose:
to compare traditional and virtual classroom experiences in terms of student learning, satisfaction, and development of social relationships.

Description:
-*size:* results of several studies are summarized, most recent study is described: 692 students used virtual classroom setting, 163 in comparison sections
-*duration:* 1 course (semester?)
-*type:* correlational field study
-*group history:* not reported
-*data collection methods:* questionnaires (pre and post course), observation of online activities, interviews, comparison of grades, faculty reports
-*design methodology:* "For some courses, there were 'matched' sections offered by the same instructor in a traditional classroom and through the Virtual Classroom (as the sole means of delivery or combined with a reduced number of face-to-face meetings). For other courses, there was no 'match', and the comparison was subjectively made by the students and instructors to previous, traditional courses. A second project … was designed to develop, offer, and assess the effectiveness of degree programs in information systems and computer science delivered via the Virtual Classroom plus videotaped lectures" (p. 47)
-*technology:* "The Virtual Classroom is NJIT's (New Jersey Institute of Technology) trademarked name for versions of its electronic information exchange system with special software structures designed to support collaborative learning, including those meant to force active participation, and to allocate unique assignment topics, and exam and gradebook facilities." (p. 46)

Summary of Findings:
It was found that students in the virtual classroom experience had at least as much mastery of course material as students in the traditional classroom, that virtual classroom students reported higher subjective satisfaction about access to professors and about the overall quality of the educational experience. Students in the virtual classroom also felt that there was a component of group as well as individual learning in the experience, and felt that this was superior to a purely individual focus. Students expressed that they were more motivated by this group openness in work, because they knew peers would be reading their work, they sensed that they needed to keep up with both the instructor and their classmates, and the virtual classroom provided them convenient daily access. Difficulties were found in the virtual classroom in establishing close personal relationships, dealing with information overload, countering the fact that it was easier to "stop attending" class when other pressures arose, and dealing with a sense of normlessness in the group, where there was a perceived lack of conformity to shared guidelines for behavior. The authors propose that some of these negative behaviors will decrease with long-term communities rather than a one-time experiment as is the case here.

Hindus, Debby, Mark S. Ackerman, Scott Mainwaring, and Brian Starr (1996). "Thunderwire: A Field Study of an Audio-Only Media Space," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 238-247.

Purpose:
to study the "potential of using only audio in a media space" and "whether participants would have a sense of telepresence or shared social presence," (p. 238)

Description:
-*size:* 9 people
-*duration:* over 2 months
-*type:* correlational field study
-*group history:* cohesive team before system introduced (including some personality tensions), members' work was independent but closely parallel
-*data collection methods:* interviews, transcripts of use, usage logs, direct observation
-*design methodology:* N/A
-*technology:* the Thunderwire system provides high quality audio, desktop headphone, microphone, and switch to connect/disconnect. The system "permitted any number of group members to be simultaneously connected, and anything said at any time by any member was heard by all." (p. 239)

Summary of Findings:
"The data overall ... Indicate that the study participants had very rich interactions, especially sociable interactions. Particularly notable is the degree to which people were able to fluidly socialize and interact through Thunderwire, unlike with low-quality audio and telephone systems." (p. 243). Not many work related task exchanges occurred. The group developed norms for use around several issues, including dealing with noise, knowing who was currently present and limiting privacy violations; the authors suggest that the development of such norms implies a sense of shared space by the participants. In conclusion, "our field study of Thunderwire use suggests ... audio can be sufficient for a usable media space, … audio spaces can lead to social spaces, … [and] the nature of these social spaces is affected by audio's affordances." (p. 244)

King, Ruth C. (1991). "The Effects of Communication Technology on Group Collaboration," *Academy of Management Best Papers Proceedings 1991*.

Purpose:
to study group collaboration via computer based technology versus multiple "technologies" (including face-to-face, phone, and written communication) in terms of performance, satisfaction, and perceived usefulness.

Description:

-*size:* 192 MBA students in 96 randomly assigned groups of 2 members each
-*duration:* not reported
-*type:* experimental field study (multiple-task class research project)
-*group history:* not reported
-*data collection methods:* questionnaires, collected email messages, graded final papers
-*design methodology:* groups were assigned to one of two communication conditions: "The first set of groups was strongly urged to conduct all the communications via computer-based communication technology (CBCT). … The second set of groups was told to use all the available communication technologies[face-to-face, telephone, written document and CBCT] to conduct the task." (p. 248)
-*technology:* email system

Summary of Findings:
The author found that the communication technology does not affect a group's overall performance; computer based communication technology groups had higher scores on quality of reasoning, lower on flow of transition. Members expressed group satisfaction in both types of groups, but multiple technology groups had higher satisfaction than computer based communication technology groups. Face-to-face communication was perceived as the most useful for collaboration by members of both types of group. Computer based communication technology was evaluated as more useful by groups where computer based communication technology was the predominant tool.

Krauss, Robert M. and Susan R. Fussell (1990). "Mutual Knowledge and Communicative Effectiveness," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 111-145.

Purpose:
to explore the development of mutual knowledge in communication and discuss implications of these findings for technology and cooperative work

Summary:
To communicate effectively, people must develop some shared understanding of what communication partners know and don't know in order to formulate what to say next. In addressing this mutual knowledge problem speakers come to conclusions about their partners' states of knowledge through listening to what they themselves have just said, making inferences about partners' knowledge from their category membership (being a part of a certain group implies certain knowledge), and by relying on direct and background feedback from partners. This mutual knowledge problem has implications for computer supported cooperative work. Certain areas of communication which have not been thought to be supported particularly well by electronic communication might have in common a strong need for shared understanding; research needs to be done to examine strategies which people currently use to establish common

ground in electronic communication as well as exploring how technology may actually help to form mutual knowledge.

Markus, M. Lynne (1994). "Electronic Mail as the Medium of Managerial Choice," *Organization Science,* 5(4):502-527.

Purpose:
to examine the accuracy of information richness theory's predictions about media choice by managers in a field study of actual managerial use of electronic mail.

Description:
-*size:* 504 managers in a risk management firm (60% of the total number of managers in the firm) surveyed, 29 interviewed, transcripts of all email messages for a day from several managers
-*duration:* N/A
-*type:* correlational field study
-*group history:* work relationships already exist
-*data collection methods:* surveys, archival data, interviews
-*design methodology:* N/A
-*technology:* email system

Summary of Findings:
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. Senior managers used email more than the theory predicts and for equivocal communication tasks, unlike theory predictions that it would be appropriate for unequivocal tasks but face-to-face or voice communication (richer media) would be appropriate for equivocal tasks which managers often face. These results cannot be explained by information richness theory; "rather, they suggest that the adoption, use and consequences 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." (p. 502) In the organization studied, email was regarded as the primary medium of internal work-related communication, while the phone was viewed as the primary medium for maintaining social relationships at work. These perceptions are consistent with actual media use patterns, whereas the perceptions of media richness as described above did not correspond to actual behavior.

McDaniel, Susan E., Gary M. Olson, and Joseph C. Magee (1996). "Identifying and Analyzing Multiple Threads in Computer-Mediated and Face-to-Face Conversations," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 39-47.

Purpose:
to examine computer mediated and face-to-face discussions and measure participation trends and number and flow of conversational threads.

Description:
-*size:* not reported: "small groups of scientists"
-*duration:* 2 year period
-*type:* correlational field study
-*group history:* same sample of scientists for both conditions, many had worked together previously as well
-*data collection methods:* transcripts of videotaped FtF conversations and online interactions
-*design methodology:* "The community of scientists we studied tends to gather data from ground based instruments located in high latitudes, often during coordinated experimental sessions called campaigns. … In the past [FtF condition], the scientists traveled to Greenland for the observations and data collection. On many occasions several scientists would go to Greenland at the same time so they could collaborate during this phase of their work. The Upper Atmospheric Research Collaboratory (UARC) project has made this kind of work possible over the Internet [CMC condition]." (p. 40)
-*technology:* "UARC makes both individual and collaborative data acquisition possible over the Internet, with the participants able to instruct the site crew in Greenland to change the observational parameters of the instruments. UARC allows participants to collaborate from several locations around the world. … viewing data and communication with one another in real time via the system." (p. 40)

Summary of Findings:
Overall the content and participation levels of computer mediated and face-to-face communication groups were similar, but the temporal flow and threading characteristics of the two types of conversation were very different. More specifically, the number of people participating in each thread, the maximum number of interleaved contributions, and the average number of words per thread were similar in both conditions. The temporal flow of conversation was different, with face-to-face more rapid fire, low latency, highly interrupted exchanges, and computer mediated communication slower paced with larger gaps and larger contributions. The number of concurrent threads was much higher in computer mediated communication than face-to-face communication, and there were a few cases of thread confusion in computer mediated communication (though not many) and none in face-to-face. Finally, while overall participation was higher in the computer mediated case, in both face-to-face and computer mediated communication, there were several dominant participants and others were secondary or marginal contributors. This counters some previous research which suggests that reduced social cues in computer mediated communication equalizes participation.

Olson, Judith S. and Stephanie Teasley (1996). "Groupware in the Wild: Lessons Learned from a Year of Virtual Collocation," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 419-427.

Purpose:
to evaluate "the planning, implementation, and use of a suite of groupware tools over the course of a year in a real group with remote members" (p. 419)

Description:
-*size:* 10 people in a design team at an automobile manufacturer with a twofold task: to design a specific part for future car and to create a knowledge-based software system to aid in design which could be used in the future. Some of the members of the design team were physically proximate and others were not.
-*duration:* 1 year
-*type:* case study
-*group history:* new as a group, not reported whether individuals had worked together in other contexts
-*data collection methods:* interviews
-*design methodology:* N/A
-*technology:* a number of technologies, supporting "real-time conversation, real-time object sharing, asynchronous conversation, asynchronous object sharing, transition between asynchronous and real-time work, and technologies and procedures to support the project management and coordination of the plans and subtasks of the group" (p. 422)

Summary of Findings:
After creating an activity flowchart to represent the workflow paths of communication between individuals, groups and tools, the authors annotated each step in the activity flow by type of interaction (tightly, moderately or loosely coupled). This categorization was based on how immediate a response is needed in this type of communication, as well as how much interaction is required for either clarification or persuasion. Higher need for immediacy and interaction implied more tightly coupled work. Existing technologies in use and additional recommended systems were analyzed in terms of how well the various interactions could be supported electronically and where remote coordination difficulties might emerge for both tightly and loosely coupled interactions. There were five general findings: "social responsibility and commitment appeared diminished or missing when people did not meet face-to-face, Notes [one of the products used within the suite to support moderately coupled work] fell into disuse for many subtle reasons, it is important to consider a suite of groupware tools to support all modes of work, our approach to analyzing the team's work and recommending groupware was generally successful with a few suggestions of enhancements, and when virtual collocation technologies involve barriers, the work changes to be more loosely coupled." (p. 425)

Rice, Ronald E., Robert E. Kraut, Colleen Cool, and Robert S. Fish (1994). "Individual, Structural and Social Influences on Use of a New Communication Medium," *Academy of Management Best Papers Proceedings 1994.*

Purpose:
to investigate media richness and critical mass influences and norm development in the use of a desktop video conferencing system.

Description:
-*size:* 160 employees (with a wide range of organizational roles) have system accounts, approximately 100 used the system
-*duration:* 42 bi-weekly periods
-*type:* correlational field study
-*group history:* not reported
-*data collection methods:* "(1) system-monitored Cruiser usage for each period; (2) system-monitored MTS usage for each period; (3) system-monitored email usage for most of these periods; (4) a baseline questionnaire administered primarily during periods 8 through 12 to those who were given Cruiser accounts… (5) organizational records; and (6) 63 hour-long personal interviews." (p. 286)
-*design methodology:* N/A
-*technology:* the Cruiser system, which connects users in two different sites using desktop computers and videocameras. Features include: "(1) a directory-based graphical user interface that let users place calls to each other by simply selecting another user's name, (2) a series of access and privacy controls that let users control the degree to which others could gain access to them, and (3) the ability to have conference calls with more than two parties at once." (p. 285) Also available to all users was the MTS system, similar to Cruiser; the two systems were separate and "so, for a particular call, people had to choose which application to use," (p. 285), and an email system.

Summary of Findings:
Some findings related task influence, media richness and social influence to levels of system usage. "It appears that early adoption is the only influence on near-term usage, and early adoption does not influence later usage. The media richness argument - that lower task analyzability should predict the use of a medium that supports real-time video and audio - gained no support. Working with different others had a slight negative effect, and info-oriented tasks had a significant negative effect, on later usage." (p. 286) "While early on in the adoption process, the tasks that people perform, and the numbers of other users in one's work unit, both influence participants' willingness to use the new medium, their influence wanes over time, replaced by a person's own use of the system in one (or an aggregated) time period as the best predictor of use in a later period." (p. 288) Critical mass also had effects on Cruiser usage; "the number of other members of a person's work group who use the video system at any one time is a moderately strong predictor of that person's use of the communication system at the next period. This phenomenon occurs, however, only early in the adoption process, and declines later on." (p. 287). "Over time, group norms develop and Cruiser becomes less risky to use. Consequently, … use by others in one's work unit comes to have no significant influence on one's later usage." (p. 288). Also, this

stabilization of group norms increased frequency of use, which made other group members aware of new uses of the system. "Over time, critical mass can reach a saturation point, where there are more potential online partners than a person wishes to, or feasibly can, interact with, creating problems of technical resources, interruptions, and trust." (p. 288)

Schmitz, J. and J. Fulk (1991). "Organizational Colleagues, Media Richness, and Electronic Mail: A Test of the Social Influence Model of Technology Use," *Communication Research,* 18(4):487-523.

Purpose:
to test the influence of co-workers and supervisor on media use and perceptions of usefulness and richness, to explore the effect of perceived media richness on email use and perceptions of usefulness, and to refine a model of these interrelationships based on the social influence model of technology use.

Description:
-*size:* 636 employees with email access (of 655 employees total)
-*duration:* N/A
-*type:* correlational field study
-*group history:* no project team orientation in the company (research center of a large petroleum company), well-established email system
-*data collection methods:* questionnaire, interviews
-*design methodology:* N/A
-*technology:* email

Summary of Findings:
"The study found: (a) perceived electronic mail richness (1) varied across individuals and (2) covaried with relational social influences and with media expertise factors; (b) perceived electronic mail richness predicted individuals' electronic mail assessments and usage; (c) social influences of colleagues had pervasive effects on others' media assessments. The study demonstrated that an explicit consideration of social influences aids understanding of how individuals perceive and use new information technology." (p. 487) More specific results of social influences indicate that frequency of email use by close co-workers and supervisor are positive predictors of an individual's frequency of email use, frequency of email use by close co-workers were positive predictors of an individual's assessment of email usefulness, frequency of email use by a supervisor was not a significant positive predictor of an individual's assessment of electronic mail usefulness, perceptions of email usefulness by close coworkers were not a significant positive predictor of individual assessment of email usefulness, perceptions of email usefulness by a supervisor was a positive predictor of an individual's usefulness perceptions, perceptions of email usefulness by close co-workers was a positive predictor of an individual's assessment of email richness, and perceptions of email usefulness by a supervisor was not a significant positive predictor of an individual's assessment of email richness.

Sproull, L. and S. Kiesler (1986). "Reducing Social Context Cues: Electronic Mail in Organizational Communication," *Management Science,* 32(11):1492-1512 [also in Greif collection: 683-712]

Purpose:
to investigate how perception of social context cues (geographic location of others, organizational position of others, and situational factors) affects information exchanges and how this relationship plays out in electronic mail versus other media

Description:
-*size:* 96 people in sample, drawn from 513 electronic mail system users, stratified on employment level and work unit
-*duration:* eight week period of data collection
-*type:* correlational field study
-*group history:* individual relationship history varied, and was one of the attributes measured for each message partner
-*data collection methods:* interviews, questionnaires, content coding of actual mail
-*design methodology:* N/A
-*technology:* email system

Summary of Findings:
There were relatively weak social context cues in the electronic mail system, electronic mail behavior is relatively self-absorbed (people focused more on themselves than on others in message salutations and closings, people overestimated their own contribution to electronic mail communications, people underestimated the number of group messages), electronic mail behavior is relatively undifferentiated by status (messages from superiors and managers looked no different from messages from subordinates and nonmanagers, people more preferred to use electronic mail systems to send messages to superiors rather than to subordinates), electronic mail behavior is relatively uninhibited and nonconforming (people behaved irresponsibly more often on electronic mail system than they did in face to face conversations, people preferred electronic mail for sending bad news, people used electronic mail for nonwork communication during the workday), and electronic mail provides new information, not just a faster way to receive old information (60% of messages contained new information). Several possible consequences for organizations of these findings are discussed. People's overestimation of their personal contribution may make them feel more committed to new decisions or policies, but it may be harder for people to reach a decision using electronic mail rather than face to face. Status equalization effects could give managers access to information they didn't get before or may make people unwilling to send bad news up the chain of command. Uninhibited behavior may promote more creativity and greater flow of ideas or may lead to information overload, and positive sociability and organizational attachment may occur.

Storck, J. and Sproull, L. (1995). "Through a Glass Darkly: What do People Learn in Videoconferences," *Human Communication Research,* 22(2):197-219.

Purpose:
to explore both first-order efficiency effects and second-order effects of interactive videoconferencing on the relationships between people and groups in organizations.

Description:
-*size:* 25 masters level students, divided into 7 project teams
-*duration:* 14 weeks
-*type:* quasi-experimental field study
-*group history:* varied across groups; acquaintanceship of individuals measured on questionnaire at beginning of study
-*data collection methods:* questionnaires, student project evaluations, grades, observations, interviews
-*design methodology:* some students were on campus, rest at 2 remote sites, course delivered via interactive video. Student groups "were expected to analyze manufacturing problems, develop solution proposals for them, present their proposals to the class, and critique other proposals." (p. 204)
-*technology:* interactive video technology, all three sites had identical system (PictureTel System 4000), with monitors, video cameras, and microphones.

Summary of Findings:
First order effects of performance indicate that "students at sites remote from the University-based professor learn as much and perform as well as students local to the University-based professor. " (p. 211). Second order effects of impressions of other students indicate that "peers who interact only via video do not come to know one another as well as peers who interact face to face. ... "People form more positive impressions of face-to-face colleagues than of video colleagues", they "use more kinds of information in forming impressions of local colleagues than of remote colleagues," and they "evaluated peers with high ...communication anxiety.. Lower when they observed them via video than when they observed them face-to-face." (p. 210) "People who interact only via video apparently use different information in forming impressions of their peers than do people who interact face-to-face. They apparently rely less on task competence information and more on communication competence information. Thus it seems that communicating via video may change the patterns of attention to information, with resulting changes in impression formation." (p. 211)

Sudweeks, Fay and Sheizaf Rafaeli (1995). "How Do You Get A Hundred Strangers to Agree: Computer Mediated Communication and Collaboration," in *Computer Networking and Scholarship in the 21st Century University,* T.M. Harrison and T.D. Stephen (eds.), SUNY Press. [ftp://ftp.arch.su.edu.au/pub/projectH/papers/sud-raf.strangers.txt]

Purpose:
Based on the experiences of ProjectH, a computer mediated collaboration of researchers, "the goal ... is twofold: 1) to focus on product: describe the promises and pitfalls of carrying out research on group computer mediated communication; and 2) to focus on process: provide an introspective examination of our own group computer mediated communication." (p. 1)

Description:
-*size:* over 100 researchers from a wide range of disciplines, 15 countries, and both university and commercial arenas
-*duration:* ongoing, begun in 1992
-*type:* case study
-*group history:* coordinators and participants have never met
-*data collection methods:* case study analysis
-*design methodology:* N/A
-*technology:* electronic discussion group supporting text-based computer mediated communication

Summary of Findings:
The researchers involved in the ProjectH study are creating a database of information about electronic discussion groups which can be used to study different social dynamics and communication issues of computer mediated communication. In addition to describing the goals of the study, the authors (coordinators of the group) analyzed their own electronic group processes and found that: there was uninhibited behavior which was beneficial in that it had an equalizing effect, "the perceived social presence of other members did not appear to have diminished with restricted bandwidth," [as compared to face to face] (p. 11) and brainstorming electronically was quite effective. They attribute the success of their group to the following factors: a common interest of members in computer mediated communication, effective structuring methods (time limits on discussions, committees), careful blend of democracy and restrained leadership ("extensive coordinating overhead is necessary to resolve conflict and foster cooperation" (p. 12)), and the ability of participants to adapt their levels of social awareness of others as appropriate (a balance of suppressing awareness to focus on work needs and raising awareness to fulfill social needs).

Turoff, Murray (1989). "Computer-Mediated Communication Requirements for Group Support (Excerpts)," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 407-417.

Purpose:
to describe goals of CMC systems and unique features offered by asynchronous electronic communication to support group processes.

Summary:
Many observations, goals and objectives for future CMC development and research are identified which address organizational, group and individual relationships to technological communication systems. In addition, specific attention is paid to the benefits of asynchronous communication provided by CMC. "The most misunderstood concept in CMC systems is the view that an asynchronous (or nonsimultaneous) communication process is a problem, because it is not the sequential process that people use in the face-to-face mode. The approach of 'How do we make CMC feel to the user like face-to-face processes?' is incorrect. The real issue is how do we use the 'opportunity of asynchronous communications' to create a group process that is actually better than face-to-face group communications?" (p. 409) Asynchronous communication is not just convenient; "the potential for real improvement in the group processes lies in the fact that individuals can deal with that part of the problem they can contribute to at a given time, regardless of where the other individuals are in the process." (p. 409) Also, the computer can support the integration of ideas from many separate individuals, each of whom has unique strengths and approaches. If individuals do not all share the same style, asynchronous communication frees them to solve problems in their own most comfortable way; "the resulting challenge for design is the communication structures and facilities to allow for synchronization of the group process, and the organization of the material for the benefit of the group." (p. 409) Individual styles can also be supported by toolbox approaches to groupware, where each individual can tailor tools to his/her approach to solving a problem. The author describes some specific systems and how they meet some of the above design goals.

Walther, J. (1996). "Computer-Mediated Communication: Impersonal, Interpersonal and Hyperpersonal Interaction," *Communication Research, 23(1):3-43.*

Purpose:
to "integrate theories and research findings pertaining to impersonal and interpersonal interactions in CMC, not by dismissing one in favor of the other but rather by specifying some conditions that favor each type of outcome... [And to offer] "a new perspective ... Regarding the heightened levels of intimacy, solidarity, and liking via CMC which have been observed and documented in several empirical and anecdotal accounts." (p. 4)

Summary:
"CMC participants in dyads and groups - even those who have never met before - use cues available to them to manage relational development in normal (or perhaps supernormal) fashion. The circumstances of their media may add some hitherto unexplored dimensions but not an enduring dampening of interpersonal affect. ... To foster normatively interpersonal interactions, it appears, CMC partners may be left with adequate access and time to develop. ... There are times, however, when it is desirable to foster impersonal interaction: to facilitate brainstorming, to encourage equal participation for democratization, or for criticism blind to status. In these circumstances, CMC's ability to bring together members' input across time and space alone will not be sufficient. However, sociotechnical circumstances may be contrived, including reduced periods for discussion, anonymous interaction, obviated floor sharing or turn-taking procedures, and ad hoc teams with no anticipation of future interaction, all of which seem to contribute to a stronger task focus and potentially more productive work." (p. 13) In addition, "CMC provides, in some cases, opportunities for selective self-presentation, idealization, and reciprocation. This renders hyperpersonal communication, forms of interaction that exceed what we may accomplish FtF in terms of our impression-generating and relational goals. ... At the level of the sender, CMC partners may select and express communication behaviors that are more stereotypically desirable in achieving their social goals and transmit messages free of the 'noise' that otherwise comes with unintended appearance or behavior features. At the other end, CMC receivers take in these stylized messages, construct idealized images of their partners and relationships, and, through reciprocation, confirm them. These processes may be further enhanced when the minimal-cue interaction is also asynchronous; freed from communicating in real time, users are released from the pressure to meet and the stress of including both task and social issues in limited time intervals typically allowed by FtF interaction." (p. 29)

Walther, J.B. (1995). "Relational Aspects of Computer-Mediated Communication: Experimental Observations over Time," *Organization Science*, 6(2):186-203.

Purpose:
to examine theoretical and methodological issues with social presence, social context cues, and media richness theories which have led to inconsistent results of computer mediated communication's effects on relational communication and to propose a new theory to explain past and present findings.

Description:
-*size:* 96 undergraduate students randomly assigned to 32 three member groups
-*duration:* 3 tasks over 5 weeks
-*type:* experimental field study
-*group history:* "no group members knew each other beforehand." (p. 193)
-*data collection methods:* videotapes, transcripts

-*design methodology:* groups were divided between computer mediated communication and face to face conditions to reach consensus on policy recommendations related to each of the three tasks
-*technology:* computer mediated groups used the COSY Conferencing System, which could be accessed from several campus terminal locations 24 hours a day or with a personal computer and modem,. COSY users can post, read messages sequentially, or re-read messages; users can also link comments to previous postings." (p. 194)

Summary of Findings:
In analyzing interactions for relational communication, intimacy, composure/relaxation, formality, dominance/inequality and task-social orientation are considered. Findings from the study show that face-to-face interaction is not more intimate and sociable than computer mediated communication over time, that computer mediated communication has more dominance than face to face in initial conversations but that this difference dissipated over time, that computer mediated groups were less formal and less task oriented over time, and that in terms of relationally positive communication, in some cases face to face and computer mediated groups converged over time, whereas in other cases computer mediated groups were more relationally positive. The author argues that these findings support the Social Information Processing Theory, where "the critical difference between face to face and computer mediated communication from this perspective is a question of rate, not capability." (p. 190); the theory predicts that though there may be initial differences between face to face and computer mediated relational communication, given time, these differences will converge. Implications of this study and theory anticipate that computer mediated communication "may be better suited to longitudinal interaction than short-term meetings, relationally speaking," (p. 199) and that computer mediated communication may function as the "electronic water cooler", allowing participants to combine work and play, a perhaps necessary but often neglected aspect of organizational life.

Walther, J.B., Jeffrey F. Anderson and David W. Park (1994). "Interpersonal Effects of Computer Mediated Interaction: A Meta-Analysis of Social and Anti-Social Communication," *Communication Research,* 21(4):460.

Purpose:
to review results of studies on the interpersonal qualities of computer mediated communication and attempt to explain contradictory findings.

Summary:
The authors argue, based on social information processing theory, that time limits imposed in many research studies interrupt computer mediated communication participants before enough messages occur for interpersonal effects to take place. In a meta-analysis of 21 articles with results about socioemotional tone and 14 articles with results on negative uninhibited communication (out of a pool of approximately 350 articles on computer mediated communication) they found that "limitation on message exchange moderates the effect of CMC

on socially-oriented communication so that a) there is a greater proportion of socially oriented communication in unrestricted (time-unlimited) than in restricted (time-limited) CMC interaction; [and] b) the difference between computer mediated communication and face to face interaction on socially oriented communication is greater in restricted (time-limited) than in unrestricted (time-unlimited) interaction." (p. 467) The hypotheses that "limitation on message exchange moderates the effect of CMC on antagonistic/negative uninhibited communication such that a) there is a smaller proportion of negative uninhibited communication in unrestricted (time-unlimited) CMC interaction and b) the difference between CMC and FtF interaction on negative uninhibited communication is greater in restricted (time-limited) than in unrestricted (time-unlimited) interaction" (p. 467) were not supported. The author concludes that since "this analysis found time differences between studies on general socially oriented communication but no differences on negative social dimensions, it is reasonable to interpret that it is the positive end of social computer mediated communication that changes over time." (p. 481)

Weedman, Judith (1991). "Task and non-task functions of a computer conference used in professional education: a measure of flexibility," *International Journal of Man-Machine Studies*, 34:303-318.

Purpose:
"In order to examine the ability of computer mediated conferences to provide variety in communication, data were gathered on task-related and non-task related uses of a computer-mediated conference in use at a research university." (p. 303)

Description:
-*size:* in 1987 registered participants: 117 students, 7 faculty, 2 staff, 18 working professionals; in 1989 172 participants: 142 students, 5 faculty, 3 staff, 22 professionals.
-*duration:* two samples, two years apart, each contained items from 9-12 months prior to sample date
-*type:* correlational field study
-*group history:* mixed. "Participants in the conference did not all know each other well outside the conference environment. Around half of the respondents to the survey indicated that they talked to practically none of the other participants frequently." (p. 318)
-*data collection methods:* transcripts of conference contents, surveys
-*design methodology:* N/A
-*technology:* student organized computer conference tool with no fixed agenda

Summary of Findings:
Despite previous study results and general perceptions that ability of computer mediated communication to convey social and personal content is moderate at best, this study shows more non-task communication than previous studies, with flexible switching between task and nontask messages. Content of messages indicates both discussion and group maintenance behaviors, variability in length of discussions, both task and nontask motivations for use, perceptions of the conference environment as not being analogous to other communication scenarios, support of

extended exchanges between individuals who may have had little contact otherwise, and uninhibited exchange, but not negative in nature. "The computer conference environment was found to be very supple, supporting a wide range of topics and interactions between individuals who differed in status and in the degree to which they know one another outside the conference." (p. 303)

3. COORDINATION

Bellotti, Victoria, and Sara Bly (1996). "Walking Away from the Desktop Computer: Distributed Collaboration and Mobility in a Product Design Team, *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 209-218.

Purpose:
"Our aims here are to show that mobility may be critical to many work settings that have been traditionally considered non-mobile and that its existence and purpose must be accommodated by CSCW design," (p. 209) by studying "a team of product designers in a consulting firm distributed over several buildings. We were interested in how they used technology and in how they collaborated with each other, support staff, and with people outside the team." (p. 210)

Description:
-*size:* 7 team members distributed between two sites
-*duration:* several months
-*type:* case study
-*group history:* this project team had been working for several months before the study began. Some team members worked on other projects simultaneously with this one. Not reported whether team members had had contact prior to this project
-*data collection methods:* meeting observation, interviews, observations of daily work activities (made transcripts, notes, videotapes, photos, audiotapes)
-*design methodology:* N/A
-*technology:* most communication through phones, faxes, email, file transfer

Summary of Findings:
The team had high levels of mobility, motivated both by the need to use shared physical resources for work tasks and by a desire for communication with coworkers. Benefits of this local mobility included "awareness of ongoing team and other activity as part and parcel of day-to-day work. This was achieved both passively and through concerted effort involving frequent informal communication. Awareness and informal communication not only support projects, but also increase personal experience and expertise in support of the consulting firm as a whole." (p. 214) While this mobility provided these important benefits to local coworkers, remotely located team members were at a disadvantage because the technology available to support remote collaboration was insufficient to support the kinds of communication achieved by local mobility. In addition, because all tools were desktop based, even when remote coworkers tried to communicate, their local counterparts were often not at their desks and so were unavailable. "Spontaneous interactions facilitate frequent exchanges of help and useful information, and that awareness of ongoing activity creates shared knowledge and provides a key context for the interactions that occur. These aspects of the work of our designers are supported by mobility and poorly supported by existing technology. The lack of these resources makes it difficult to collaborate

successfully over distance." (p. 216) The authors suggest that these findings have several implications for CSCW design; there needs to be work done to provide support for remote team members to participate in informal communication and to build the team awareness which occurs locally through mobility, and changes should be made to allow contact to occur away from the desk, so that remote collaborators will not be doubly punished in trying to communicate with coworkers.

Berlin, Lucy M. and Robin Jeffries (1992). "Consultants and Apprentices: Observations about Learning and Collaborative Problem Solving," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 130-137.

Purpose:
to use an empirical study of apprentice computer programmers and experts to "provide insights into the nature of this informal collaborative work practice" (p. 130) and to "expose issues to be addressed by technologies for supporting collaborative work." (p. 136)

Description:
-*size:* 3 apprentices and 3 experts
-*duration:* 4 months
-*type:* correlational field study
-*group history:* not reported
-*data collection methods:* tape recordings of face-to-face consulting sessions, interviews
-*design methodology:* N/A
-*technology:* email, access to programming project files by apprentices and experts

Summary of Findings:
"We have confirmed that computer-based tasks require knowing details about many tools and concepts, often details conceptually peripheral to the goals of the apprentices. We found consulting interactions to involve a complex negotiation of the content, with the apprentice in charge of the overall direction. The shared artifacts and cooperative problem-solving trigger much incidental learning, learning necessary for the apprentices to grow into experts. Thus, we believe that consulting interactions are crucial, not only in helping the learners past immediate obstacles, but in transmitting a variety of useful, hard-to-find information essential to proficiency." (p. 137) "We suggest that technology can help facilitate cooperative apprenticeship learning by helping apprentices switch among subproblems while they wait for a consultant, by facilitating communication about the experts' interruptability, by making consultations more productive, and by complementing the human consultants with other computer-based aids." (p. 131)

Conklin, E. Jeffrey (1992). "Capturing Organizational Memory," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 561-565.

Purpose:
to describe the concept of organizational memory and suggest requirements for a system to provide effective capture, recall and storage of organizational memory.

Summary:
Achieving organizational memory, "the record of an organization that is embodied in a set of documents and artifacts" (p. 561), has been elusive, as there are enormous amounts of data and documents but the organization and quality of this information has been lacking. What is needed is storage of the process as well as the content of the artifacts, that is, a record of "the assumptions, values, experiences, conversations, and decisions which lead to and constitute the context and background of the artifacts." (p. 563) For tools to capture the process data as well as the artifact data without requiring a heavy added documentation burden on users, systems must be able to capture this information as it is already occurring in the process of the organization. The authors suggest that three elements are necessary to support this efficient capture and recall: hypertext (for flexible display of complicated data), a rhetorical model (for providing a structure to conversations, to both improve the communication process and for more meaningful capture of conversations to the system), and groupware. Groupware makes it possible, as it is being used to support communication and collaboration, to "'tap into' the existing flow of process interactions between the members of the organization, and to crystallize this, ongoingly, into the key elements of the organizational memory. Groupware can provide the medium for organizational dialogues which, because they occur via the computer, create a computable record of semi-structured documents. The ability then exists to manipulate, distribute or share this information and intelligence throughout the organization or team, effectively and ongoingly creating a memory and learning tool." (p. 564) Finally, the organization must commit to a shift from an artifact-oriented to a process-oriented view to support the growth of organizational memory.

Fitzpatrick, Geraldine, Simon Kaplan, and Tim Mansfield (1996). "Physical Spaces, Virtual Places and Social Worlds: A study of Work in the Virtual," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 334-343.

Purpose:
to examine a group of system administrators in a computer science department whose work is "largely in a virtual space on a virtual object" (p. 334) and draw implications about how to build collaborative systems.

Description:
-*size:* 6 system administrators providing software support for a large computer science department
-*duration:* 3 months

-*type:* correlational field study
-*group history:* administrators had been working together before study
-*data collection methods:* naturalistic observation, formal and informal interviews, meeting attendance, subscription to mailing lists and newsgroups, access to hardcopy and online materials
-*design methodology:* N/A
-*technology:* UNIX environment

Summary of Findings:
Despite the physical separation and appearance of very individual-based work, because of the complexities of the system, much of their work is actually very interdependent. The system administrators have developed strategies to work together in a virtual domain rather than a physical one, though as it currently stood communication and coordination support were minimally provided by the virtual workspace. This often led to breakdowns, usually involving some lack of communication about actions or changes made by one system administrator which would affect others, lack of awareness of the work of others, or lack of understanding of the system in a more global perspective. "The way that group members were able to make sense of their complex virtual work environment suggests a new interpretation of spatial metaphors for the design of collaborative systems." (p. 334) They do their work in multiple social worlds (groups of people who share commitment to collective action) which shape their perspectives of the system and what they draw from it. "The spatial representations in the virtual reflect the logical and/or functional structure of the system, not physical proximity of geography." (p. 339) CSCW systems need to begin to provide more support for this kind of work given these virtual group structures, then, not just provide tools based on spatial metaphors which may not be appropriate for a group whose work and communication is not physically based such as in this study.

Gutwin, Carl and Saul Greenberg (1996). "Workspace Awareness for Groupware," *Proceedings of CHI96.*

Purpose:
to discuss issues that arise in providing workspace awareness in virtual workspaces and to provide a framework of elements that make up workspace awareness and mechanisms used to gather workspace awareness information

Summary:
Workspace awareness, "the collection of up-to-the-minute knowledge a person uses to capture another's interaction with the workspace" (p. 1) including "locations, activities, and intentions relative to the task" (p. 1) is important, as it helps the coordination of tasks and resources and assists in transitions between individual and shared activities. This awareness has been more difficult to capture in virtual workspaces than in physical settings because with groupware tools people may only see a fraction of the workspace, different people may see different parts, the interface may hide some things that are visible in the physical workspace (less richness of communication), and mechanisms (such as scrolling) that are used to model physical mechanisms (such as glancing) that maintain workspace awareness are comparatively slow and clumsy. Groupware designers must answer two questions in order to provide workspace awareness

support: What information should a groupware system capture about another's interaction with the workspace? And how should this information be presented to other participants? The authors present a framework of possible answers to these two design questions (elements include presence, location, activity level, actions, intentions, changes, and others, while mechanisms include direct communication, indirect productions, consequential communication, feedthrough, and environmental feedback), and suggest that having broken them down in such an identification, designers could create techniques and tools to provide each of these elements.

Hollan, Jim and Scott Stornetta (1992). "Beyond Being There," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA.

Purpose:
to question the current base assumption underlying telecommunications research that physically proximate communication is the absolute goal which truly successful technology must emulate and to present an alternative model.

Summary:
Most telecommunications research has focused on creating "a system that affords the same richness and variety of interaction that we have when we are physically proximate, even when we are physically distant" (p. 848) by working on establishing ever higher quality audio and video communication channels to remote locations. These attempts all aim at imitation of physical proximity; the authors argue that no matter how high quality, any imitation will always be at a disadvantage to the real thing, just because it is an imitation. Therefore, the goal of telecommunications research should be to discover tools that provide some quality that is actually not as well provided by physically proximate communication. If we frame the problem in terms of needs, media and mechanisms, "the goal then becomes identifying needs which are not ideally met in the medium of physical proximity, and evolving mechanisms which leverage the strengths of the new medium to meet those needs," (p. 848) Given that computer mediated communication offers asynchronous communication, anonymous communication, and automatic archiving and face to face communication does not have these features, we should explore needs that may be met by these mechanisms that aren't currently met by face to face communication. The authors suggest several new systems ideas which draw on these ideas: ephemeral interest groups, informal ways of meeting others, discussions based on anonymous exchange, and semisynchronous discussions.

Isaacs, Ellen A., John C. Tang, and Trevor Morris (1996). "Piazza: A Desktop Environment Supporting Impromptu and Planned Interactions," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 315-324.

Purpose:
"to explore ways of enabling ... unintended interactions [which often are critical to the

coordination, productivity and well-being of a group] for communities that are distributed across different locations." (p. 315)

Description:
-*size:* 12 people located in 4 different sites of a large computer development corporation
-*duration:* N/A
-*type:* correlational field study
-*group history:* not addressed, though implies that unintended interactions are between known individuals
-*data collection methods:* interviews
-*design methodology:* N/A
-*technology:* Piazza system, "enabling spontaneous interactions on the desktop" (p. 318)

Summary of Findings:
The authors found that informal interactions were an important means of communication: "people disseminated information using formal mechanisms, but they received information through informal means, people believe that channels they use to disseminate information are not very effective, information disseminators are wary of word of mouth, those receiving information felt they were getting an inappropriate amount of information, and not often the right information, [and] although effective 'networkers' were critical to information flow, they were not formally recognized." (p. 318) Previous systems to support unintended interactions have limitations; they "require people to rendezvous at a specified on-line place in the network to see others, lack enough context to help people enter interactions, do not enable a seamless transition from a sighting to an interaction, and involve a preset group of people." (p. 316) Based on these observations, the authors designed a system, Piazza, to address these issues, supporting and improving the effectiveness of word-of-mouth communication, supporting encounters with others working on similar tasks, and supporting easily initiated interactions, all integrated with any application on the desktop, to keep awareness open. "Our primary goal was to make it possible to have opportunistic and spontaneous interactions with other members of a large distributed community. Piazza attempts to do so by allowing people to see who else is 'nearby' (i.e. working on a similar task at about the same time) and then to naturally transition into an interaction through video, audio, text, or whatever medium is available. ... Another goal was to make it easier for members of a large community to distribute information in the way that most people like to receive it. ... The Project Rooms were designed to make it easy to disperse a message using relatively formal mechanisms (documents, web pages, email messages), while still providing a way to talk informally with people who are interested in the message." (p. 323)

Kraut, Robert E., Robert S. Fish, Robert W. Root, and Barbara L. Chalfonte (1990). "Informal Communication in Organizations: Form, Function and Technology," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA, 1993.

Purpose:

"to understand the communication processes underlying group work in order to improve the communication technologies that groups have available to them…. We are especially interested in communication tools to support distributed groups." (p. 288)

Description:
-*size:* 695 people total in the research and development lab, randomly captured conversations of 267 of these
-*duration:* N/A
-*type:* correlational field study
-*group history:* participants were coworkers who had worked together previous to the time of the study
-*data collection methods:* videotaped conversations, questionnaires
-*design methodology:* several substudies were done at the same research and development lab, including 1) videotaping certain locations and conversations that occurred there and 2) sampling potential sites of informal communication and asking participants to complete a questionnaire
-*technology:* N/A

Summary of Findings:
The results show "that informal communication is frequent in R & D organizations, that it aids organizational members in learning about one another and their work, that it supports both production work and the social relations that underlie work, and that it provides a critical mechanism that collaborators rely on to start joint work, maintain it, and drive it to conclusion. Proximity leads to increased frequency of communication in general, and of informal communication specifically. Proximate colleagues have more opportunity for intended, opportunistic, and spontaneous conversations. Increased informal communication between colleagues leads to greater familiarity as well as increased respect for colleagues and their work." (p. 306) When groups are not physically proximate, they may be able to use computer mediated communication to provide some of the characteristics which support informal communication. These include providing a concentration of suitable partners, co-presence, low personal costs, and a visual channel. There are several tradeoffs which must be resolved in supporting informal communication at a distance: "System designers must understand and be sensitive to the needs and concerns of system users. They must be alert to the subtleties of etiquette and the protocols that govern social interactions, be concerned with the possibility of unwanted intrusions or surveillance, and balance the need for casual access against the desire for control of one's personal space." (p. 313) Two systems, the VideoWindow System and Cruiser, are described to illustrate the potential of computer systems to support informal communication.

Kraut, Robert E., Carmen Egido and Jolene Galegher (1990). "Patterns of Contact and Communication in Scientific Research Collaboration," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 149-171.

Purpose:

to "describe the influence of physical proximity on the development of collaborative relationships between scientific researchers and on the execution of their work," (p. 149), and to discuss how communications technology could be designed to support collaborations given these factors.

Description:
-*size:* a)1 member of each of 90 research teams in social psychology, computer science and management science, b) 66 psychologists, c) 93 members of research and development organization
-*duration:* N/A
-*type:* correlational field study
-*group history:* N/A
-*data collection methods:* a) telephone interviews, b) survey, c) archival study
-*design methodology:* N/A
-*technology:* N/A

Summary of Findings:
Physical proximity has a number of effects on the collaborative process, including partner selection, planning of research tasks, and execution of work. Pairs of researchers whose offices were close to each other were more likely to collaborate, physical proximity provides informal contact and communication (high in both frequency and quality) which "makes it possible for potential collaborators to find each other and to manage their work efficiently." (p. 163) These findings have implications for technology to support collaborative work: "communication technologies that allow more free-form interaction in real-time and time-shifted modes to augment and even to substitute for physical proximity are likely to yield greater benefits. ... The aim should be to increase the frequency and quality and to decrease the cost of interactions among potential collaborators who are working across barriers of place and time." (p. 165) More specifically, the following types of tools should be developed: "(a) communication tools to facilitate both planned and unplanned real-time and delayed interactions among collaborators, (b) coordination and management tools to minimize the overhead inherent in multiperson work, and (c) task-oriented tools designed to facilitate the completion and integration of specific work products whether individually or jointly executed." (p. 165)

McDaniel, Susan (1996). "Providing Awareness Information to Support Transitions in Remote Computer-Mediated Collaboration," *Proceedings of CHI96.*

Purpose:
to discuss issues in determining what workspace awareness information is necessary and what medium is necessary to support the transmission of this information.

Summary:

There are several open questions about workspace awareness, including what comprises adequate information about the presence and activities of collaborators for transitioning between asynchronous and synchronous work situations and whether there are more lightweight and low cost forms than video to effectively transmit this information (such as text of graphics). Given that group collaboration may vary along many dimensions (including time, dependency, formality of interaction, group size, group roles, task and location) and that gathering of awareness information can be explicit or implicit, different amounts and types of information may be necessary to maintain workspace awareness in different situations; video may actually provide more information than is necessary in most situations. The author describes her plans to build a set of information displays which provide a subset of the workspace information available, and allow users to select which information they want to receive at given points. By measuring the use of these displays, the selections users make, the level of collaboration before and after introduction of the tool, and the users' satisfaction with the information provided, the author hopes to be able to more accurately determine what kinds of information are sufficient to provide workspace awareness over this range of situational variables.

Pickering, Jeanne M. and John Leslie King (1992). "Hardwiring Weak Ties: Individual and Institutional Issues in Computer Mediated Communication," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 356-361.

Purpose:
to explore "the question of when, and under what circumstances, institutional investments that provide communications benefits for individuals [to maintain weak ties] will be initiated and maintained over time without restrictions on individual use." (p. 356).

Summary:
Weak ties (those with less frequency, emotional intensity, and sharing of confidences than strong ties) are maintained by individuals because they "preserve the option of shifting oneself into new strong tie networks, or ... Facilitate access to locally unavailable but important information." (p. 358) Computer mediated communication systems may serve a supplemental role in strong-tie communications, but have a very strong potential for weak-tie communication because of the low cost and ease of use for individuals. Institutions are supporting more of the cost and may be getting less benefit from computer mediated communication supported weak tie communication than the individual. "We argue that some institutional settings are highly dependent on maintenance of weak interpersonal ties across broad geographic or social distances, and in such settings the computer mediated communication infrastructure will continue to be provided by institutions even if there are substantial benefits to the private individuals using that infrastructure. However, in other institutional settings where maintenance of weak ties is not important to institutional welfare, or where structural and organizational characteristics of the setting facilitate weak tie maintenance without the need for computer mediated communication infrastructure, the institutional incentive to provide such infrastructure will be weak." (p. 356)

Sproull, Lee and Sara Kiesler (1991). "Increasing Personal Connections," in *Connections: New Ways of Working in the Networked Organization,* MIT Press, Cambridge. [also in Baecker 1993: 418-430.

Purpose:
to explore the potential of electronic communication to affect communications between central and peripheral employees, using a number of previous study results for supporting evidence

Summary:
Typically in organizations, communications originate in the center of the organization and move out toward the periphery. Higher levels of information may increase employee motivation and commitment; a number of strategies have been tried to reduce the distance between employees in the center and those on the periphery; "Electronic communication may offer peripheral employees new opportunities to initiate connections within the organization to reduce the information gap and increase motivation. ... It can increase both connections between the periphery and the center of the organization and connections among peripheral workers." (p. 456) "Receiving mail can affect employees' attitudes toward their organization by increasing their informational and emotional connections to other employees. This is especially true for peripheral employees who participate in large electronic distribution lists, bulletin boards, or conferences." (p. 457) "Sending electronic mail can also increase informational and emotional connections." (p. 460) There are three issues involved in better including peripheral workers: 1) logistics - the collection of peripheral workers' opinions can be time-consuming and expensive, 2) peripheral employees may be hesitant to contribute, fearing recrimination, and 3) central management must be ready to hear what peripheral employees have to say. The first of these issues may be solved by electronic communication, and the second may be helped. "Workers feel less intimidated about talking to the boss electronically than they do about talking to him or her face-to-face, particularly if what the worker wants to say is in any way negative. Because there are few reminders of status differences, the fear of evaluation or criticism declines." (p. 463) Electronic discussion groups also provide the opportunity for employees to belong to many more groups, to receive more information and to increase ties between workers that would otherwise not have contact. This group membership, especially for those who belong to few face-to-face groups (most often the peripheral employees) may lead to increased commitment to the organization by workers.

Tollmar, Konrad, Ovidiu Sandor, and Anna Schomer (1996). "Supporting Social Awareness @ Work Design and Experience," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 298-307.

Purpose:
to provide and evaluate a computer-based tool "intended to strengthen social group awareness within a research laboratory." (p. 298)

Summary:
"The system described in this paper is intended to provide through computer support similar advantages as physical proximity, bridging the gaps between people, and strengthening awareness and group consciousness among the lab members. The goal of the project has been to provide a system to be used naturally and regularly by the group members to inform each other where they are, what they are doing, and how they could be reached. By this we hope to encourage informal, spontaneous collaboration and support community building." (p. 298) Designed with user input through several prototype phases, this video conferencing tool provides thumbnail images of who is on the system and awareness information (such as situation states, an audio link, and short email tool) as well as a watch mechanism for notification when someone's situation changes. Users set their own state information. The system has also been integrated with the phone system to help support access from outside the company. In addition, the authors argue that a computer mediated communication tool such as this may in fact be able to provide better awareness information than physical proximity does; they suggest, for instance, that being able to ignore another person by filtering out awareness information and communication channels to/from that person would be much easier via a computer mediated system than face-to-face.

Whittaker, Steve and Heinrich Schwarz (1995). "Back to the Future: Pen and Paper Technology Supports Complex Group Coordination," *Proceedings of CHI95.*

Purpose:
to study the use of an electronic and a nonelectronic group planning and coordination tool, discover strengths and weaknesses of each in order to present suggestions for moving forward in research combining the strengths of both systems.

Description:
-*size:* 2 multidisciplinary teams of about 20 people each
-*duration:* 14 weeks
-*type:* case study
-*group history:* existing groups were studied
-*data collection methods:* interviews, examination of artifacts, observation of interactions
-*design methodology:* one group used electronic support for scheduling and the other group used a large physical wallboard on which to keep scheduling information
-*technology:* the MS-ProjectTM scheduling tool, email and electronic bulletin boards were used by the electronically supported group

Summary of Findings:
There are four major issues with scheduling: initial planning, updating, replanning, and coordination. In initial planning, the physical manipulation of paper seemed "to encourage more reflection about what one is doing and its impact on others. In contrast, the simplicity of changing numbers in electronic scheduling tools reduces this thoughtful handling of the estimations," (p. 5) and made changes less concrete, reflective and thoughtful. The public, visible nature of the physical wallboard motivated more responsibility and commitment to the updating

process, with many collaborative updates taking place. The electronic version made detailed updates much easier, though, which encourages the accuracy and frequency of updates occurring. In the replanning stage, "interacting, negotiating, context-related, manual, visual aspects afforded by the [wall]board" (p. 7) were helpful in the same way as in the initial stage, with not only managers (as was more the case with the electronic system), but workers being involved in the process. Finally, in terms of coordination, the visibility and "easy public access to the group's goals as well as individual's tasks and commitments" (p. 9) provided by the wallboard were effective for group coordination; the electronic system tended to facilitate private progress checking rather than group coordination. The electronic system also provided so much detail that it was difficult for individuals to see the bigger group picture at times. Also some workers felt that the effort to maintain this level of detail was not worth the amount of benefit received. The wallboard system, on the other hand, had some difficulties in providing distribution of materials (especially for external coordination), integrating the scheduling information with other electronic information, and protecting possible display of sensitive or confidential information in the public space. Generally, then, "the size, public location and physical qualities of material tools engender certain group processes that current online technologies fail to support. ... Material tools fall short on several other dimensions, [however], such as distribution, complex dependency tracking, and versioning." (p. 1) Designers need to incorporate some of the benefits of material tools into electronic systems.

4. GROUP PROCESS

Bostrom, Robert P. and Robert Anson (1992). "The Face-to-Face Electronic Meeting: A Tutorial," in *Computer Augmented Teamwork: A Guided Tour*, R. Bostram, R. Watson and S.T. Kinney (eds.), Van Nostrand Reinhold, New York: 16-33.

Purpose:
to identify potential benefits and obstacles of electronically supported meetings and to evaluate their accuracy through a case study using a GSS system.

Description:
-*size:* 14 members of an international professional association's officers group
-*duration:* 114 minutes total for the long range plan procedure (all electronic), 11 hours for the budget review procedure (approximately 2.5 hours electronic, the remainder non-electronic)
-*type:* case study
-*group history:* existing group meeting 6-7 times per year. Specific member history of time with group not reported
-*data collection methods:* observations, pre- and post-meeting surveys, telephone interviews
-*design methodology:* The group task at the electronically supported meeting was "updating the three-year plan for the association and developing a budget for the coming year." (p. 24)
-*technology:* the GroupSystems tool was used to support both the long range planning and budget review procedures. Components used included Topic Commentator for generation of ideas, Public Screen for group review, Voting for prioritization, Idea Organizer for generating and reviewing criteria, Alternative Evaluator for rating recommendations, and Lotus Spreadsheet for applying changes to create the budget.

Summary of Findings:
In general, group support systems have several features which provide benefits and obstacles to effective meetings. They can provide simultaneous input which provides the opportunity for broader, equal and more active participation, participation and contribution at individual users' own levels of ability and interest, more input in less time, and less dominance by a few members of the group. Their support of anonymity can foster less individual inhibitions, more focus by the group on the idea rather than the contributor, and enhanced group ownership of ideas. They can provide process and agenda structuring support, which can facilitate agenda control and completion, and improve focus on the topic. Electronic recording and display allow immediate display of data, complete and immediate meeting minutes, enhanced group memory and easier modification. Finally, electronic systems can provide extended information processing capacity, automating complex tasks and creating easy accessibility to information, others' ideas and other software tools. Potential obstacles identified include difficulties in matching the group support system technology to the group, task and desired outcome (as there may be some situations where they are inappropriate) and in effective facilitation of group process and technology. In evaluation

of the particular case study, “responses to the technology, the facilitation, and the meeting overall were very positive across all research media.” (p. 29) The findings support the positive potential of GSSs described above. “Anonymity made it easier for people to contribute ideas and to focus on the merit of the ideas expressed. Simultaneity made eliciting ideas and judgments more efficient. Structuring helped to make the problem solving approach more organized and the examination more systematic. Electronic recording and display prevented ideas from getting lost along the way. Expanded information-processing capacity made it possible to gather and evaluate the group’s position and thinking. Furthermore, participants’ comments emphasized the importance of the facilitator in moving the group through its work. Major overall improvements in how the members worked together were noted by both the officers and staff.” (p. 31)

Cannon-Bowers, Janis A., Eduardo Salas, and Sharolyn Converse (1993). “Shared Mental Models in Expert Team Decision Making,” in *Individual and Group Decision Making: Current Issues,* N. John Castellan (ed.), Erlbaum, Hillsdale, NJ: 221-246.

Purpose:
to describe the concept of shared mental models and how they affect team performance

Summary:
Effective team performance requires “team members to coordinate activity, to adapt to changing task and team demands, and to anticipate needs of tasks and team” [and] will be enhanced via shared mental models of the task and team.” (p. 241) Shared mental models are “knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and, in turn, to coordinate their actions and adapt their behavior to demands of the task and other team members.” (p. 228) Multiple mental models may exist concurrently in teams with complex tasks; there may be an equipment model, a task model, a team interaction model (including roles, responsibilities and interactions) and a team model (focusing on individual team members and their characteristics), for instance. Each member of the team will hold expectations of the team and task generated from his/her mental models, and it is important for team effectiveness that team members share the same expectations. This does not mean that the content of their mental models must be equivalent, as different mental models may generate the same expectations, but rather that there must be compatible outcome expectations shared. The authors suggest that methods should be developed to train people in groups in the generation of shared mental models.

Chidambaram, L., R.P. Bostrom, and B.E.Wynne (1991). "A Longitudinal Study of the Impact of Group Decision Support Systems on Group Development," *Journal of Management Information Systems,* 7(3):7-25.

Purpose:
to look at the degree of cohesiveness and ability to manage conflict in groups using group decision support systems versus face to face groups over multiple sessions rather than a single session as most previous studies have done.

Description:
-*size:* 140 undergraduate students randomly assigned to 28 groups of 5
-*duration:* 4 weeks, 4 tasks (1 task per week), each task was given a time limit of 90 minutes
-*type:* experimental laboratory study
-*group history:* it was assumed that group members had not worked together as a group before the study, reinforced by "soliciting subjects early in the semester, so they had little or no opportunity to work together as a group, except for this experiment." (p. 23). Prior individual relationships were not taken into account.
-*data collection methods:* survey, questionnaires
-*design methodology:* groups were randomly assigned to one of two experimental conditions, group decision support system (GDSS) aided groups, and manual groups, each performed task consisting of generating ideas, holding discussion, and voting, each had a facilitator
-*technology:* GROUPSYSTEMS software (using three separate tools for generation, review and evaluation) for GDSS supported groups, installed in an electronic meeting room lab "comprised of ten microcomputers with color displays seated on a U-shaped table, connected to a rear-mounted public screen and linked by a Novell LAN." (p. 13)

Summary of Findings:
On average over the time period, there was no significant difference between the manual and electronically supported groups in terms of conflict management or cohesiveness, but the development of these properties was very different between the groups. Both were initially higher in manual groups, but the pattern reversed over time, with group decision support system groups scoring higher on both measures in the later sessions. The authors pose several reasons for these results: the group decision support system groups may have needed more time to appropriate the technology effectively, support features of the group decision support systems and their effects (including active and equal member participation, criticism of ideas, not people, exploration of alternatives, use of structured procedures, and task focus) may have contributed to group maturity in both areas, manual groups seemed to form coalitions faster and have more dominant personalities control the discussion which led to more conflict and more difficulty in maintaining cohesion, whereas group decision support system groups had discussions that were more task oriented, personality roles were kept to a minimum, and anonymity of input reduced the emergence of strong dominant personalities early on, and group decision support system groups more readily viewed ideas as "ours" rather than "mine" because of the anonymity provided.

Cole, Paul and Judith Nast-Cole (1992). "A Primer on Group Dynamics for Groupware Developers," in *Groupware: Software for Computer-Supported Cooperative Work*, David Marca and Geoffrey Bock (eds.), IEEE Computer Society Press, Los Alamitos, CA: 44-57.

Purpose:
to present ideas about how groupware technology might be used by groups as they pass through the various stages of group development

Summary:
Group dynamics include issues of leadership, roles, norms, communication and development; each of these will affect the use of technology by a group. A group's use of technology will also evolve as the group progresses through its various stages of development (forming, norming, storming and performing). In the forming state, "groups need to establish patterns of interaction and communication prior to using an electronic mail or computer conferencing system for complex, controversial, or emotional issues." (p. 55). The authors believe that a group is likely to use groupware in a relatively superficial passive manner at this stage. In the norming stage, it is necessary for groups to have explicit conversations about the role of the groupware technology; "it is difficult and time consuming for a group using predominantly electronic means of communication to establish common norms because of the ambiguous feedback and the absence of common group learning." (p. 55) During the storming stage, groupware use may increase but with negative effects: it is "critical to ensure that the predictable conflicts and disagreements be managed primarily in face to face meetings. Conflicts may escalate inadvertently when handled through electronic means because of the lack of immediate feedback, the increased likelihood of misinterpretation, and the emotional distance the technology falsely creates, reducing awareness of the impact of one's communication." (p. 55) The performing stage is where the authors believe groupware technology can be optimally used, as "the need of all the group members to fully participate in face to face meetings will diminish and they will be increasingly able to work effectively in smaller and different configurations. As the whole group continues to effectively subdivide its work the reliance on electronic communication and groupware technology will increase." (p. 55)

Finholt, Tom and Lee S. Sproull (1990). "Electronic Groups at Work," *Organization Science*, 1(1):41-64. [also in Baecker 1993:431-442]

Purpose:
to consider "how computer-based communication technology, specifically electronic group mail, might affect group behavior in organizations." (p. 41)

Description:
-*size:* stratified random sample of 96 employees selected from 2 units of a large office products company, each with approximately 300 employees.
-*duration:* 3 day period of email saved for each employee, collected over a 6 week period
-*type:* correlational field study
-*group history:* not specified
-*data collection methods:* hardcopies of all incoming and outgoing messages, interviews
-*design methodology:* "Because every group message was sent to every group member, we were

able to use sequential sampling of group messages across people as an approximation of continuous sampling from each DL [distribution list] as a whole." (p. 48)
-*technology:* email system which supports multiple distribution lists, some required, others discretionary

Summary of Findings:
There was an extensive scope and diversity of distribution list activity, and "at least some groups behaved like real social groups - despite the fact that they shared no physical space, their members were invisible, and their interaction was asynchronous." (p. 59) The authors discuss that there are three classes of variables that affect group communication in organizations: group attributes (including physical setting, member characteristics such as physical appearance and social status, membership criteria of informal versus formal groups, and task type), group processes (including interaction, influence attempts, and identity maintenance), and organizational consequences ("groups influence employee participation by providing information that helps people know how to behave, by affecting how people regard their work, by shaping attitudes toward the larger organization, and by channeling their contributions." (p. 45)). They describe how electronic mail systems may affect these variables. Group attributes of physical setting and member characteristics may be quite different when email is used, as it lacks the shared physical setting and visible participants of face to face interactions. All group processes described may be difficult to achieve through email, since it is a text-only communication medium. Email systems may have a strong effect on organizational consequences as well. Email may make it easier for employees to join and be socialized into electronic groups, may allow for more equal participation, may reduce process loss since there is not physical meeting space, specified meeting length or constraints on how many people can speak at once, and electronic groups may become information buffers where memory and current information is available in a readily accessible form and fast diffusion of ideas within and between groups can be supported.

Finholt, Tom, Lee Sproull, and Sara Kiesler (1990). "Communication and Performance in Ad Hoc Task Groups," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 291-325.

Purpose:
to study the ability of computer mail to support the work of ad hoc groups by measuring performance, functions of computer mail vs. face to face correspondence in the group, support of most competent group members to work in subgroups and communicate with the entire group, and consequences of computer mail use for the individual.

Description:
-*size:* 7 student software development teams of 7-10 members
-*duration:* 3 months
-*type:* quasi-experimental field study

-*group history:* "These teams were newly constituted for this task; they had not worked together as a group before. However, through participation in the same academic program, they did share common experience in previous courses, common skills, and information." (p. 299)
-*data collection methods:* archival data on participants, questionnaires, observation of meetings, self report of interactions, project evaluations from clients, individual evaluations from teammates
-*design methodology:* N/A
-*technology:* "Each team had a regularly scheduled meeting time during the week. Each team member also had access to the university's computer mail system and unlimited account allocations for using computer mail. Each student was given a directory with all students' telephone numbers, addresses, and computer mail addresses. Distribution lists (DLs) were established for all groups." (p. 300)

Summary of Findings:
"We have shown that a computer mail system can influence the productivity of ad hoc task groups or project teams. In particular, we found a strong relationship between levels of computer mail use and group performance. Further, we established that in these groups increased computer mail use was associated with reduced amounts of other communication, such as face-to-face meetings, phone conversations, and hardcopy memoranda. Also, we showed a strong association between information content and communication medium, with a high proportion of non-status reporting computer mail devoted to coordinating messages and a high proportion of non-status reporting face-to-face interaction devoted to consensus formation. These results suggest that the use of computer mail did change the output of group work by streamlining communication and by matching information efficiently to the most appropriate medium. .. We showed that in many groups the highest performing individuals appeared to use one-to-one computer mail to form electronic in-groups [with other high performers], and used all-group mail to maintain contact with the entire group. We found that managers in every group sent the majority of all-group mail, and that the majority of one-to-one mail was exchanged between managers and non-managers. However, we also found weak evidence of one-to-one traffic among non-managers and of all-group mail sent by non-managers. These results indicate that the use of computer mail did alter the pattern of group work by facilitating the formation of constructive in-groups and by creating the opportunity for new functional communication structures, although the nature of manager to non-manager interaction in these groups suggests that members experimented with these structures, rather than using them extensively. Finally, we showed that there were individual consequences of computer mail use, including positive relationships between mail use and individual evaluation, between mail use and commitment to the group, and between mail use and perception of coordination by low face-to-face communicators." (p. 319)

Gabarro, John J. (1990). "The Development of Working Relationships," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 79-110.

Purpose:
to describe the dimensions of relationships, the states of the relationship formation process

generally and within the workplace, and to present a model of the development of new working relationships.

Summary:
Social relationships develop along dimensions of openness and self-disclosure, knowledge of each other, predictability of others' reactions and responses, uniqueness of interaction, multimodality of communication, substitutability of communication, capacity for conflict and evaluation, spontaneity of exchange, synchronization and pacing, efficiency of communication, and mutual investment. These factors are interrelated and moderated in specific relationships by individual factors, context, and outcomes of exchanges for those involved. Early stages of relationships usually "involve interactions that are socially 'safe' or stereotypical, concerning topics that are routine, superficial, or prescribed by role expectations" (p. 91), whereas later stages "are characterized by richer and more penetrating exchanges, more commitment to the other and to the relationship itself, and finally greater permanence and stability." (p. 91)
Working relationships have the same basic underlying process, but may be more segmental (with exchange focused more on task issues and with less personal openness), participants may be more judged by task-related competencies, and role definitions may have a stronger function (participants may "temper their openness, trust and self-disclosure ... and retard the degree of social penetration that is likely to occur." (p. 96)) Based on these observations, the author presents a four stage model of the development of new working relationships: 1) orientation and impression formation, 2) exploration beyond impressions, 3) testing and working through, and 4) stabilization. For each, he provides characteristics, major tasks to be accomplished, issues, and questions of the stage. The quality of a relationship depends not on whether it progresses through the stages, but on how well the problems and dilemmas of each stage are dealt with.

Hiltz, S.R., K. Johnson, and M. Turoff (1986). "Experiments in Group Decision Making: Communication Process and Outcome in Face to Face Versus Computerized Conferences," *Human Communication Research,* 13(2):225-252.

Purpose:
to study the performance and communication characteristics of groups using a computerized conferencing system as compared to face to face groups each executing the same decision making tasks, one an information exchange based task, and the other a socio-emotional, value based task.

Description:
-*size:* 80 students, in groups of size 5
-*duration:* 60 minutes for task1, 90 minutes for task 2
-*type:* quasi-experimental laboratory study
-*group history:* group members had not worked together before; "students from the same class were assigned to different groups, in order to decrease the likelihood that group members would know each other." (p. 232)

-*data collection methods:* expert judgment of solution quality, transcripts of sessions (audio for face-to-face and written in computerized conference)
-*design methodology:* groups were divided into face-to-face and computerized conferencing conditions, each performed a human relations task and a technical ranking problem.
-*technology:* "a simplified subset of the Electronic Information Exchange System" (p. 233), where participants could be in a "write" mode for typing in ideas and a "read" mode for viewing comments of other group members (in printed form). Upon completion of a write entry, a read was automatically performed; in addition during the composition of a write entry, the user had the option to execute a read.

Summary of Findings:
Overall, "there were two to three times as many communication units in face-to-face groups … as in the computerized conferencing mode of communication during the same elapsed time. Group decisions were equally good in the two modes, but the groups were less likely to reach agreement in the computerized conferencing mode. There were proportionally more of the types of task-oriented communication associated with decision quality in the computerized conferences." (p. 225) More specifically, in the value based task, the computer conferencing groups for the most part did not have a dominant individual emerge in the discussion and had significantly more offering of opinions; this seemed to prevent the group from reaching agreement, but did lead to high quality of group decisions. Reasons suggested for the inability of computer conferencing groups to reach agreement center around the slower rate of information flow than in face to face groups (implying that the computer conferencing groups would have reached agreement given more time), the fact that no clear leader emerged in the computer conferencing groups and this may be necessary, especially in problems based on value decisions, and that with less socio-emotional communication in computer conferencing groups there is less group cohesion and so members don't have as strong a motivation to reach agreement as in face to face groups. Reference is also made to several later studies, in which variations of the above experiment were done, including the election of a leader, different types of tasks, and anonymous participation.

Hymes, Charles McLaughlin and Gary M. Olson (1992). "Unblocking Brainstorming through the Use of a Simple Group Editor," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 99-106.

Purpose:
to examine "the ability of a simple, unstructured [electronic] parallel editor to facilitate idea generation in face to face groups." (p. 99) by comparing brainstorming effectiveness in nominal, interacting serial, and interacting parallel groups.

Description:
-*size:* 116 subjects from the local community placed in groups of 4, all members of a group were of the same gender
-*duration:* 15 minutes for each brainstorming task (warmup and actual study)
-*type:* quasi-experimental laboratory study
-*group history:* subjects did not know each other
-*data collection methods:* timestamped transcripts of all typing by participants, questionnaires
-*design methodology:* groups were divided to measure three conditions: interacting serial groups (face to face interaction with serial recording of ideas for the group), nominal groups (individuals generating and recording their own ideas, then pooled lists), and interacting parallel groups (face to face interaction with parallel recording of ideas - group members could see others' inputs immediately on the screen).
-*technology:* "The study was run in the Collaboration Technology Suite (CTS), a special computerized meeting room that has been designed to be as similar to a regular meetings room as possible," (p. 102) with members of a group sitting around a table each with a computer in front of them. In the interacting parallel groups, ShrEdit software was used; this is a multi-use text editor that "allows all users to type and edit the same document at the same time… As the individuals edit, the other members of the group see the changes immediately. … The Nominal and Interacting Serial groups used UnShrEdit, a single-user version of ShrEdit which had the identical editing functions but had the multi-user aspects removed." (p. 102)

Summary of Findings:
Nominal groups produced many more ideas than serial interacting groups (which replicates many previous study findings), parallel groups produced many more ideas than serial interacting groups, and nominal and parallel interacting groups did not differ. "We have shown that as has been hypothesized in the major reviews, production blocking [when individuals have to wait to express ideas because only one person can communicate at a time and which may result in participants forgetting ideas or choosing not to contribute them later as well as keeping participants from thinking of other ideas] is a major factor in the poor relative performance of real groups as compared to nominal groups. Production blocking can be substantially reduced through the use of a simple electronic workspace that allows parallel entry of ideas." (p. 105) The authors postulate that the reason no difference was shown between parallel interacting and nominal groups (whereas other studies have shown parallel groups with higher brainstorming effectiveness than nominal groups) may correspond to both the higher rate of idea generation in this particular task and the ability of participants to see all other ideas generated continually (rather than in some sort of batches), which may have led to idea blocking, where the time spent processing the ideas of other group members takes away from time spent by the participant generating his/her own ideas.

Johansen, Robert (1992). "An Introduction to Computer-Augmented Teamwork," in *Computer Augmented Teamwork: A Guided Tour,* R. Bostrom, R. Watson, and S. Kinney (eds.), Van Nostran Reinhold, New York: 5-15.

Purpose:
to examine the potential use of groupware tools at various stages of group development, based on models of team stages and groupware classification by time and place.

Summary:
Team needs (as defined by Drexler, Sibbet and Forester (1988)) fall into creating and sustaining stages. Creating stages include orientation, trust building, goal and role clarification, and commitment, while sustaining stages include commitment, implementation, high performance, and renewal. Using this model and a modified version of the DeSanctis and Gallupe (1987) categorization of groupware products into four groups: same time/same place (face to face meeting support), same time/different place (cross-distance meeting support), different time/same place (administrative filing and filtering support) and different time/different place (ongoing coordination support), the author describes which group stage activities he believes should be supported by each of the four types of groupware systems. Early stages of group development should be supported by same time/same place (face to face) meetings; "orientation and trust building activities almost always need to take place in a same time/same place mode. The immediate feedback offered by face-to-face meetings, coupled with the opportunities at informal meetings to get to know others in subtle ways, are important characteristics for teams to consider." (p. 8) Electronic tools can be helpful within these face to face meetings, however, to provide "a written record of what was agreed upon during the meeting, anonymous discussions, simultaneous input of ideas, and voting or ranking of alternatives." (p. 9) Same time/different place tools are useful in the goal/role clarification and commitment stages, and to review progress during the implementation stage. Different time/different place technology support should be used during the implementation and performance stages, as they provide convenience and flexibility at a time when there is not time for face-to-face meetings. Few groupware products have focused on different time/same place support, though groups could be supported in the future by team rooms, for instance, where "groupware can be used for shared filing and the storage of tools and displays (e.g., graphics or videos), which can be used by the team members at different times in the same team room." (p. 11)

Kiesler, Sara, Jane Siegel and Timothy W. McGuire (1988). "Social Psychological Aspects of Computer-Mediated Communication," in *Computer Supported Cooperative Work: A Book of Readings,* Irene Greif (ed.), Morgan Kaufmann, San Mateo, CA: 657-682.

Purpose:
to examine communication efficiency, participation, interpersonal behavior and group choice shift in face to face, anonymous, and nonanonymous groups trying to reach consensus on a choice-dilemma problem.

Description:

-*size:* students, in groups of size 3
-*duration:* not reported
-*type:* quasi-experimental laboratory study
-*group history:* not reported
-*data collection methods:* not reported
-*design methodology:* groups were assigned to one of three contexts: anonymous computer mediated, nonanonymous computer mediated, and face to face conditions. Each was given a choice-dilemma problem; the experiments were "carried out in offices and rooms where terminals were already in use so as to duplicate the actual setting where communication typically takes place." (p. 667)
-*technology:* "Converse" program, "which divides the screen into three or more parts and allows messages from different people to appear simultaneously and scroll independently." (p. 667)

The authors also briefly describe and refer to several other studies which are variations of the above.

Summary of Findings:
Computer mediated communication groups took longer to reach consensus than face to face groups, and exchanged fewer remarks. Both computer mediated and face to face groups were equally task oriented. There was more equal participation in computer mediated groups, and communications were more uninhibited. In addition, there was significantly higher choice shift in computer mediated groups than in face to face groups. In one of the additional variation studies, analysis was done to compare groups made up of strangers and those of friends; results were similar in these two cases. The authors theorize that greater choice shift may occur in computer mediated groups because norms are weaker, and group members might be less likely to simply average initial opinions or obey an initial majority. Instead, there is a more broad distribution of opinions and extreme opinions are less likely to be withheld; this airing of more diverse opinions may account for greater choice shift.

Lea, Martin and Russell Spears (1991). "Computer-mediated communication, de-individuation and group decision-making," *International Journal of Man-Machine Studies,* 34:283-301. [also in Greenberg 1991]

Purpose:
to investigate group polarization taking into account social factors (context and norms) as well as deindividuation of individuals within the group

Description:
-*size:* 48 students randomly placed in groups of 3
-*duration:* 4 group discussions on controversial issues, 10 minutes each with a two minute break

between
-*type:* experimental laboratory study
-*group history:* not reported
-*data collection methods:* questionnaires, message traffic log, discussion transcripts
-*design methodology:* four experimental conditions were established: group identity/deindividuation, individual identity/deindividuation, group identity/individuation, and individual identity/individuation, where deindividuation was manipulated "by virtue of being isolated and anonymous as opposed to being co-present." (p. 289).
-*technology:* email system used by all conditions: "our face-to-face condition also communicated via computer [though they were physically co-located], in order to control for the constraints and effects of the communication system." (p. 289)

Summary of Findings:
"The main focus for comparison is between the de-individuated-group condition and the de-individuated-individual condition. Subjects in the de-individuated-group condition were significantly more polarized in the direction of the group norm. Greater polarization was associated with the exchange of significantly fewer words, shorter messages, and a significantly smaller proportion of remarks related to the discussion topic. Participation was also more unequal. Subjects in the condition exchanged more social remarks and perceived least disagreement among themselves after the discussions. Greater polarization was not associated with more uninhibited behaviour or the reduced perception of social cues." (p. 295) In other words, if group identity is salient, deindividuation can lead to fewer perceived differences, enhancing the group salience and therefore pushing toward the group norm, whereas if group identity is not salient, deindividuation enhances the sense of individuality and participants move away from the group norm. In addition, "both one's group identity can be salient and influential in the absence of other group members, and the co-presence of others can actually undermine group salience by facilitating the perception of intragroup differences." (p. 296) These findings argue against earlier theories which claim that disinhibition and greater equality of participation facilitate exchange of extreme persuasive arguments resulting in polarization.

Losada, Marcial, Pedro Sanchez and Elizabeth E. Noble (1990). "Collaborative Technology and Group Process Feedback: Their Impacts on Interactive Sequences in Meetings," *Proceedings of the Conference on Computer Supported Cooperative Work 1990:* 53-64.

Purpose:
"to tackle the complexity of group process by using both state-of-the-art computerized coding technology and time series methods of analysis," (p. 53), "to analyze the effect of computer collaborative technology on interactive sequences," (p. 54), and "to investigate the effect that group process feedback may have on interactive sequences." (p. 54)

Description:
-*size:* 151 students (34 groups of 3 to 6 participants)
-*duration:* 30 minutes for task 1, 50 minutes for task 2

-*type:* experimental laboratory study
-*group history:* "The groups were not ad hoc groups created for the purpose of the experiment, but groups that were already extant due to their ongoing university work." (p. 55)
-*data collection methods:* Group Analyzer system used, which codes behaviors and timestamps them.
-*design methodology:* groups were randomly assigned to 1 of 4 conditions: no technology/no feedback, no technology/feedback, technology/no feedback, or technology/feedback. Task 1 was a ranking task, while task 2 asked groups to reach consensus on actions for a character to take. In the feedback present conditions, "subjects were shown, at the end of the first task, a diagram portraying their group behavior. The subjects compared their group behavior with guidelines for effective group process, discussed differences among themselves, and proceeded to the second task." (p. 55)
-*technology:* CaptureLab, a computer supported collaborative environment with publicly shared screen accessible from personal workstations embedded in the conference table

Summary of Findings:
A group interaction diagram is used to represent each group's meeting: "The groupID displays the complete results of time series analysis and provides a comprehensive overview of interactive sequences throughout the meeting, giving valuable insights into the group process and fulfilling our first objective of unraveling the complexity of group process." (p. 57) In terms of effects of technology and feedback on the group process, "the results of this study show that: 1) if technology is used without group process feedback, we observe a substantial reduction in socio-emotional interactive sequences; 2) if technology is used with group process feedback we observe a significant increase in socio-emotional interactive sequences; [and] 3) if group process feedback is given without technology we observe a significant reduction in socio-emotional interactive sequences." (p. 60) Potentially, then, these research results "suggest that group process feedback could be instrumental in reducing social dynamics losses in computer supported collaborative technology. … Finally, our study also suggests … that by giving feedback on their social dynamics to meeting participants, a greater awareness of the interactions that could hinder collaboration (such as excessive dominance or negativity) may help improve group processes in computer supported collaborative environments." (p. 62)

Mandviwalla, Munir and Lorne Olfman, (1994). "What Do Groups Need? A Proposed Set of Generic Groupware Requirements," *ACM Transactions on Computer-Human Interaction,* 1(3):245-268.

Purpose:
to use a "multidisciplinary literature analysis … to identify important work group characteristics … [and to] propose a set of generic groupware design requirements based on this analysis." (p. 245).

Summary:

Generic groupware design requirements which should be examined by designers and users suggest that groupware systems should: "support multiple group tasks, … support multiple work methods, … support the development of the group, … provide interchangeable interaction methods, … sustain multiple behavioral characteristics, … accommodate permeable group boundaries, … [and be] adjustable to the group's context." (p. 252) Not every product can or should meet every one of these suggested requirements; rather "groupware designers can use the proposed requirements as a tool for starting the design process. The requirements serve as a check list to make sure that all the needs of the wok group have been considered, even if in the end only a subset of the requirements are met. Our goal was to devise a comprehensive set of groupware design considerations so that when a situation does call for a particular requirement it will be easily apparent to the designer." (p. 261). Examples of groupware systems are used throughout to point out strategies and issues in the implementation of the design requirements.

Mark, Gloria, Jorg M. Haake, and Norman A. Streitz (1996). "Hypermedia Structures and the Division of Labot in Meeting Room Collaboration," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 170-179.

Purpose:
to focus "on the effect that using hypermedia structures in an electronic meeting room had on collaborative style" (p. 170), in terms of parallel as opposed to collaborative working within a group.

Description:
-*size:* 48 students and staff, randomly placed in groups of 3
-*duration:* 60 minutes: 20 brainstorming and 40 "structuring and developing their ideas which they had generated during brainstorming." (p. 173) (plus a 40 minute training, and 20 minute practice period on the DOLPHIN system)
-*type:* experimental laboratory study
-*group history:* not reported
-*data collection methods:* screendumps from workstations and liveboard, videotape of meetings, notes by observer
-*design methodology:* groups performed early phase group problem solving (brainstorming, planning, and organizing information). Some groups used non-hypermedia structures, others hypermedia structures.
-*technology:* "Subjects worked with DOLPHIN as a multi-user application [supporting concurrent operations by different users] shared between the Liveboard [an electronic whiteboard] and networked computers. One subject worked on the Liveboard and two subjects were seated at the workstations." (p. 173) In the non-hypermedia condition, subjects used on a standard electronic whiteboard provided by DOLPHIN, while in the hypermedia condition, subjects received training on creating and using hypermedia structures (nodes and links) as well.

Summary of Findings:
"The use of hypermedia structures facilitates groups to divide up their labor and work in parallel,

especially during the early problem-solving phase of idea development. These groups were not only more likely to use a top-down strategy in planning, but also to submit proposals on how to divide up their work and carry them through. The switch between planning and developing phases occurred more often in hypermedia than in non-hypermedia groups. In this context, parallel work may offer advantages since the hypermedia documents were also found to be more deeply elaborated." (p. 178) The author identifies various benefits and costs of collective work as opposed to parallel work; benefits include an ability for the group to maintain a shared focus and improved performance, while costs include potential difficulty for the group of keeping track of shared resources and the overhead involved in coordination: negotiating subtasks, keeping track of what others are doing, coordinating finished work, making midcourse corrections, and dealing with increased potential for conflict. Since both types of work seem appropriate for different task phases, systems should support both and the transitions between the two.

Markus, M. Lynne (1992). "Asynchronous Technologies in Small Face-to-Face Groups," *Information Technology and People*, 6(1):29-48.

Purpose:
to study whether groups that can meet face-to-face will adopt new asynchronous technologies for communicating among group members and for what purposes group members will use asynchronous technologies "introduced primarily to support communication within the groups rather than with outsiders who are less accessible physically." (p.30)

Description:
-*size:* 4 teams of 3-4 graduate students
-*duration:* 1 year
-*type:* correlational field study
-*group history:* not reported
-*data collection methods:* computer monitored logs of number and duration of accesses, complete printed transcript of all electronic communications, interviews

-*design methodology:* teams all had access to and training in the technology but were not required to use the supplied technology
-*technology:* team members each given computers and software with processing and communication tools (electronic mail, bulletin board service, file transfer)

Summary of Findings:
Some findings were consistent with expectations derived from previous theory and research: "1.) adoption and usage patterns differed across the three asynchronous technologies. The groups used electronic mail and file transfer to a much greater extent than the electronic bulletin board. 2.) not all of the groups adopted electronic messaging for internal use. In those that did, not all members participated. Internal electronic messaging was sporadic, varying with member accessibility. 3.) external messaging [with those outside the group] was generally used more than

internal messaging in spite of severe constraints on the number and composition of outsiders with access to the technology. 4.) while technological inaccessibility undoubtedly limited the adoption and usage of asynchronous technologies, the groups nevertheless used them when they had strong incentives, such as the need to overcome geographic distance, media incompatibilities and poor group relations." (p. 43) Several other findings were unexpected: "1.) three groups used asynchronous file transfer to overcome media incompatibilities they themselves created through their choice of word processing hardware, 2.) two of the three groups used asynchronous file transfer synchronously … and 3.) the one group to use file transfer asynchronously - the expected manner - had poor social relations and used the technology precisely in order to avoid the face-to-face interactions that would otherwise be needed to accomplish its tasks. (p. 43)

McGrath, Joseph E. (1990). "Time Matters in Groups," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 23-61.

Purpose:
to describe the temporal structure and patterning of group behavior and to suggest the effects of technology on these temporal matters of cooperative work.

Summary:
The temporal structure of group project activity can be described in four phases: 1.) inception and acceptance of a project (goal choice), 2.) solution of technical issues (means choice), 3.) resolution of conflict/political issues (policy choice), and 4.) execution of performance requirements (goal attainment); phases 1 and 4 are always involved in any project while 2 and 3 may or may not be, and some projects may go through some of the stages several times in at least one of the group function areas. Groups also have multiple functions (production, member support, and group well-being) which interact simultaneously with the group's stage of development, all of which can be affected by new technology. Synchronization, scheduling, and allocation, the elements of temporal patterning of group activity, can be both facilitated and perturbed by new communication technologies, as the technology may alter the temporal features and entrainment processes of the group. In addition, the attention given by the groups to stages 2 and 3 above may be reduced because the affect and interpersonal content of the group's communication may be reduced by computer mediated communication. Therefore computer mediated communication systems are likely to work better for tasks where stages 2 and 3 are either relatively unimportant or already resolved; "this implies that such systems will work best for already-established groups doing relatively routine and well-practiced tasks, for which they already have a well-established division of labor and allocation of payoffs." (p. 57) If these stages are deemphasized in the production area, early inputs by group members will have a disproportionate influence on the group's problem solving strategy; if technological tools have depersonalizing effects, all stages of the group well-being and member support functions may suffer. Suggestions to explore include initially creating face to face workgroups and only adding technological tools when the groups are established, or creating large computer mediated groups

that deal with only routine communication matters, and then letting subgroups form that are more specific and can utilize face to face as well as computer mediated communication forms.

Miranda, S.M. (1994). "Avoidance of Groupthink: Meeting Management Using Group Support Systems," *Small Group Research,* 25:105-136.

Purpose:
to discuss how technological group support systems may affect the groupthink phenomenon (the tendency of groups to respond to normative pressure toward unanimity instead of making decisions based on careful analysis of the options).

Summary:
Antecedent conditions of groupthink, high group cohesiveness, directive leadership, group insulation, homogeneity of group members' background and ideology, and certain task difficulties, are remedied by task focus, equal participation and influence, use of external information, group conflict, and optimistic problem formulation, respectively. There are also certain procedural conditions that preclude effective problem solving and increase the probability of groupthink occurring: lack of methodical procedures, examination of few alternatives, discouragement of dissent, perceptions of invulnerability, and lack of expert advice. These can be countered by use of methodical procedures, consideration of a large number of alternatives, group conflict, and use of external information. Structural features supported by group support systems support many of the remedies of both these antecedent conditions and procedural conditions, and when appropriately used, may mitigate certain of these characteristics that predispose groupthink. These structural features include anonymity, simultaneous input, process structuring, extended information processing capacity, access to external information, written input, electronic recording, and a public screen interface. The author notes findings of previous studies (many of which, she points out, are inconsistent) which have investigated the effects of technology and which may apply to some of these problem and remedy areas, including submission to normative pressure, status differentials, conflict management, and participation patterns in groups working with group support systems versus face to face groups.

Pinsonneault, A. and Kenneth L. Kraemer (1990). "Technology and Groups: Assessment of the Empirical Research," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* J. Galegher, R.E. Kraut, and C. Egido (eds.), Erlbaum, Hillsdale, NJ, pp. 375-406). [also in Baecker 1993:754-774]

Purpose:
to provide a review of studies on group decision support systems and group communication support systems based on a framework which ties in the contextual variables of the study, the group process and the task and group outcomes, and to summarize the impacts of these systems

on groups.

Summary:
A meta-analysis of 19 studies (9 group decision support systems, 10 group communication support systems) was performed. Both group decision support systems and group communication support systems increased the depth of analysis, increased participation, decreased domination by a few members, and increased decision quality of groups. Group decision support systems increased consensus reaching, increased confidence in the decision, increased satisfaction of group members with the process, and increased satisfaction of group members with the decision; however, group communication support systems decreased cooperation, increased the time to reach a decision, decreased confidence in decisions, and decreased satisfaction of group members with the group process. There are several possible explanations for these results. First, group communication support systems might not meet the expectations of participants relative to their view of a technically supported group process. Second, while group decision support systems are perceived as providing benefits at all stages of group development, group communication support systems seem to have different effects at different stages, for instance increasing confidence in decisions at early stages, but not providing any perceived benefits at later stages (therefore confidence in the decision and process satisfaction decrease). Third, by increasing the focus on personally oriented communication in addition to task focus, group communication support systems decrease cooperation and confidence of members in the process.

Romm, Celia T. and Nava Pliskin (1996). "Email as a Facilitator of Power Plays: Analysis of Political Events at a University." [http://hsb.baylor.edu/ramsower/acis/papers/pliskin.htm]

Purpose:
to "add to the understanding of the role of email on organizational power and politics" (p. 1) based on a case study

Description:
-*size:* intermediate size university (approximately 15,000 students, 500 academics and 200 administrative staff)
-*duration:* not reported
-*type:* case study
-*group history:* organization was observed as is (relationships were already established)
-*data collection methods:* textual analysis, interviews, observations
-*design methodology:* N/A
-*technology:* email system used by employees and administrators

Summary of Findings:
Both management and employees of the University studied used email to further their political goals. "First, email is an effective means for democratizing organizations, opening channels of

communication between members at the top and bottom of the academic hierarchy. Email can create a perception of smallness, allowing large organizations to experience proximity and intimacy which are normally typical of much smaller groups. Second, thanks to its broadcasting feature …, email is a politically potent technology, lending itself quite easily to coalition building, on one hand, and to smart maneuvering that can diminish the democratizing effects of email, on the other hand." (p. 3)

Swigger, Kathleen M. and Robert Brazile (1995). "Evaluating Group Effectiveness through a computer-supported cooperative training environment," *International Journal of Human Computer Studies,* 43:523-538.

Purpose:
to evaluate the computer supported cooperative training (CSCT) tool (used to teach effective computer supported cooperative problem solving skills) "and delineate the group behaviors that lead to successful task performance in this environment." (p. 523)

Description:
-*size:* 48 graduate students randomly divided into 2 member groups
-*duration:* 1 session, no time limit set
-*type:* experimental field study
-*group history:* not reported, though implied that there was no previous relationship
-*data collection methods:* final papers' bibliographic entries analyzed, questionnaire
-*design methodology:* each group consisted of one computer science major, required to write a paper and consult with a librarian to obtain sources, and one library science major. Half of the groups used face to face consultation, the other half worked within the CSCT environment.
-*technology:* "The CSCT environment is a highly interactive program, allowing groups to pose questions and conduct exchanges within a computer environment, testing and enriching their knowledge of group skills by manipulating various online tools. It does this in the context of an information retrieval task by providing an environment that fosters the exchange of information between remote users and librarians." (p. 525)

Summary of Findings:
The CSCT system is based on developing group competencies which lead to group effectiveness: establishing operating procedures, analyzing problems, establishing criteria for good solutions, generating alternative solutions, and evaluating solutions. It is "designed to be a guided discovery system. … Groups are free to exchange information, conduct online searches, and apply the online tools to organize their information in an effective way. Tools available for these activities include those that assist in establishing correct operating procedures, a second that aids in problem orientation, a third that helps establish criteria, and a fourth that facilitates solution activities." (p. 525) Results of the study show that effectiveness scores of CSCT groups (as based on a precision score which measures the ratio or relevant retrieved documents to the total number of retrieved documents and a recall score which measures the ratio of relevant hits to the total number of relevant documents that exist in the entire database) were higher than the scores

of face to face groups. The difference in the problem-solving effectiveness of these more successful CSCT groups "was found to be significantly related to the behaviors associated with problem orientation and generation of alternate solutions" (p. 536), two of the group competency areas.

Viller, Stephen (1991). "The Group Facilitator: A CSCW Perspective," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 145-152.

Purpose:
to discuss the facilitator's role, how it will change, and how it will need to be supported in the context of computer supported cooperative work systems, an area which has largely been ignored.

Summary:
"The facilitator is a well established and important role in 'traditional' group work, existing to enable the other members of a group to achieve the group's objectives by assisting them in negotiating any problems that might occur. [The facilitator's role, focusing on group process rather than content, will vary over the course of the group's development and on the nature of the problems that arise.] "Communicating via computer has a number of effects on the interaction between members of a group, and therefore on the actions undertaken by the facilitator when performing his/her duties. These effects differ depending on the 'scenario' in which the interaction takes place, but are primarily due to the removal of face-to-face channels of communication, the addition of a new computer-mediated channel, and interaction between usage of the two types of channel." (p. 151) Computer supported cooperative work systems which support fully distributed communication (different time, different place) and those that support face-to-face meetings (same time, same place) have distinct adaptations of the traditional facilitator role which are necessary to support such group communications options and are discussed. In either case, computer support tools must be provided for the facilitator as well as the group as part of the computer supported cooperative work system, helping the facilitator to be more effective and ultimately supporting the effectiveness of the group.

Walther, J.B. (1997). "Group and Interpersonal Effects in International Computer-Mediated Collaboration," *Human Communication Research,* 23(3):342.

Purpose:
to examine "hypotheses involving the joint effects of salient group versus individual identity and long-term versus short-term group membership on the social, interpersonal, and intellectual responses of group members collaborating via computer mediated communication." (p. 342)

Description:

-*size:* 54 students (10 groups each with 5-6 members)
-*duration:* 2 assignments, each given 2 week time frame
-*type:* experimental field study
-*group history:* group members were unknown to each other
-*data collection methods:* questionnaires
-*design methodology:* groups were composed of either a) students local to the same U.S. university using face to face and computer mediated communication or b) a mix of students from a U.S. university and a university in England using computer mediated communication only. There were two consecutive group assignments: to "read, review and write a common document summarizing, critiquing, and commenting on five articles." (p. 354) Groups were randomly assigned to the experimental conditions of long-term outlook (same partners for both assignments) versus short-term outlook (different partners) and social versus individual identity instantiation.
-*technology:* electronic distribution list

Summary of Findings:
With computer mediated only partners, a similar pattern occurred in measures of relational communication, attractiveness, and study effort. In each, the highest ratings were experienced in groups with long term group identity, the lowest ratings were experienced in groups with short term group identity, and both short and long term individuated identity groups had moderate ratings. In relational communication, then, groups with long term group identity experienced the greatest affection from their partners, in terms of attractiveness, long term group identity partners were rated the highest in social attractiveness (and physical attractiveness), and long term group identity members showed somewhat more academic effort. In the mixed face to face/computer mediated communication groups, differences among partner assessments are based on the length of time variable but not the group salience variable. Members of long term groups (of both group and individual identity) communicated more affection than short term group members, and members of long term groups were rated higher in social attractiveness, though in both of these measures there was less effect than in the computer mediated groups "This research finds that certain social conditions and technology lead people from different places, who have never and will never see each other, to communicate more affection, to like each other more, to think they look better, and to work harder than people working together under other conditions in computer mediated communication or by working together face to face." (p. 365). Unexpectedly, the greatest work effort was not found in the condition expected to be the most task oriented (the short term group identity condition), but instead in the most socially oriented condition (the long term group identity condition). Overall, rather than supporting the theory that time and anticipated future interaction have uniform effects on computer mediated relational development or that salient group identity alone leads to social attraction and positive evaluations of other group members, "the present results support a magnification effect for social identity, prompting greater adherence to norms even when such adherence leads to unattractive outcomes" [such as in the short term group identity condition], where "the effect of temporal factors on positive relational development is undermined when partners' motivation to engage is dampened by a salient individual identity." (p. 362)

Weisband, S.P., S.K. Schneider, and T. Connolly (1995). "Computer-Mediated Communication and Social Information: Status Salience and Status Differences," *Academy of Management Journal,* 38(4):1124-1151.

Purpose:
"Many studies have found that groups that interact by computer-mediated communication (CMC) technologies are less prone to domination by high-status members than are face-to-face groups. We report here the results of three experiments designed to investigate participation and influence equality in mixed-status groups." (p. 1124)

Description:
-*size:* experiment 1: 54 students, experiment 2: 105 students, experiment 3: 105 students (all in groups of 3), different subjects for each experiment
-*duration:* one hour session for each task
-*type:* experimental laboratory study
-*group history:* students did not know each other before the experiments
-*data collection methods:* questionnaire
-*design methodology:* experiment 1: each group had 2 graduate (high status) and 1 undergraduate (low status) students. Group members were told that the group was of mixed status and individual member status was defined. Some were face to face groups, others computer mediated. Face to face group members introduced themselves to each other; computer mediated group messages all had name of sender included. Groups were assigned two ethical decision tasks experiment 2: some groups had 1 graduate and 2 undergraduate students, others had 1 undergraduate and 2 graduate students. The same tasks as in experiment 1 were assigned. Experiment 3: groups were divided along four conditions: face to face, computer-identified (as in experiment 1), computer-anonymous (where group status composition was identified at the start, but messages were anonymous), and computer-mislabeled (where group members were informed of the group status and which individuals had which status, but this information incorrectly labeled a graduate student as an undergraduate student). Three decision tasks were assigned.
-*technology:* email system

Summary of Findings:
The findings contrast those of previous studies: "In all three studies conducted here, high-status members participated more in group discussions than did low-status members. This was true (1) in computer-mediated and face-to-face groups, (2) for high-status members both in the majority and in the minority in their groups, (3) for groups whose members knew one another's names and for anonymous groups, and (4) with use of two different technologies for computerized interaction. In experiment 3, high-status members also exercised disproportionate influence on final results, regardless of the communication modality in use. The progression from face-to-face interaction (presumably rich in social context cues) through identified computer mediated interaction to anonymous computer mediated interaction (presumably much less rich in these cues) left untouched the basic inequalities: graduate students participated more than undergraduates and had greater influence on group decisions. There is, in short, little evidence here for the phenomenon of equalization through computer mediated interaction." (p. 1145) In

addition, peer evaluations of high and low status members were more equal in face-to-face groups than in computer mediated groups; undergraduates were evaluated more on personal information in the face-to-face groups and more on stereotypes in the computer mediated groups. "We propose that if group status differences are strong and salient, as they are in some organizations, status differences will persist or even be magnified, and unique personal information about people will be made less salient, when communication is computer mediated." (p. 1147) Overall, "status differences persisted in both face-to-face and electronic groups. We suggest that status labels and impressions based on them have a larger impact on participation and influence than do communication media." (p. 1124)

5. ORGANIZATIONAL IMPLICATIONS

Andriessen, J. H. Erik (1996). "The Why, How and What to Evaluate of Interaction Technology: A Review and Proposed Integration," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 107-124.

Purpose:
to develop a framework (meta-model) for the evaluation process of interaction technology that encompasses many existing evaluation approaches.

Summary:
The author describes current methodologies for evaluating interaction technology, identifying four "research traditions", each with its own combination of research paradigms, strategies, data collection and data analysis techniques. These four traditions are: analysis of human-computer interaction, analysis of communication structure and behavior, group interaction analysis, and media choice and media role. In evaluating interaction technology there are three levels of interaction that should be examined: between user and tool, between users mediated by a tool, and organizational context. Outcomes (products, individual rewards, group viability, and organizational environment impact) and inputs (tasks, tools, users and the organizational environment) must also be evaluated. He proposes a framework for the evaluation process, seven steps to be taken to ensure a complete evaluation process, based on the ideas above. Evaluation should: "1) analyze the intensity and frequency of system use, 2) analyze the impact of the system (on processes, outcomes, and possibly on input)…, 3) analyze the problems encountered, i.e. characterisation of the constraints or requirements for optimal system use, 4) characterise the system used …, 5) describe the input elements…, 6) identify the intended success criteria, and 7) …evaluate and explain by comparing these results, in order to find answers to the following basic questions: a) does the system improve the interaction process and its outcomes? To what extent and why? b) is the communication process improved? To what extent and why? c) does the system meet its purposes? d) is the system enabling new activities? And e) what are the advantages of the system, what are its costs, and are the benefits outweighing the costs?" (p. 123)

Bullen, Christine V. and John L. Bennett (1991). "Groupware in Practice: An Interpretation of Work Experiences," in *Computerization and Controversy,* Rob Kling (ed.), Academic Press, San Diego, CA.: 348-382. [also in Baecker 1993, Marca 1992]

Purpose:
"to investigate the current status of group work in organizations and to observe how computer-based tools were being employed in the facilitation of group work.... To develop insight on

factors that should be influencing software design and to report experiences that can help guide managers who put group support systems into practice." (p. 350)

Description:
-*size:* 223 people in 25 organizations at 31 sites
-*duration:* not reported
-*type:* correlational field study
-*group history:* interviewed groups were already "cohesive business teams" (p. 351)
-*data collection methods:* interviews, observations, and interactions
-*design methodology:* interviewed people from a wide range of industries, different size companies that work in business teams of 7-35 people and that had some form of technology to support different time, different place group work
-*technology:* all companies studied had at least one groupware system in use, though the specific systems varied from company to company; "all of the systems studied provided the following functionality: construction/editing facilities, … electronic exchange of text, … directory, … time marking and time keeping, … and general tools." (p. 354)

Summary of Findings:
From a design perspective, there were a number of findings. First, electronic message communication is the primary tool used; "electronic messaging capability, regardless of its user interface design, ease or difficulty, or level of sophistication, was used extensively." (p. 359) Second, the ability of electronic messaging systems to provide various kinds of links between messages was an important improvement over traditional forms of communication. More specifically, advantages included "collection of notes in one place, [a] chronological record, [the] ability for latecomers to view an entire record of interaction, [and] knowledge of the 'right' place to put new messages." (p. 361) Third, the functionality that is included in a technological system and how it is offered are important factors, and fourth, if tools are isolated from one another or in the way they affect user work flow, this can have a negative impact on how productive groupware systems are. From an organizational perspective: " people report [that the] most value [is received] from tools that parallel their non-electronic activities, [that the] benefits gained need to balance or outweigh the invested resource, [that] groupware implementation is simultaneously a social and technical intervention [factors such as expectations, training, champions, and evolution are important to note], process redesign may be required to realize productivity improvement, [and] creating productive teams is a challenge." (p. 367)

Eason, Ken and Wendy Olphert (1996). "Early Evaluation of the Organizational Implications of CSCW Systems," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 75-89.

Purpose:
to present "a method (the user-cost benefit assessment method) for making an evaluation of the organizational implications of a CSCW system" (p. 76) which is explicitly designed as an early evaluation technique, whereas many existing studies are done at later stages.

Summary:
The early evaluation method presented is "based upon a mixture of organizational analysis and interpretation by the user community. The philosophy underpinning this approach is that effective systems are created by a partnership between developers and the users and/or stakeholders in the organization which is to operate the new system." (p. 78) "The essence of this method is to provide a usage scenario and a process by which the stakeholders in an organization can predict the implications of a development and make an assessment of these implications. The usage scenario specifies a mapping of the functionality of the technical system onto the organizational structure. The evaluation process examines the usage scenario by exploring its implications in terms of changes, advantages, and disadvantages (benefits and costs) for each group of stakeholders who could be affected by the system." (p. 78) There are four stages in the method: 1) using an outline of the technical system and current organization, a preliminary analysis is done which includes a user population mapping and a description of role responsibilities; 2) usage scenarios are evaluated using checklists to rate the impact of the technical system on user groups at the task, job and group/organization levels; 3) a profile of organizational impacts and their acceptability is made and examined against the desired benefits that the organization has for the system; and 4) further analysis (loops through the previous three steps) is done using additional and modified usage scenarios.

Easterbrook, Steve (1996). "Coordination Breakdowns: How Flexible Is Collaborative Work," in *CSCW Requirements and Evaluation*, Peter Thomas (ed.), Springer Verlag, New York: 91-106.

Purpose:
to argue "that existing approaches to the analysis of group activities do not adequately predict the results of introducing a new software system," and to begin to address the problem by developing "a model of collaborative behavior that focuses on the concepts of shared understanding, breakdown, and conflict," finally suggesting ways this framework "can be used to assist in the development of new groupware applications." (p. 106)

Summary:
Using email as an example source of group support systems and their communication problems, the author identifies features of email that contribute to miscommunication (including lack of status cues, easy access, isolation from one's audience, immediacy, no regulatory feedback, and lack of inflection), and problems which have resulted from these features (including established organizational and cultural norms disregarded, requesters-informers imbalance, messages circulating too widely, ill-considered thoughts and gut reactions conveyed, and messages invoking unintended reactions in their recipients through misunderstood humor and irony), as well as describing several protocols which have emerged to help users maintain a shared understanding of the communication process to deal with these problem areas. He then presents a framework to allow more accurate prediction of the impact of a new software system on group interaction. This framework is based on the belief that "shared understanding (equivalent expectations about a situation) provides a basis for communication and coordinated action," (p. 104), that

communication breakdowns (where the expectations of two or more participants are mismatched) are useful in pointing out assumptions and conflicts between participants, and that identified conflict can be worked through to provide new shared understandings. The author discusses mechanisms and techniques of both breakdown and harmonizing methods (which assist in developing shared understanding), which can help in the analysis of group interactions as well as in evaluating proposed groupware systems "in terms of support for these mechanisms, [and] to predict how well a group will adapt to it. The model indicates where coordination breakdowns are likely to occur, and therefore where attention must be paid to the way in which the group support system improves or hinders discovery of breakdown." (p. 106)

Garton, L. and B. Wellman (1995). "Social Impacts of Electronic Mail in Organizations: A Review of the Research Literature," *Communication Yearbook*, 18:434-53.

Purpose:
to review "research into how e-mail shapes - and is shaped by - organizational structures and processes," (p. 434) including benefits, concerns and effects of e-mail at the individual, group and overall organizational level.

Summary:
Many advantages have been hoped for in computer mediated communication, including "productivity and efficiency gains; greater organizational communication, commitment, and solidarity; more participatory and egalitarian decision making; better decisions; and administrative and geographic decentralization." (p. 435) These technological systems have also raised concerns about "increased management surveillance and control, more standardized work, centralized power and loss of branch autonomy, disrupted group processes and decision making, and increased worker alienation." (p. 435) Because email has been found to provide fewer cues that face to face communication about social roles, physical context, and interactions, it fosters status equalization but misunderstandings may be more likely. Email communication has been found in some cases to be more uninhibited, nonconformist, and conflictual. Email groups have been slower to develop leaders and reach consensus, but a greater range of ideas may produce more innovative and better decisions. Email increases access to new people and information that would otherwise be unavailable, and may encourage more fluid groups with broader leadership and participation. The authors suggest that research must be broadened to take into account previous relationships among group members, analyze group interactions over longer periods of time, and study more real organizations, where group members must simultaneously balance a number of tasks and social relationships.

Gash, Debra C. and Wanda J. Orlikowski (1991). "Changing Frames: Towards an Understanding of Information Technology and Organizational Change," *Academy of Management Best Papers Proceedings,* Academy of Management, Miami Beach, FL, pp. 189-193.

Purpose:
to describe how "technological frames" contribute to different orders of organizational change.

Summary:
Technological frames are "the assumptions, meanings, and cognitions that people use to understand the nature and role of technology in organizations." (p. 189) Frames may vary between people, and may vary within an individual over time or in different contexts. "Technology is interpretively flexible, hence, open to different interpretations by multiple social groups who will construct different technological frames or interpretations of the technology based on their interactions with it. ... Technological frames are powerful in that assumptions held about the function, value and role of technology will strongly influence the choices made regarding the design or use of those technologies." (p. 189) These technological frames affect the level of change that occurs when technology is introduced into an organization, in both intended and unintended ways. "Actors in organizations may purposively intend organizational interventions to create either first, second or third order changes, while examination of actual interventions suggests that there may be differences between the order of change intended or planned, and that which emerges." (p. 190) First order change brings incremental change in operations; "automation of existing tasks and processes creates information systems that reflect and reaffirm the organizational status quo, resulting in linear changes in current practices and structures." (p. 190) Sometimes in addition to the intended first order changes, there can be unintended consequences due to a number of interacting factors, including technological complexity, poorly understood scope of change, badly trained users, and unanticipated opportunities. These unintended changes may be of the first order magnitude, or may actually be unexpected (and perhaps unrecognized) second order change. Second order change occurs when information technology creates innovative ways of doing things, replacing the status quo; "existing assumptions, tasks, knowledge, processes, social relations, and strategies may no longer apply after the deployment of information technology." (p. 191) Unintended second order changes may occur even if some second order change was intended, if potential interactions were not foreseen or if workers are uncomfortable with the level of change, feeling "threatened by the transformation of familiar structures, social relations, status, and knowledge." (p. 191) Finally and most transformative, the shift involved in third order change "does not require the adoption of new assumptions about technology, but a recognition of technological frames, and an understanding of their influence on managers, systems designers, and users in planning, creating, maintaining, and using technology." (p. 191) In this case, the technology itself must provide support for the required monitoring and examination of assumptions underlying technological frames by being adaptable to changes in the organization as well as supporting task execution. Support for this level of change is not provided in current technology; customizable tools with flexibility of module grouping would be necessary. In addition, awareness by managers of the intended order of change and work on finding appropriate methods to measure second and third order change (the quantitative models appropriate for measuring first order change may not be appropriate) are important areas to be addressed.

Grudin, J. (1994). "Groupware and Social Dynamics. Eight Challenges for Developers," *Communications of the ACM,* 37(1):93-105.

Purpose:
to describe differences involved in the computer support of group work from support focused on entire organizations or single individuals and to identify challenges in the development of groupware systems that arise from these differences.

Summary:
Unlike large scale organizational information systems, which have high visibility and large perceived benefits, groupware systems tend to affect smaller groups, promise smaller scale benefits and require less expense, thereby garnering less management commitment and organizational restructuring to support successful integration. Designers must have a better understanding of the organizational context into which their groupware product will be placed. Eight major challenges exist of which groupware developers must be aware: 1) a disparity in work and benefit, 2) critical mass and prisoner's dilemma problems, 3) disruption of social processes, 4) exception handling, 5) unobtrusive accessibility, 6) difficulty of evaluation, 7) failure of intuition, and 8) the adoption process. Email has been such a success because it has properties that minimize all eight of the problems mentioned above. Suggested methods to foster success at meeting some of the organizational challenges to groupware development and use include extending successful single-user applications by adding group support features, finding and building on niches where existing groupware succeeds, finding ways to provide direct benefits for all group members, educating managers and developers about groupware, the risks involved, and the resources and approaches that are required, and better anticipating organizational change, among others.

Johnson-Lenz, Peter and Trudy Johnson-Lenz (1991). "Post-mechanistic Groupware Primitives: Rhythms, Boundaries and Containers," in *Computer-Supported Cooperative Work and Groupware,* Saul Greenberg (ed.), Academic Press, San Mateo, CA: 271-293.

Purpose:
to explore a system which would support groups in tailoring a groupware system as needs and purposes of the group change.

Summary:
Current groupware systems are based on one of two polar approaches, "(1) mechanism - making groups work through the use of explicit forms and procedures [or] (2) context or open space - allowing groups to self-organize." (p. 271) Groups actually need more than either of these two approaches; they need some facility for each plus the ability to tailor the system to fit the current

needs of the group. The authors have developed a system of "post-mechanistic" groupware primitives including six components (open space (context), timing, rhythms, boundaries, containers, and procedures (mechanisms)) which they argue bridge these two extremes. The components are tailorable to meet specific group needs; future more complex versions of this "purpose centered groupware" idea should be able to support fundamental change in organizations to allow continuous learning.

Markus, M. Lynne (1994). "Finding a Happy Medium: Explaining the Negative Effects of Electronic Communication on Social Life at Work," *ACM Transactions on Information Systems*, 12(2):119-149.

Purpose:
to explore several alternative explanations for why electronic communication technology sometimes has negative social effects.

Description:
-*size:* 29 manager and administrative assistant interviews, 504 managers surveyed (out of 825 in the company)
-*duration:* N/A
-*type:* correlational field study
-*group history:* established managerial relationships
-*data collection methods:* interviews, surveys, and archives (email and paper mail samples from interviewees, several managers' complete logs of email for a typical day)
-*design methodology:* N/A
-*technology:* email system

Summary of Findings:
Technological determinism (focusing on the material characteristics of media), the rational actor perspective (focusing on users' intentions and behaviors and their deliberate use of technology in support of certain social goals), and the emergent process perspective (focusing on the social definition of technology's uses) are three theories that would each explain the negative social effects of electronic communication differently. In this case study there "was some evidence of negative social effects due to the widespread and heavy use of e-mail, but these effects did not appear to be particularly severe." (p. 517) Observed behavior included avoidance of personal contact, use of email to deliver negative messages, avoidance of messages and/or careful wording to allay concerns about a forwarding trail being used against the sender at a later time. The "rational actor" explanation was consistent with the findings: "managers themselves tended to attribute the negative effects they observed to other people's deliberately intended inappropriate behavior, rather than to the technological characteristics of the technology. And they themselves deliberately behaved in ways that could be viewed as intended to produce the so-called negative effects." (p. 517) Other findings suggest that the emergent process perspective also contributed; "some negative effects occurred despite HCP managers' deliberate attempts to prevent them, and these effects can actually be attributed in part to users' well-intentioned efforts to use email effectively in the context of the social relationships at work." (p. 517) Examples of such negative

effects based on positive intent include compulsive documentation, aggressive accountability games, and managers interrupting face to face meetings in an effort to effectively screen their own email messages. Using these perspectives to explain negative social effects (looking beyond only the technological determinist perspective) may support explanations of more complicated issues and results.

Monk, Andrew, John McCarthy, Leon Watts and Owen Daly-Jones (1996). "Measures of Process," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 125-139.

Purpose:
"to identify measures of the communication process (i.e., the interaction between participants) with demonstrable discriminative power," (p. 138) and to suggest ways to determine which measures are best used in a particular context.

Summary:
A variety of measures are candidates for use in discriminating between different equipment configurations for computer mediated communication. These include global measures of social salience (as measured by common ground as agreement in recall), measures derived from surface features of conversational content (measures of first and second person pronouns to determine social context, conferring expressions vs. explicit topic openings to measure common ground), and measures of conversational structures (including topic mention, coherence, utterance, overlap and interruptions, and gaze states over video links). Measuring a variety of these variables is recommended; "the relative importance of those criteria will depend on the eventual work context in which the configuration is to be used." (p. 134) Criteria of a specific work context which can be ranked to determine which methods are the best match for measurement needs of the given context include ease of communication, clarity of commitment, task focus, non-verbal sensitivity, and interactivity.

Okamura, Kazuo, Masayo Fujimoto, Wanda J. Orlikowski and JoAnne Yates (1995). "Helping CSCW Applications Succeed: The Role of Mediators in the Context of Use," *The Information Society,* 11(3):157-172. Also in *Proceedings of the Conference on Computer Supported Cooperative Work 1994,* Association of Computing Machinery.

Purpose:
to examine the role of mediators in a computer conferencing system and to propose general suggestions for effective mediators

Description:

-*size:* 177 project group members, divided into 6 teams (an administration team, a hardware development team, and four software development teams).
-*duration:* 17 months
-*type:* correlational field study
-*group history:* newly formed group for this particular project, not reported whether individuals had previous experience together
-*data collection methods:* interviews, computerized records of all email and newsgroup postings
-*design methodology:* N/A
-*technology:* an asynchronous computer conferencing system using newsgroups "to support communication among the members of a project group developing a new computer product." (p. 56)

Summary of Findings:
Mediators, "individuals who intervene deliberately and with organizational authorization in the ongoing use of CSCW technology within its context of use," (p. 56) acted in several ways to shape the example conferencing system, defining the role of the news system and promoting usage as the technology was introduced, and modifying the system (overall structure and usage of specific newsgroups) as the context changed over time. The mediators studied were effective, providing a good blend of proactive leadership and reaction to user feedback. "Our findings suggest that a CSCW application was introduced and used relatively effectively because a group of mediators managed not only the technical issues, but also issues of context and use, with carefully planned objectives and constructive reactions to users' feedback. This suggests that intervenors may be more effective when they are organizationally authorized and play an ongoing role in facilitating technology use." (p. 63) The authors suggest that to be most effective, mediators should be users as well as mediators, should be sensitive to user feedback, and should be technically skilled. To facilitate effective adaptation of technology as contexts of use change, in addition to encouraging user feedback, mediators should employ "ongoing monitoring of usage patterns to detect errors, misunderstandings, and areas of potential improvement; routine minor modifications of technology and usage guidelines to maintain and promote current use; [and] periodic reassessments and changes to the technology and its norms of use to reflect changed organizational and technological circumstances." (p. 64)

Orlikowski, Wanda J. (1993). "Learning from Notes: Organizational Issues in Groupware Implementation," *The Information Society*, 9(3):237-250. [also in Kling, *Computerization and Controversy*]

Purpose:
"to investigate whether and how the use of a collaborative tool changes the nature of work and the pattern of social interactions in the office, and with what intended and unintended consequences." (p. 174)

Description:

-*size:* 91 interviewees, employees at a large consulting services firm
-*duration:* 5 months
-*type:* case study
-*group history:* strong hierarchical career structure at the firm, operations based more on a matrix structure, relationships within the company already established at the time of observation
-*data collection methods:* unstructured interviews, document review, observation of meetings, work sessions and training classes
-*design methodology:* N/A
-*technology:* Lotus Notes

Summary of Findings:
"Where people's mental models do not understand or appreciate the collaborative nature of groupware, such technologies will be interpreted and used as if they were more familiar technologies, such as personal stand-alone software." (p. 174) Specifically, in this organization no explicit information was provided to employees on why Notes was purchased, and there was no formal implementation plan, dissemination strategy, or emphasis on training, so users approached the system through their existing mental models which were based on traditional personal computing software programs. In addition, the structural elements of the organization (reward systems, policies and procedures, and firm culture and work norms) all promoted individual productivity and competence rather than the shared focus that management expected to be supported by Notes. "Where the premises underlying the groupware technology (shared effort, cooperation, collaboration) are countercultural to an organization's structural properties (competitive and individualistic culture, rigid hierarchy, etc.), the technology will be unlikely to facilitate collective use and value. ... Conversely, where the structural properties do support shared effort, cooperation, and collaboration, it is likely that the technology will be used collaboratively, that is, it will be another medium within which those values and norms are expressed." (p. 174)

Palen, Leysia Ann (1997). "Groupware Adoption and Adaptation," *Proceedings CHI97.*

Purpose:
to study the use of calendaring systems and the "technical, behavioral, and organizational factors that enabled initial adoption." (p. 1)

Summary:
In this preliminary report, the author presents interim findings of the behavioral and organizational effects of calendaring systems at two sites as well as factors which promote their use. These findings suggest that social norms and communication behaviors about arranging meetings might be influenced by the amount of information calendars reveal, that tangible artifacts can be created out of technologically supported collaborations which in turn are useful for other purposes, and that there are potentially critical tradeoffs between efficiency, information resource creation, and privacy. In addition, factors that contribute to widespread adoption are identified, including a bottom up adoption trajectory, strong technical infrastructures, mature "behavioral

infrastructures" (where employees reliably monitor and respond to electronic communication), and incorporation of linguistic references to the calendaring systems into everyday conversations.

Perin, Constance (1991). "Electronic Social Fields in Bureaucracies," *Communications of the ACM*, 34(12):75-82.

Purpose:
"Drawing on several illustrative examples of puzzling organizational responses to groupware systems, this article suggests a social and cultural explanation of the institutional dynamics inhibiting their intended effectiveness." (p. 76)

Description:
-*size:* 150 managers and professionals from a variety of organizations
-*duration:* N/A
-*type:* case study
-*group history:* N/A
-*data collection methods:* interviews, focus group discussions
-*design methodology:* N/A
-*technology:* various organizations and their specific systems are used for examples

Summary of Findings:
Social fields, "semiautonomous and self-regulating human associations that regularly appear within established institutions and organizations," (p. 76) describe an important, often misunderstood, aspect of organizations which are affected by groupware systems. Manager and employee perceptions of electronic social fields influence levels of hierarchy and cooperation in the organization; these perceptions are based on cultural beliefs about social fields including 1) "managers may see social fields as back regions and associate escape, subterfuge, and subversion with them" (because traditional organizational control enforced by time and location constraints may be broken by technology), 2) electronic "social fields' principles of self-management, self-regulation, semiautonomy, sharing, and disclosure borrow from the cultural domains of family life and leisure, which challenge the hierarchical, rule-bound, and disciplinary premises of work organizations," 3.) "electronic social fields are by their nature ambiguous and unpredictable forces, characteristics that, in any social context, evoke suspicions and negativism", and 4.) "electronic social fields reveal tensions between employees' spontaneity and bureaucratic routines." (p. 80) Groupware design, adoption and support must take these social fields into account in order to be fully effective.

Rogers, Yvonne (1994). "Exploring Obstacles: Integrating CSCW in Evolving Organizations," *Proceedings of the Conference on Computer Supported Cooperative Work 1994*, Association of Computing Machinery.

Purpose:
to examine "the co-evolution process involved in tailoring a CSCW system to fit in with the current organisational structure, whilst concurrently adapting the work practices to enable the system to support collaboration." (p, 67), and to consider how this process can be better facilitated.

Description:
-*size:* met with 4 directors, sales managers, sales consultants, and accounting staff of a travel agency with about 50 staff members
-*duration:* 4 months
-*type:* case study
-*group history:* work structures already in place, highly interdependent tasks
-*data collection methods:* observation, tape recordings of conversations, discussion participation
-*design methodology:* N/A
-*technology:* old system: C-Base, a multi-user booking and ticketing system accessed by many different staff members; new system: Gecko, a new multi-user booking and ticketing system which supported "the need to break away from their parent company, to which the existing system was linked, the need to expand incrementally, which was not allowed by the current system; and the need for better accounting and marketing facilities, which the current system did not provide." (p. 70)

Summary of Findings:
Problems caused in the integration of the new system focus on the following areas: "(i) what the local and global consequences are for various users when a CSCW system restructures the working procedures of another set of users, and (ii) what kinds of interactions and conflicts emerge when different users seek to change the system and their working practices, and how those interactions and conflicts get resolved." (p. 69) These two views are addressed in terms of the framework concepts of distributed knock-on viscosity and the gradient of resistance. "In the context of CSCW, the concept of viscosity is extended to describe the distributed knock-on effects that can occur across users who are supported by the same system. More specifically, the system may be designed to enable one group of users to carry out their tasks in a flexible and unconstrained manner (i.e., low viscosity), but which has consequences that are propagated to other users, requiring them to carry out extraneous work or by constraining them to work in an inflexible way (i.e., high viscosity). Hence, in the study, the system was configured to be highly viscous for the consultants, making it difficult for them to make amendments to the client files, but providing management and the accountancy staff with a highly flexible support environment." (p. 71) "The notion of 'gradient of resistance' refers to the different forms of resistance that are encountered in the design process, where some are more severe than others. … In the example analysed above, different forms of resistance were encountered: making small changes (e.g., amending the authorisation process) was met with shallow resistances as the need for change was considered central for the company to be able to function in the customary way. On the other hand, proposals for substantial changes (e.g., the implementation of shared automated databases) were confronted with steeper gradients of resistance. … The resistances were also seen as interacting: a steep gradient could be offset by eliminating some of the smaller gradients. For example, introducing a radical new way of working was seen as a way of eliminating the need to

make smaller modifications to the system." (p. 75) In addition to providing suggestions on handling specifics with each of these two areas of difficulty, the author suggests that for a successful implementation, "above all, the company needs to be able to make decisions and manage the emergent and interacting resistances and viscosities that multiply during the transition phase." (p. 76)

Tyre, Marcie J. and Wanda J. Orlikowski (1994). "Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations," *Organization Science,* 5(1):98-118.

Purpose:
to examine the pattern of technological adaptation in organizations and forces influencing this pattern.

Description:
-*size:* company 1: 41 project groups, 89 participants; company 2: 5 project groups, 119 participants; company 3: 51 individual users, 51 participants
-*duration:* study 1 (company 1): retrospective; study 2: longitudinal (8 months); study 3: longitudinal (4 months)
-*type:* correlational field study
-*group history:* not reported
-*data collection methods:* varied over the three studies; combinations of interviews, questionnaires, and observation, and review of documents. "All three included in-depth field research. … Two of the studies were longitudinal, … the third study was retrospective and relied on project records and documentation to reconstruct users' initial expectations and their activities over time." (p. 101)
-*design methodology:* "Each of the three projects focused on multiple technologies within a single organization, and examined use and adaptations by groups or individual users. The studies were matched on four dimensions to ensure comparability: (i) The technologies studied had passed the test of technical and organizational feasibility; … (ii) The technologies studied altered the work in some obvious although not radical ways; … (iii) The technologies were open-ended in the sense that users (with or without assistance) had the means to make changes; … [and] (iv) The focus of the research was consistent across the three studies; that is, all investigated new process technologies from the time of initial installation of the technology until full and regular use was achieved." (p. 101)
-*technology:* varied over the three sites: site 1: production equipment; site 2: computer-aided software engineering tools; site 3: personal computing environments

Summary of Findings:
Technological adaptation, "the adjustments and changes following installation of a new technology in a given setting," (p. 99) refers to changes in both the physical aspects of technology and the users' procedures, assumptions, knowledge or relationships. "Adaptation efforts

appeared to fall off abruptly after a short initial introduction period. This initial period seemed to represent a finite window of opportunity during which users found it relatively easy to make changes to new technologies-in-use. Afterward, adaptation efforts dropped off, with users finding few opportunities to examine outstanding questions or to review initial choices." (p. 104) This effect was noticeable regardless of the size of the project or differences in time to full integration of various projects. Several organizational forces influence this pattern of adaptation. First, pressures of production create a heightened recognition that making changes could mean making mistakes or otherwise affecting the production process in a negative way. Second, "patterns of use congeal and become constraining over time. … As users gained experience, they established stable routines, norms and habits for using the technology which decreased the need for discussion, coordination or effortful decision making." (p. 107) Third, "expectations adjust to fit experience. …As time went on, problems or opportunities often disappeared from view - not because the technology was improved, but because standards were lowered or interpretations amended." (p. 108) Fourth, there is an erosion of team membership and enthusiasm as people's focus shifts to other tasks and demands. Modifications did occur after this initial period, however. Like the initial adaptation period, these episodes were also of limited duration. They often occurred in response to some disruptive event or interruption, such as the addition of new tools, new product requirements, new management action, new personnel, schedule loosening, etc. These interruptions "appear to open up the way for a period of experimentation, reflection, and modification. However, as pent up performance demands resurface, and as modifications succeed in enabling participants to turn their attention to these demands, the openness to further adaptation diminishes rapidly." (p. 115) Generally, then, "this finding suggests that what appears, at an aggregate level, to be 'continuous improvement' may more accurately be described as the sum of discrete episodes of adaptive activity carried out at different times and applied to different technologies." (p. 113)

Whittaker, Steve (1996). "Talking to Strangers: An Evaluation of the Factors Affecting Electronic Collaboration," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 409-418.

Purpose:
to compare user perceptions of how database moderation, database size, and group diversity factors that contribute to the successful use of Lotus Notes with study findings on actual database use of these same factors

Description:
-*size:* 21 Notes users
-*duration:* N/A
-*type:* correlational field study
-*group history:* N/A
-*data collection methods:* interviews, database archives and communication logs

-*design methodology:* collected data on each document and on the database generally: how often accessed (read and contributed to), browsing ratio (reads to writes), conversational thread lengths, number of dead ends
-*technology:* Lotus Notes

Summary of Findings:
Users believed that the presence of moderation in a database and restricting the database size both contribute to the successful use of Notes. There was disagreement on the effects of group diversity, with some users predicting positive effects (with increased chance of getting an answer to an obscure question, and multiple perspectives available on general discussion topics) and others predicting negative effects (arguing that small, focused groups have more commitment and motivation, and are easier to keep focused). Study findings of actual documents revealed that moderation discouraged conversations: moderated databases had shorter conversations with more dead ends and reduced browsing (no impact on the number of reads). Diversity was found to be beneficial; having more participants resulted in longer conversations, fewer deadends, and more reading (no impact on browsing). Size of the database also contributed positively: larger databases had longer conversations, fewer deadends, and more reading (no effect on browsing). In other words, contrary to user expectations, moderation did not contribute to successful use of Notes, while large size and diversity were beneficial. The authors "discuss possible reasons for these findings in terms of critical mass and media competition, and conclude with implications for design." (p. 409)

6. CITATION LIST

(with section number of citation)

Andriessen, J. H. Erik (1996). "The Why, How and What to Evaluate of Interaction Technology: A Review and Proposed Integration," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 107-124. (5)

Bellotti, Victoria, and Sara Bly (1996). "Walking Away from the Desktop Computer: Distributed Collaboration and Mobility in a Product Design Team, *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 209-218. (3)

Berlin, Lucy M. and Robin Jeffries (1992). "Consultants and Apprentices: Observations about Learning and Collaborative Problem Solving," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 130-137. (3)

Bostram, R., R. Watson, and S.T. Kinney (eds.) (1992). *Computer Augmented Teamwork: A Guided Tour,* Van Nostrand Reinhold, New York. (1)

Bostrom, Robert P. and Robert Anson (1992). "The Face-to-Face Electronic Meeting: A Tutorial," in *Computer Augmented Teamwork: A Guided Tour,* R. Bostram, R. Watson and S.T. Kinney (eds.), Van Nostrand Reinhold, New York: 16-33. (4)

Bullen, Christine V. and John L. Bennett (1991). "Groupware in Practice: An Interpretation of Work Experiences," in *Computerization and Controversy,* Rob Kling (ed.), Academic Press, San Diego, CA. [also in Baecker 1993, Marca 1992] (5)

Cannon-Bowers, Janis A., Eduardo Salas, and Sharolyn Converse (1993). "Shared Mental Models in Expert Team Decision Making," in *Individual and Group Decision Making: Current Issues,* N. John Castellan (ed.), Erlbaum, Hillsdale, NJ: 221-246. (4)

Carlson, John R. and Robert W. Zmud (1994). "Channel Expansion Theory: A Dynamic View of Media and Information Richness Perceptions," *Academy of Management Best Papers Proceedings 1994.* (2)

Chidambaram, L., R.P. Bostrom, and B.E.Wynne (1991). "A Longitudinal Study of the Impact of Group Decision Support Systems on Group Development," *Journal of Management Information Systems,* 7(3):7-25. (4)

Cole, Paul and Judith Nast-Cole (1992). "A Primer on Group Dynamics for Groupware Developers," in *Groupware: Software for Computer-Supported Cooperative Work,* David Marca and Geoffrey Bock (eds.), IEEE Computer Society Press, Los Alamitos, CA: 44-57. (4)

Conklin, E. Jeffrey (1992). "Capturing Organizational Memory," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 561-565. (3)

Eason, Ken and Wendy Olphert (1996). "Early Evaluation of the Organizational Implications of CSCW Systems," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 75-89. (5)

Easterbrook, Steve (1996). "Coordination Breakdowns: How Flexible Is Collaborative Work," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 91-106. (5)

Ellis, C.A., S.J. Gibbs, and G.L. Rein (1991), "Groupware: Some Issues and Experiences," *Communications of the ACM,* 34(1):38-58. [also in Marca and Bock 1992] (1)

Finholt, Tom and Lee S. Sproull (1990). "Electronic Groups at Work," *Organization Science,* 1(1):41-64. [also in Baecker 1993:431-442] (4)

Finholt, Tom, Lee Sproull, and Sara Kiesler (1990). "Communication and Performance in Ad Hoc Task Groups," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 291-325. (4)

Fitzpatrick, Geraldine, Simon Kaplan, and Tim Mansfield (1996). "Physical Spaces, Virtual Places and Social Worlds: A study of Work in the Virtual," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 334-343. (3)

Gabarro, John J. (1990). "The Development of Working Relationships," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 79-110. (4)

Garton, L. and B. Wellman (1995). "Social Impacts of Electronic Mail in Organizations: A Review of the Research Literature," *Communication Yearbook,* 18:434-53. (4)

Gash, Debra C. and Wanda J. Orlikowski (1991). "Changing Frames: Towards an Understanding of Information Technology and Organizational Change," *Academy of Management Best Papers Proceedings,* Academy of Management, Miami Beach, FL, pp. 189-193. (5)

Grudin, J. (1994). "Groupware and Social Dynamics. Eight Challenges for Developers," *Communications of the ACM,* 37(1):93-105. (5)

Grudin, Jonathan (1994). "Computer Supported Cooperative Work: History and Focus," *Computer,* 27(5), 19-26. (1)

Gutwin, Carl and Saul Greenberg (1996). "Workspace Awareness for Groupware," *Proceedings of CHI96. (3)*

Hiltz, Starr Roxanne and Barry Wellman (1997). "Asynchronous Learning Networks as a Virtual Classroom," *Communications of the ACM,* 40(9): 44-49. (2)

Hiltz, S.R., K. Johnson, and M. Turoff (1986). "Experiments in Group Decision Making: Communication Process and Outcome in Face to Face Versus Computerized Conferences," *Human Communication Research,* 13(2):225-52. (4)

Hindus, Debby, Mark S. Ackerman, Scott Mainwaring, and Brian Starr (1996). "Thunderwire: A Field Study of an Audio-Only Media Space," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 238-247. (2)

Hollan, Jim and Scott Stornetta (1992). "Beyond Being There," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA. (3)

Holmes, Michael E. (1995). "Don't Blink Or You'll Miss It: Issues in Electronic Mail Research," *Communication Yearbook,* 18: 454-463. (1)

Hymes, Charles McLaughlin and Gary M. Olson (1992). "Unblocking Brainstorming through the Use of a Simple Group Editor," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 99-106. (4)

Isaacs, Ellen A., John C. Tang, and Trevor Morris (1996). "Piazza: A Desktop Environment Supporting Impromptu and Planned Interactions," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 315-324. (3)

Johansen, Robert (1992). "An Introduction to Computer-Augmented Teamwork," in *Computer Augmented Teamwork: A Guided Tour,* R. Bostrom, R. Watson, and S. Kinney (eds.), Van Nostran Reinhold, New York: 5-15. (4)

Johnson-Lenz, Peter and Trudy Johnson-Lenz (1991). "Post-mechanistic Groupware Primitives: Rhythms, Boundaries and Containers," in *Computer-Supported Cooperative Work and Groupware,* Saul Greenberg (ed.), Academic Press, San Mateo, CA: 271-293. (5)

Kiesler, Sara, Jane Siegel and Timothy W. McGuire (1988). "Social Psychological Aspects of Computer-Mediated Communication," in *Computer Supported Cooperative Work: A Book of Readings,* Irene Greif (ed.), Morgan Kaufmann, San Mateo, CA: 657-682. (4)

King, Ruth C. (1991). "The Effects of Communication Technology on Group Collaboration," *Academy of Management Best Papers Proceedings 1991*. (2)

Krauss, Robert M. and Susan R. Fussell (1990). "Mutual Knowledge and Communicative Effectiveness," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 111-145. (2)

Kraut, Robert E., Robert S. Fish, Robert W. Root, and Barbara L. Chalfonte (1990). "Informal Communication in Organizations: Form, Function and Technology," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA, 1993. (3)

Kraut, Robert E., Carmen Egido and Jolene Galegher (1990). "Patterns of Contact and Communication in Scientific Research Collaboration," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 149-171. (3)

Lea, Martin and Russell Spears (1991). "Computer-mediated communication, de-individuation and group decision-making," *International Journal of Man-Machine Studies,* 34:283-301.[also in Greenberg 1991] (4)

Losada, Marcial, Pedro Sanchez and Elizabeth E. Noble (1990). "Collaborative Technology and Group Process Feedback: Their Impacts on Interactive Sequences in Meetings," *Proceedings of the Conference on Computer Supported Cooperative Work 1990:* 53-64. (4)

Mandviwalla, Munir and Lorne Olfman, (1994). "What Do Groups Need? A Proposed Set of Generic Groupware Requirements," *ACM Transactions on Computer-Human Interaction,* 1(3):245-268. (4)

Mark, Gloria, Jorg M. Haake, and Norman A. Streitz (1996). "Hypermedia Structures and the Division of Labor in Meeting Room Collaboration," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 170-179. (4)

Markus, M. Lynne (1994). "Finding a Happy Medium: Explaining the Negative Effects of Electronic Communication on Social Life at Work, *ACM Transactions on Information Systems,* 12(2):119-149. (5)

Markus, M. Lynne (1992). "Asynchronous Technologies in Small Face-to-Face Groups," *Information Technology and People,* 6(1):29-48. (4)

Markus, M. Lynne (1994). "Electronic Mail as the Medium of Managerial Choice," *Organization Science,* 5(4):502-527. (2)

McDaniel, Susan E., Gary M. Olson, and Joseph C. Magee (1996). "Identifying and Analyzing Multiple Threads in Computer-Mediated and Face-to-Face Conversations," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 39-47. (2)

McGrath, Joseph E. (1990). "Time Matters in Groups," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 23-61. (4)

Miranda, S.M. (1994). "Avoidance of Groupthink: Meeting Management Using Group Support Systems," *Small Group Research,* 25:105-136. (4)

Monk, Andrew, John McCarthy, Leon Watts and Owen Daly-Jones (1996). "Measures of Process," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 125-139. (5)

Okamura, Kazuo, Masayo Fujimoto, Wanda J. Orlikowski and JoAnne Yates (1995). "Helping CSCW Applications Succeed: The Role of Mediators in the Context of Use," *The Information Society,* 11(3):157-172. Also in *Proceedings of the Conference on Computer Supported Cooperative Work 1994,* Association of Computing Machinery. (5)

Olson, Judith S. and Stephanie Teasley (1996). "Groupware in the Wild: Lessons Learned from a Year of Virtual Collocation," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 419-427. (2)

Orlikowski, Wanda J. (1993). "Learning from Notes: Organizational Issues in Groupware Implementation," *The Information Society,* 9(3):237-250. (5)

Palen, Leysia Ann (1997). "Groupware Adoption and Adaptation," *Proceedings CHI97.* (5)

Perin, Constance (1991). "Electronic Social Fields in Bureaucracies," *Communications of the ACM,* 34(12):75-82. (5)

Pickering, Jeanne M. and John Leslie King (1992). "Hardwiring Weak Ties: Individual and Institutional Issues in Computer Mediated Communication," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 356-361. (3)

Pinsonneault, A. and Kenneth L. Kraemer (1990). "Technology and Groups: Assessment of the Empirical Research," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* J. Galegher, R.E. Kraut, and C. Edido (eds.), Erlbaum, Hillsdale, NJ, pp. 375-406). [also in Baecker 1993:754-774] (4)

Rice, Ronald E., Robert E. Kraut, Colleen Cool, and Robert S. Fish (1994). "Individual, Structural and Social Influences on Use of a New Communication Medium," *Academy of Management Best Papers Proceedings 1994.* (2)

Robinson, M. (1991). "Computer Supported Co-operative Work: Cases and Concepts," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 29-49. (5)

Rogers, Yvonne (1994). “Exploring Obstacles: Integrating CSCW in Evolving Organizations,” *Proceedings of the Conference on Computer Supported Cooperative Work 1994,* Association of Computing Machinery. (5)

Romm, Celia T. and Nava Pliskin (1996). "Email as a Facilitator of Power Plays: Analysis of Political Events at a University." [http://hsb.baylor.edu/ramsower/acis/papers/pliskin.htm] (4)

Santoro, G.M. (1995). "What is Computer Mediated Communication?" in *Computer Mediated Communication and the Online Classroom. Vol 1: Overview and Perspectives,* Z.L. Berge and M.P. Collins (eds.), Hampton, Cresskill, NJ, pp. 11-28. (1)

Schmitz, J. and J. Fulk (1991). "Organizational Colleagues, Media Richness, and Electronic Mail: A Test of the Social Influence Model of Technology Use," *Communication Research,* 18(4):487-523. (2)

Seibold, D.R., M.A. Heller, and N.S. Contractor (1994). "Group Decision Support Systems (GDSS): Review, Taxonomy, and Research Agenda," in *New Approaches to Organizational Communication,* B. Kovacic (ed.), SUNY Press, Albany, NY, pp. 143-168. (1)

Sproull, Lee and Sara Kiesler (1991). "Increasing Personal Connections," in *Connections: New Ways of Working in the Networked Organization,* MIT Press, Cambridge. [also in Baecker 1993: 418-430. (3)

Sproull, L. and S. Kiesler (1986). "Reducing Social Context Cues: Electronic Mail in Organizational Communication," *Management Science,* 32(11):1492-1512. [also in Greif collection: 683-712] (2)

Storck, J. and Sproull, L. (1995). "Through a Glass Darkly: What Do People Learn in Videoconferences," *Human Communication Research,* 22(2):197-219. (2)

Sudweeks, Fay and Sheizaf Rafaeli (1995). "How Do You Get A Hundred Strangers to Agree: Computer Mediated Communication and Collaboration," in *Computer Networking and Scholarship in the 21st Century University,* T.M. Harrison and T.D. Stephen (eds.), SUNY Press. [ftp://ftp.arch.su.edu.au/pub/projectH/papers/sud-raf.strangers.txt] (2)

Swigger, Kathleen M. and Robert Brazile (1995). “Evaluating Group Effectiveness through a Computer-Supported Cooperative Training Environment,” *International Journal of Human Computer Studies,* 43:523-538. (4)

Tollmar, Konrad, Ovidiu Sandor, and Anna Schomer (1996). “Supporting Social Awareness @ Work Design and Experience,” *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 298-307. (3)

Turoff, Murray (1989). "Computer-Mediated Communication Requirements for Group Support (Excerpts)," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 407-417. (2)

Tyre, Marcie J. and Wanda J. Orlikowski (1994). "Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations," *Organization Science,* 5(1):98-118. (5)

Viller, Stephen (1991). "The Group Facilitator: A CSCW Perspective," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 145-152. (4)

Walther, J.B. (1997). "Group and Interpersonal Effects in International Computer-Mediated Collaboration," *Human Communication Research,* 23(3):342. (4)

Walther, J. (1996). "Computer-Mediated Communication: Impersonal, Interpersonal and Hyperpersonal Interaction," *Communication Research, 23(1):3-43.* (2)

Walther, J.B. (1995). "Relational Aspects of Computer-Mediated Communication: Experimental Observations over Time," *Organization Science,* 6(2):186-203. (2)

Walther, J.B., Jeffrey F. Anderson and David W. Park (1994). "Interpersonal Effects of Computer Mediated Interaction: A Meta-Analysis of Social and Anti-Social Communication," *Communication Research,* 21(4):460. (2)

Weedman, Judith (1991). "Task and Non-task Functions of a Computer Conference Used in Professional Education: A Measure of Flexibility," *International Journal of Man-Machine Studies,* 34:303-318. (2)

Weisband, S.P., S.K. Schneider, and T. Connolly (1995). "Computer-Mediated Communication and Social Information: Status Salience and Status Differences," *Academy of Management Journal,* 38(4):1124-1151. (4)

Whittaker, Steve (1996). "Talking to Strangers: An Evaluation of the Factors Affecting Electronic Collaboration," *Proceedings of the Conference on Computer Supported Cooperative Work 1996:* 409-418. (5)

Whittaker, Steve and Heinrich Schwarz (1995). "Back to the Future: Pen and Paper Technology Supports Complex Group Coordination," *Proceedings of CHI95.* (2)

7. COLLECTIONS FROM WHICH ANNOTATED ARTICLES APPEAR

Baecker, Ronald M. (ed.) (1993). *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Morgan Kaufmann, San Mateo, CA. (2, 3, 4, 5)

Berge, Zane and M.P Colllins (eds.) (1995). *Computer Mediated Communication and the Online Classroom,* Hampton Press, Cresskill NJ. (1)

Bostram, R., R. Watson, and S.T. Kinney (eds.) (1992). *Computer Augmented Teamwork: A Guided Tour,* Van Nostrand Reinhold, New York. (4)

Castellan, N. John (ed.) (1993). *Individual and Group Decision Making: Current Issues,* Erlbaum, Hillsdale, NJ. (4)

Galegher, Jolene, Robert E. Kraut and Carmen Egido (1990). *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Erlbaum, Hillsdale, NJ. (2, 3, 4)

Greenberg, Saul (ed.) (1991). *Computer Supported Cooperative Work and Groupware,* Academic Press, San Diego. (4, 5)

Greif, Irene (ed.) (1988). *Computer Supported Cooperative Work: A Book of Readings,* Morgan Kaufmann, San Mateo, CA. (2, 4)

Kling, Rob (ed.) (1996). *Computerization and Controversy: Value Conflicts and Social Choices,* Academic Press, San Diego, CA.

Kovacic, B. (ed.) (1994). *New Approaches to Organizational Communication,* SUNY Press, Albany, NY. (1)

Marca, David and Geoffrey Bock (eds.) (1992). *Groupware: Software for Computer Supported Cooperative Work,* IEEE Computer Society Press, Los Alamitos, CA. (1, 4, 5)

Thomas, Peter J. (1996). *CSCW Requirements and Evaluation,* Springer, New York. (5)

8. WORKS NOT ANNOTATED

Abel, Mark J. (1990). "Experiences in an Exploratory Distributed Organization," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 489-510.

Ackerman, Mark S. and Leysia Palen (1996). "The Zephyr Help Instance: Promoting Ongoing Activity in a CSCW System," *Proceedings CHI96.*

Ambe, Mioko and Andrew Monk (1997). "Criteria for Effective Groupware 2," *Proceedings CHI97.*

Applegate, Lynda M. (1992). "A Case Study in the Assimilation of Technology Support for Teams," in *Computer Augmented Teamwork: A Guided Tour,* R. Bostram, R. Watson and S.T. Kinney (eds.), Van Nostrand Reinhold, New York: 34-62.

Attewell, Paul and James Rule (1988). "Computing and Organizations: What We Know and What We Don't Know," in *Computer Supported Cooperative Work: A Book of Readings*, Irene Greif (ed.), Morgan Kaufmann, San Mateo, CA: 557-579.

Baecker, Ronald M. (ed.) (1993). *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration),* Morgan Kaufmann, San Mateo, CA.

Bannon, L. and K. Schmidt (1991). "CSCW: Four Characters in Search of a Context," in *Studies in Computer Supported Cooperative Work,* J.M. Bowers and S.D. Benford (eds.), North Holland, New York, pp. 3-16. [also in Baecker: 50-56]

Berge, Zane (1995). *Computer Mediated Communication and the Online Classroom,* Hampton Press, Cresskill NJ.

Bikson, Tora K. and J.D. Eveland (1990). "The Interplay of Work Group Structures and Computer Support," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 245-290.

Blomberg, Jeanette L. (1988). "The Variable Impact of Computer Technologies on the Organization of Work Activities," in *Computer Supported Cooperative Work: A Book of Readings,* Irene Greif (ed.), Morgan Kaufmann, San Mateo, CA: 771-781.

Boland, Richard J., Jr., Anil K. Maheshwari, Dov Te'eni, David G. Schwartz, and Ramkrishnan V. Tenkasi (1992). "Sharing Perspectives in Distributed Decision Making," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 306-313.

Bowers, John, James Pycock and Jon O'Brien (1996). "Talk and Embodiment in Collaborative Virtual Environments," *Proceedings CHI96.*

Bowers, John (1995). "Making It Work: A Field Study of a 'CSCW Network'," *The Information Society,* 11(3):189-208. [also in CSCW '94]

Bullen, Christine V. and John L. Bennett (1990). "Learning from User Experience with Groupware," *Proceedings of the Conference on Computer Supported Cooperative Work 1990:* 291-302.

Carswell, Linda (1997). "Teaching via the Internet: The Impact of the Internet as a communication medium on Distance Learning Introductory Computing Students," *Proceedings of the Conference on Integrating Technology into Computer Science Education 1997, SIGCSE Bulletin,* 29(3): 1-5.

Clark, Herbert H. and Susan E. Brennan (1991). "Grounding in Communication," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA.

Clement, Andrew (1990). "Cooperative Support for Computer Work: A Social Perspective on the Empowering of End Users," *Proceedings of the Conference on Computer Supported Cooperative Work 1990:* 223-236. [also in Baecker 1993]

Cockburn, A.J.G. and H. Thimbleby (1991). "A Reflexive Perspective of CSCW," *ACM SIGCHI Bulletin,* 23(3):63-68.

Contractor, Nashir S. (1994). "Self Organizing Systems Perspective in the Study of Organizational Communication," in *New Approaches to Organizational Communication,* Branizlav Kovacic (ed.), State University of New York Press, Albany NY.

DeSanctis, G., and R.B. Gallupe (1987). "A Foundation for the Study of Group Decision Support Systems," *Management Science,* 33(5): 589-609.

Drexler, A.B., D. Sibbet, and R.H. Forrester (1988). "The Team Performance Model," in *Team Building,* W.B. Reddy and K. Jamison (eds.), NTL Institute for Applied Behavioral Science, Alexandria, VA.

Dubs, Shelli and Stephen C. Hayne (1992). "Distributed Facilitation: A Concept Whose Time Has Come?" *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 314-321.

Ellsworth, Jill H. (1995). "Using Computer-Mediated Communication in Teaching University Courses," in *Computer-Mediated Communication and the Online Classroom vol. 1,* Zane L. Berge and Mauri P. Collins (eds.), Hampton Press, Cresskill, NJ: 29-36.

Francik, Ellen, Susan Ehrlich Rudman, Donna Cooper and Stephen Levine (1994). "Putting Information to Work: Adoption Strategies for Multimedia Communication Systems," *Communications of the ACM,* 34(12):53-63.

Galegher, Jolene and Robert E. Kraut (1992). "Computer-Mediated Communication and Collaborative Writing: Media Influence and Adaptation to Communication Constraints," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 155-162.

Galegher, Jolene and Robert E. Kraut (1990). "Computer Mediated Communication for Intellectual Teamwork: A Field Experiment in Group Writing," *Proceedings of the Conference on Computer Supported Cooperative Work 1990:* 65-78.

Grudin, Jonathan and Steven Poltrock (1996). "CSCW, Groupware, and Workflow: Experiences, State of Art, and Future Trends," *Proceedings of CHI96.*

Grudin, Jonathan (1992). "Why CSCW Applications Fail: Problems in the Design and Evaluation of Organizational Interfaces," in *Groupware: Software for Computer-Supported Cooperative Work,* David Marca and Geoffrey Bock (eds.), IEEE Computer Society Press, Los Alamitos, CA: 552-560.

Grudin, Jonathan (1990). "Groupware and Cooperative Work: Problems and Prospects," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA.

Gutek, Barbara A. (1990). "Work Group Structure and Information Technology: A Structural Contingency Approach," in *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work,* Jolene Galegher, Robert E. Kraut and Carmen Egido (Eds.), Erlbaum, Hillsdale, NJ: 63-78.

Harper, Richard H.R. (1992). "Looking at Ourselves: An Examination of the Social Organisation of Two Research Laboratories," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 330-337.

Horvath, A.F. and J. Fulk (1994). "Information Technology and the Prospects for Organizational Transformation," in *New Approaches to Organizational Communication,* Branizlav Kovacic (ed.), State University of New York Press, Albany NY, pp. 117-141.

Kling, Rob (1991). "Cooperation, Coordination and Control in Computer-Supported Work," *Communications of the ACM,* 34(12):83-88.

Kling, Rob and Jonathan P. Allen (1996). "Can Computer Science Solve Organizational Problems? The Case for Organizational Informatics," in *Computerization and Controversy: Value Conflicts and Social Choices,* Rob Kling (ed.), Academic Press, San Diego, CA: 261-276.

Kling, Rob and Tom Jewett (1994). "The Social Design of Worklife with Computers and Networks: An Open Natural Systems Perspective," in *Advances in Computers* v. 39, Marshall Yovits, ed., Academic Press, Orlando, FL, pp. 239-293. [http://www.ics.uci.edu/~kling/worknt.html]

Kurland, Tania and Paul Barber (1996). "User Requirements from a Group Perspective: The Case of Distance Learning Mediated by Computer Conferencing," in *CSCW Requirements and Evaluation,* Peter Thomas (ed.), Springer Verlag, New York: 49-74.

Kydd, Christine T. and Diane L. Ferry (1996). "Electronic Mail and New Methods for Measuring Media Richness." [http://hsb.baylor.edu/ramsower/acis/papers/kydd.htm]

Kyng, Morten (1994). "Designing for Cooperation: Cooperating in Design," *Communications of the ACM,* 34(12):65-73.

Lindstaedt, Stefanie N. (1996). "Towards Organizational Learning: Growing Group Memories in the Workplace," *Proceedings of CHI96.*

Lloyd, Peter and Roger Whitehead (eds.) (1996). *Transforming Organizations through Groupware: Lotus Notes in Action,* Springer-Verlag, New York.

Luff, Paul, Christian Heath and David Greatbatch (1992). "Tasks-in-interaction: paper and screen based documentation in collaborative activity," *Proceedings of the Conference on Computer Supported Cooperative Work 1992:* 163-170.

Mackay, Wendy E. (1992). "Diversity in the Use of Electronic Mail: A Preliminary Inquiry," in *Groupware: Software for Computer-Supported Cooperative Work,* David Marca and Geoffrey Bock (eds.), IEEE Computer Society Press, Los Alamitos, CA: 404-421.

Malone, Thomas W. and Kevin Crowston (1990). "What is Coordination Theory and How Can It Help Design Cooperative Work Systems?" *Proceedings of the Conference on Computer Supported Cooperative Work 1990:* 357-370.

Markus, M. Lynne and Terry Connolly (1990). "Why CSCW Applications Fail: Problems in the Adoption of Interdependent Work Tools," *Proceedings of the Conference on Computer Supported Cooperative Work 1990:* 371-380.

Markus, M. Lynne (1984). *Systems in Organizations,* Pitman, Boston.

McDaniel, Susan E. and Tom Brinck (1997). "Awareness in Collaborative Systems," *Proceedings of CHI97.*

Nunamaker, J.F., A.R. Dennis, J.S. Alacich, D.R. Vogel and J.F. George (1991). "Electronic Meeting Systems to Support Group Work," *Communications of the ACM*, 34(7):40-61. [also in Marca and Bost 1992 and Baecker 1993:718-739]

Nunamaker, Jay, Doug Vogel, Alan Heminger, and Ben Martz (1989). "Experiences at IBM with Group Support Systems: A Field Study," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 740-753.

Orlikowski, Wanda J. and Jack J. Baroudi (1991). "Studying Information Technology in Organizations: Research Approaches and Assumptions," *Information Systems Research,* 2(1):1-28.

Orlikowski, Wanda J. and Daniel Robey (1991). "IT and the Structuring of Organizations," *Information Systems Research,* 2(2):143-169.

Palmer, James D., N. Ann Fields and Peggy Lane Brouse (1994). "Multigroup Decision-Support Systems in CSCW," *Computer,* 27(5):67-72.

Rouncefield, Mark, Stephen Viller, John A. Hughes and Tom Rodden (1995). "Working with 'Constant Interruption': CSCW and the Small Office," *The Information Society,* 11(3):173-199.

Short, John, Ederyn Williams and Bruce Christie (1993). "Communication Modes and Task Performance," in *Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration,* Ronald M. Baecker (ed.), Morgan Kaufmann, San Mateo, CA: 169-176.

Simon, Alan R. and William Marion (1996). *Workgroup Computing: Workflow, Groupware and Messaging,* McGraw Hill, New York.

Starr, Brian, Mark S. Ackerman, and Michael Pazzani (1996). "Do-I-Care: A Collaborative Web Agent," *Proceedings of CHI96.*

Steinfield, Charles W. (1986). "Computer-Mediated Communication in an Organizational Setting: Explaining Task-Related and Socioemotional Uses," in *Communication Yearbook,* vol.9, Margaret L. McLaughlin (ed.), Sage, Beverly Hills.

Stewart, Jason E. (1997). "Single Display Groupware," *Proceedings of CHI97.*

Tang, J.C. (1991). "Findings from Observational Studies of Collaborative Work," *International Journal of Man Machine Studies,* 34(2):143-160. [also in Greenberg 1991]

Tatar, Deborah G., Gregg Foster and Daniel G. Bobrow (1990). “Design for conversation: lessons from Cognoter,” *International Journal of Man-Machine Studies*, 34:185-209. [also in Greenberg 1991, Baecker 1993: 596-608]

Taylor, Jacqueline (1997). “Using online seminars to demonstrate the social psychological impacts of computer-mediated communication systems,” *Proceedings of the Conference on Integrating Technology into Computer Science Education 1997, SIGCSE Bulletin*, 29(3): 80-84.

Telleen, Steven L. (?) "IntraNets and Adaptive Innovation: The Move from Control to Coordination in Today's Organizations," http://www.amdahl.com/doc/products/bsg/intra/adapt.html

Valacich, Joseph S., Alan R. Dennis and J.F. Nunamaker (1991). “Electronic Meeting Support: the GroupSystems Concept,” in *Computer-Supported Cooperative Work and Groupware*, Saul Greenberg (ed.), Academic Press, San Mateo, CA: 133-154.

Walther, J.B. (1992). "Interpersonal Effects in Computer-Mediated Interaction: A Relational Perspective," *Communication Research*, 19(1):52-90.

Wellens, A.R. (1993). "Group Situation Awareness and Distributed Decision Making," in *Individual and Group Decision Making*, N.J. Castellan, Jr. (ed), Lawrence Erlbaum, Hillsdale, NJ, pp. 267-293.

Winograd, Terry (1988). “A Language/Action Perspective on the Design of Cooperative Work,” in *Computer Supported Cooperative Work: A Book of Readings*, Irene Greif (ed.), Morgan Kaufmann, San Mateo, CA: 623-653.

9. ACKNOWLEDGEMENTS

This annotated bibliography has benefited from the helpful suggestions and comments of my advisors, James K. Doyle and Stanley M. Selkow.