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6 Computer Conferencing

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I. INTRODUCTION: TERMS AND CAPABILITIES

A. Electronic Mail and Computer Conferencing

Before discussing various computer conferencing (c.c.) systems and related research, some clarification of terms will be helpful. Miller (1978) suggests that electronic mail and computer conferencing are a heterogeneous "third force" beginning to take its place alongside established data processing and newer word processing technologies. Even now, however, such distinctions are rapidly blurring as these technologies converge or are integrated in organizational or networked contexts. For the moment, we can agree with Price (1975) in stating that the third force (and particularly c.c.) is distinguished by using the computer for establishing controllable links between and among individuals and groups and *not* for the transfer or processing of data.

The distinctions *within* the force of electronic messaging and c.c. are important, however. This is primarily because c.c. has such considerable potential applicability and new characteristics that it should not be constrained by users' or regulators' preconceptions derived from simpler messaging media (such as letters or telephones) which may well describe electronic messaging usage (Turoff and Hiltz, 1977a).

Both media involve some terminal device (currently, a hard-copy print terminal or a cathode-ray video terminal); some communication link (direct cables, acoustic coupler and telephone lines, microwave, satellite, etc.); and a/several computer(s) (a local computer providing within-system links, or a local "node" computer interconnected via networks with other "nodes" and one or more "host" computers which provide the switching, software, and storage). Major network service providers are ADP, ARPANET, Control Data, General Electric, Telenet, and Tymnet. The "computer" in computer-based conferencing provides fundamentally new (as well as more elaborate, controlled, or efficient) capabilities to communicators, using switching and routing of the communications, storing, processing, retrieving, and monitoring.

Electronic/computer mail/messaging allows one user to transmit a message, in the form of a discrete file containing (usually) text, to another user, who does not have to be simultaneously operating a terminal, or to a number of other users on a particular "distribution list," perhaps according to preestablished distribution times. It is thus quite similar to sending a letter. Indeed, early systems were referred to as "electronic mailboxes." When a user activates the proper account via the terminal, the messaging program will inform the user of any mail in the "in basket" and then will print out, usually sequentially, the messages when instructed to do so. As Miller (1978) emphasizes, there is usually very little processing or preorganizing of the

messages by the program. Topic- or task-related organization is usually performed by the users.

Computer conferencing, both because of its historical roots (see below) and its explicit capabilities, has been quite different from electronic messaging. (1) Technically, c.c. involves *shared* files; an entry is not a separate file transmitted to another user, but an addition to a multiaccessible data base. (Some users may not be *allowed* to access some parts of the file, however.) Thus the emphasis is upon the sharing, and not on the transmission, of communications. (2) This file and its contents can then be processed in various ways by the conferencing software according to the tasks and rules of the relevant conference. Hiltz and Turoff (1978a) particularly point out the use of the computer to structure and facilitate communication. (3) As one of several *teleconferencing* media (see Short et al., 1976), c.c. emphasizes communications between and among specified groups separated by time and space, (4) engaged in collective dialogues, perhaps with a given agenda.

B. Capabilities of Computer Conferencing Systems

Carter (1980), Hiltz and Turoff (1978a), and Miller (1978) provide the sources for describing the capabilities of a general c.c. system. In addition to shared files, computer processing, telecommunications and facilitation of group communications, c.c. systems usually offer the following.

(1) Public and private entries. A user may transmit an entry to one, several or all of a group's members via a "private" entry, which is identifiable as such and which nonaddressed members cannot read. Or, a user may transmit an entry to the whole group or a subset which is holding a (electronic) conference, and which may access such "public" entries.

(2) Labelling of user. Particularly for Delphi or sensitive decision analysis (see below), the ability to use anonymous or pen name identifications is important. Or, one's own name may be attached to an entry.

(3) Individual and group control. An individual may retrieve or delete one's own entries. A group or conference may continually retrieve, but usually not delete or alter public entries. A conference or group leader usually has that ability.

(4) Word-processing and searching. The c.c. system may allow text (not just "messages") to be edited, formatted, recopied, associated, retrieved by various indices (date, author, content, etc.), and printed. This usually implies the existence of private and public workspaces where text may be individually or jointly produced and processed. Other users may also be searched for, by their related identifying information.

(5) Synchronous and asynchronous modes. Sending and receiving entries in "real time"—synchronous interaction—allows users to emulate a live

conference or meeting. Some system conferences will require all members to be on-line simultaneously, and the commands will automatically deliver entries to others, delayed only by computer, networking, and text sequencing activities. In some systems, a special command will allow one to transmit a synchronous entry to another on-line user. Usually, however, entries are asynchronous, where receipt and response are delayed until the other user enters the system, is informed which entries are yet unread, reads them, and chooses to respond. This mode is somewhat similar to typical electronic messaging.

Other capabilities may include graphics, interfacing with computer programs and other systems, adaptable levels of command complexity, scheduling of users' accessibility, automated evaluation from system and conference traffic, etc. Additional capabilities of specific systems are noted in Section III.

C. Costs

Because of the rapidly changing technologies, designs, applications, and usage scales associated with c.c., providing costs would be an exercise in being specific to a future audience based upon generalizations from already past experience. The main points to note are that most traditional means of mediated communication are becoming more expensive (because they use materials such as paper, and energy such as labor); c.c. is becoming less expensive (because it involves increasingly efficient communications technologies and electronic signals); and c.c. can provide some old and some new communications more efficiently and powerfully. Therefore, cost-justifications will increasingly favor the use of computer-mediated communications. (These are not the only relevant evaluations, however; see Section IV.) Summaries and descriptions of costs are provided by Hiltz & Turoff (1978a), Infomedia (1979), and Panko (1978).

System and/or software may be bought or leased, or access to a commercial system may be gained through computer networks with a combination service, connect and usage charge. C.c. systems may reside in and be accessed through large time-shared computers, but even the EIES conferencing system (see below) requires only two minicomputers (one for backup and research) and a dual disk system, for a total less than $200,000.00 (Turoff and Hiltz, 1977b). Leased satellite links and rooftop antennae will avoid the high costs of telephone links.

II. HISTORY

It has been suggested that the first computer conferencing system was

(unsuccessfully) to join its teletypes on a central line. Indeed, by 1965, over 57 organizations had private, computer-based writing systems involving Telex and TWX (Panko, 1977). However, two major sources for c.c. are familiar to the literature.

The first motivating source was the development of Delphi analysis, used for forecasting and assessing information, usually by a panel of experts, in iterative rounds. Delphi analysis attempts to structure group communication so the process is effective in allowing a whole group to deal with a complex problem, particularly when accurate information is unavailable or costly, or when information is heavily subjective. Techniques involved include feedback, assessment of group views, opportunities to revise views, some anonymity, and controlled asychronous entries. Linstone and Turoff (1975) provide the definitive text on Delphi analysis.

Delphi was a spinoff of defense research in the early fifties, in the sixties was used to assess the long-range trends of science and technology, and then seeped into aerospace corporations and academic institutions. The wedding of computer-mediated communications with Delphi analysis was a marriage made at least in the highlands of Greece, as communications can easily be structured and sequenced, individuals do not need to travel to several conferences or wait for mail, and group results may be compiled and presented. Scientists including Paul Baran Norman Dalkey and Olaf Helmer at Rand Corporation and the Advanced Research Project Agency (ARPA) were involved early in systems which supported structured group interaction for futures research (Informed (a) 1979).

The second major motivating source was the needs of the Office of Emergency Preparedness (OEP) and the Defense community for communications during crises (Price, 1975; Turoff, 1972; Turoff and Hiltz, 1977a, b). Researchers including Richard Wilcox, Robert Kupperman, Tom Balden and Wallace Sinaiko were involved in early systems for crisis management. Turoff (in Hiltz and Turoff, 1978a) describes his rather underground and politic-laden development of OEP's EMISARI (Emergency Management Information System and Reference Index) and its precursors (DELPHI conference PARTYLINE and discussion). The crises involving the need for rapid assessment of the steel industry in 1970 and the need for regional monitoring of the 1971 wage-price freeze led the way in establishing such a system. Now known as RIMS (Resource Interruption Monitoring Systems), EMISARI included Delphi-like communications in a complex system providing particular tasks (such as report-generation, data collection, scheduling status transitory conferences, numerical estimation, and graphic presentation) matched to definite responsibilities located at known nodes.

The rise of computer networking (Hiltz and Turoff, 1978a), packet switching as a transmission strategy (Roberts, 1978) and inexpensive computer components met these historical needs to motivate the proliferation

of computer-mediated communications systems. By 1979, there were over seventeen major computer-mediated teleconferencing systems in use, up from seven in 1975. Price et al. (1980) claim the number of computer-based electronic mail or teleconferencing services has risen to fifty. The Yankee Group estimates that by 1983, over two-thirds of the Fortune 500 corporations will have implemented electronic messaging systems. Dunn (1978), in discussing obstacles to market growth (user learning costs, regulatory policies, and network structures) is less optimistic—or more realistic.

III. SYSTEMS AND APPLICATIONS

An article in EMMS (An electronic mail and messenger system primer, 1978) provides a good technical introduction to electronic messaging and conferencing systems, while Hiltz and Turoff (1978a), Lipinski and Miller (1974), and Lipinski et al. (1979) describe the appropriate file structures and algorithmic strategies. The Hiltz and Turoff book is the major text on all aspects of computer conferencing. See Carlisle (1975), Hough (1976), Johansen et al. (1977), Price (1975), and especially Leduc et al. (1979) for system descriptions and bibliographies.

This section will mention a number of current and developing systems and then will describe in greater detail three major systems. Applications of these systems will be noted where appropriate. Some major commercial computer mail systems are:

- Telenet: TELEMAIL
- Bolt, Beranek and Newman (Cambridge, MA): HERMES
- Hewlett-Packard (Palo Alto, CA): HP-2026 and COMSYS
- Scientific Time Sharing Corporation (Washington, DC): MAILBOX
- Tymshare, Inc. (Cupertino, CA): ON TYME
- Computer Corporation of America (Cambridge, MA): COMET
- CITIBANK (NY): Integrated Electronic Office
- Cook Industries: Cook Administrative Message System

Some computer conferencing systems not described below are:

- University of Illinois: DISCUSS (part of PLATO)
- University of Michigan: CONFER (see Carter, 1974)
- National Technical Information Service (Washington, D.C.): DEP Conferencing System
- National Physical Laboratory (United Kingdom): CONFER (part of scrapbook)

- Northwestern University: ORACLE (conferencing as a component of education, combined with information files, computing and CAI) (see Schuyler and Johansen, 1972)
- Memo from Turner System and MINT, derived from DELPHI conference; later, General Conference System, LTD. (Canada) (see Hough, 1976)
  (in Canada) (see Irving, 1978)
- BELL'S TOPES (includes graphics) (see Pford et al., 1978)
- Bell Northern Research (in Canada): CMI, derived from DELPHI conference

As noted above, more integrated systems are devleoping along the lines of "automated offices" (see Keen and Morton, 1979; Uhlig et al., 1979). New York's CITIBANK has been experimenting with two such systems since 1976 (White, 1977), and a variety of other large corporations are beginning to develop and market massive systems. These include the U.S. Postal Service, Western Union, the Satellite Business System consortium, XEROX, AT&T's Advanced Communication Service, and Bell Northern Research's Integrated Electronic Office. Three systems with particular emphasis on conferencing will now be described in more detail.

A. Forum-Planet-Hub-Notepad

PLANET was developed at the Institute for the Future (IFF) (founded by several early DELPHI inventors) out of various versions of FORUM, which had been available on the ARPANET since 1973 (Amara and Vallee, 1974; Lipinski and Miller, 1974.) Also used on Tymshare and Telenet networks, these are relatively simple conferencing and messaging systems designed for groups of small to moderate size, and used extensively for evaluations of and experiments with conferencing. FORUM offers discussion or question and answer activities. In discussion activities, public, private, and anonymous entries are possible. The second activity allows answers in the form of numbers, probabilities, and essays, and can summarize and process numeric input for statistical tables. Several "help" or user information capabilities are provided, including a "skill rating" routine to require shorter system commands as the user becomes more familiar with FORUM.

PLANET is being used at the IFF for continued experiments and evaluations, and in various versions is offered by the first commercial computer conferencing company, Infomedia (1977). After typing the commands on a terminal to enter PLANET, the user types in a name and password. Some preliminary information is followed by a list of activities (or conferences) in which the user is participating, and who the other participants are. Then entries, activity summaries, etc. may be received and sent. If

requested, PLANET collects and processes a group's responses to a question, and allows the user to review some or all of those responses (by date, last N entries, etc.) and their statistics, note the status of participants, or shift to another activity.

One particularly powerful PLANET facility is the MONITOR, a set of routines which collects and analyses user communication traffic and system data to provide a variety of insights into the use and evolution of a particular conference. These analyses may be used to help better structure the group's activities, identify users having difficulties, make cost-effectiveness choices, judge training effectiveness, etc. Some results of these analyses appear in Section IV.

The IFF has recently developed and begun testing a sophisticated system involving PLANET as one tool in issue formulation, problem identification, and quantitative modelling by research communities (Lipinski et al., 1979): HUB. Four modules are connected under the HUB program, which acts as an interface and switcher between the modules. PLANET is one module. Program Workspaces are entered to run modelling programs, from which results and program transcripts can be entered into PLANET via HUB. Shared Visual Workspaces allow the development and sharing of flowcharts and graphical output to conceptualize a problem. Finally, Documentation Workspaces allow documentation and reports to be developed and shared. The use of HUB by several modelling groups is currently being evaluated at the IFF.

Infomedia's NOTEPAD is somewhat similar to HUB, except that it is designed for larger organizations and does not require the user to pass through a central switcher to access another module. NOTEPAD provides specialized support to sets of working groups.

B. NLS-Augment

The OnLine System (NLS) was conceived and developed by Douglas Englebart at Stanford Research Institute (SRI) in the mid-1960s as a comprehensive knowledge augmentation workshop (see Bair 1973, 1974, 1980; Englebart et al., 1976; Uhlig et al., 1979). The intention of NLS development was to provide an extension of intellect by means of computer-based tools; later, group and organizational capabilities were added. As such, it includes messaging and conferencing capabilities but also many others. Messages can be stored, indexed, cross-referenced, and cataloged. Multiple authors may create journals and reports (including photo-composition), with internal cross-references automatically updated. Text structures are hierarchically and laterally indexed and may be retreived and associated in a variety of ways. Management information, personal notation and reminders, computer processing, custom-built subsystems, and organizational

aspects developed and planned include a hand-held cursor control (called a "mouse") which activates execute, delete, and point commands; a one-hand binary key set which allows keying of alphanumerics on a video terminal; handwriting and voice input; and integrated text and image filing. NLS is implemented and supported in over 20 companies and government agencies, and will be marketed by Tymshare as its AUGMENT service.

C. EIES

The Electronic Information Exchange System (EIES), developed by Murray Turoff at the New Jersey Institute for Technology, is a comprehensive, continually evolving electronic world (see Hiltz and Turoff, 1978a). A wide variety of experiments and evaluations involving EIES has been supported by NSF in an attempt to understand the uses, impacts, and required designs of c.c. "EIES to date has logged almost 60,000 hours of use with about 700 users. This includes the writing of over 100,000 messages, 40,000 conference comments, and 15,000 notepad pages. In terms of items delivered this is about 200,000 messages, 400,000 conference comments and 20,000 notebook pages" (Hiltz and Turoff, 1980, p. 5). The philosophical motivation behind the development of EIES is that communication systems should be continually redesigned to reflect users' experiences, suggestions, and evolving behavior.

The EIES user network consists of ten or more formal groups (each with up to 50 members), "guest" users invited to participate in some of the numerous public or private conferences, user consultants who provide and revise system facilities and on-line explanations, special task-specific research groups, shifting sets of controlled experiments or demonstrations, newsletters, and more.

Some of the EIES features, in addition to the facilities basic to most c.c. systems already described, include: (1) the EIES menu, a hierarchical summary of the facilities or system actions available at each command step. Table I, a sample EIES session, shows some of the choices revealed by the first-level menu. An experienced user may string the choice numbers together, or use a preestablished system command instead of travelling through the menu. (2) A membership directory, which includes user-entered descriptions, addresses, and group memberships. (3) A sophisticated microprocessor which can be activated as a group member to provide analyses and graphics, interact with other computers, or mediate with other conferencing systems. (4) Self-defined sequences of operations in the form of a single command. (5) Special programs for specific group purposes, such as voting on terms to be used in negotiations, or providing on-line questionnaires and automated data-gathering and analysis, and various games. (6) Structured communication interfaces (such as the LEGITECH network of inquiries and responses about licensing, hazardous waste, etc.; users receive all current and future responses to selected inquiry topics). (7) Applications of EIES with

TABLE I
Sample *EIES* Session*

RONALD E RICE (RICE, 352) ON AT 2/8/80 5:00 PM EST ON LINE 11
LAST ACTIVE: 1/31/80 5:51 PM
EIES NEWS HEADLINE 2/3/80 6:45 PM
New era of cc opens with digitalized communication on ham radio! Also new feature: "observer" status in conferences and notebooks. Name a new public conference and win free hour of connect time. +WEEKLY for details in CHIMO.
LIST THOSE NOW ON-LINE(Y/N)?n
WAITING:
3 CONFIRMATIONS
3 PRIVATE MESSAGES
1 GROUP MESSAGE
ACCEPT ABOVE COMMUNICATIONS (Y/N/#)?y
M 4227 GEORGE CARTER (GEORGE, 402) 2/5/80 10:46 PM L:9
Ron, We are now neighbors. New address is in ++5,1,402. My...
DO YOU WISH TO:

GET ITEMS	(1)
DISPLAY ITEMS	(2)
SEARCH/FIND	(3)
SEND/COMPOSE/SUBMIT	(4)
EDIT/DELETE	(5)
ORGANIZE ITEMS	(6)
VOTE/FORM	(7)
SET/OPTIONS	(8)

MESSAGE CHOICE?+4
ENTERING SCRATCHPAD:
1? Alvin...a little late ressonding to your symposia notice,
2?/resa/resp/
1: Alvin...a little late responding to your symposia notice,...
TO (#'s/NAMES)? 386
ALVIN WOLFE (WOLFE, 386)
ASSOCIATED MESSAGE (#)?1520
KEYS (/WORD/PHRASE/)?Symposia
OKAY TO SEND (Y/N/-)?y
...
INITIAL CHOICE?+gc 35
GROUP CONFERENCE: GENERAL CONFERENCE GROUP 35
THERE ARE NOW 1 MEMBERS ACTIVE.
272 ITEMS CC 272 WRITTEN ON 1/28/80 5:11 PM
NO ITEMS WAITING.
INITIAL CHOICE?++5,1,402
NAME: GEORGE CARTER
NICKNAME: GEORGE
TELEPHONE: [number]
LAST ACTIVE: 2/8/80 1:29 AM
ADDRESS: [address listed, and George's self-description printed]
...
MESSAGE CHOICE?+get N1000P282L22T

TABLE I
Sample *EIES* Session

EIES FACT SHEET #9
RESEARCH ON TECHNOLOGY FOR THE HANDICAPPED
EIES offers unique opportunities in the research and development of devices for physically disabled people. [...] A multidisciplinary group involved in the research and development of devices for the disabled has been using EIES since 1977 to explore....
....
INITIAL CHOICE?+WEEKLY
[...reading the weekly CHIMO (EIES newsletter)...]
....
INITIAL CHOICE?–
TIME USED: 0:27
TOTAL USED: 39:50
RONALD E RICE (RICE, 352) OFF AT 2/8/80 5:27 PM EST

*This sample session illustrates only some very simple uses, and some EIES responses, commands, etc. have been edited for clarity.

custom-designed structures as an office and management augmentation system. (8) Programming languages allowing custom EIES structures (which could, for example, emulate PLANET), and, in the future, BASIC for computer processing.

Applications of EIES are already numerous and the possibilities are vast (see Hiltz and Turoff, 1978a). Some of these include: controlled laboratory experiments (Hiltz, 1978a); increased communication and productivity in invisible colleges (Freeman and Freeman, 1979); joint discussion for publishing articles (Computers and super-literates, 1980); international communication (Turoff and Hiltz, 1978); structured group negotiation, decision-making and simulation (Turoff and Hiltz, 1977a); communication and information-retrieval services for the handicapped; and interactive education and planning.

IV. EMPIRICAL RESEARCH ON COMPUTER CONFERENCING

This section will consider several areas of research on the use and effects of c.c. (satisfaction, frequency and pattern style, etc.) comparisons with alternative media (capacity, effects on group processes, appropriate uses) and substitutability (for other media and experiences). The quite extensive and growing research on computer-mediated conferencing indicates the potential significance and fertile analytical environment of this new medium. The single most comprehensive and influential review of research about the effects of noncomputer-based teleconferencing media is by Short et al. (1976). Only

research relevant to conferencing mediated by the computer will be considered here. The two most accessible primary works in this area: Hiltz and Turoff (1978a) wrote the first major text on all aspects of computer conferencing, while Johansen (1977) has provided the best organized and succinct review of teleconferencing meda comparisons to date. Other, less accessible, but useful overviews are Carlisle (1975) and Day (1975). The early major set of studies by the Institute for Defense Analysis (Bailey et al., 1963) remains useful for suggested variables and results from the use of computer conferencing in simulated crisis. For research designs in conferencing research, see Johansen et al. (1975, 1977).

A. Usage: Acceptance

Not all "users" actually use a computer-based conferencing system much! Difficult access to a terminal, unreliable telephone lines, or other professional activities with higher priority can be very significant reasons for limited use (Hiltz, 1978c; Johansen et al., 1977). Poor system reliability may lead to perceptions of decreased reliability of other tools used within a conference, increased status of technically expert members, and decreased emphasis on problem-solving (Lipinski et al., 1979). Also, perceptions of slow, unresponsive systems are manifested in more tangible ways; maintenance on terminals used to access such systems can be 50% higher than average (Bair, 1979b). A common objection, the necessity of typing skills, does not seem to be a major factor (Chapanis, 1975; Johansen et al., 1977; Miller, 1980), at least after the beginning period. Apparently most of the user's time is spent in nontyping activities or combines slow typing with mental composition. Neither the cost of use nor typing difficulties seem to be very important factors in acceptance—other than access, the social and work relationships and contextual factors such as conflict resolution and authority in an organizational usage setting are the major factors (Shulman and Steinman, 1978).

B. Usage: Patterns

There seems to be stages in acquiring c.c. facility:

1) culture shock, learning the commands, loss of interpersonal cues, new social dynamics
2) ability to use basic commands
3) push toward sociability, introduction of new cues and group norms, learning
4) serious use, perhaps dependence/addiction (Hiltz, 1978c,d; Hiltz and Turoff, 1978a, b; Turoff, 1978).

At early levels of usage, the textual styles of the first users within a conference appear to be imitated by following users, even if the later users belong to other conferences (Miller, 1980). In the beginning, entries are generally longer (Johansen et al., 1977) and in the form of private messages. At the second learning level a preference for group conferencing develops; at very high usage levels users tend to return to messaging and to begin to use private workspaces (Hiltz and Turoff, 1980; Turoff, 1978). Irving (1978) reported initial rises to high activity followed by a decrease and then levelling off to the end of a 9-month pilot use. Experienced users evaluate asynchronous conferencing more favorably than do new users. And, communication links among users tend to become more dense with use (Hiltz and Turoff, 1978b). In general, with increased hours of usage, items per session increase (from four to six), session length increases (from 15 to 40 minutes), the items sent/received ratio decreases (from ten to four), the number of conference comments rises then falls (Hiltz and Turoff, 1980), and the number of words per session may increase (Infomedia, 1979).

These usage patterns are based largely on pilot or subsidized applications; commercial uses can have planned, and rather different, patterns (see Carter, 1980; Infomedia, 1979). In the organizational contexts, private messaging seems to stabilize around 30 to 50 percent, and sessions are shorter (around 6 to 8 minutes with message length around 60 characters. It may be that the different systems used in these varying contexts perform similar *functions* but require different user *processes*. When synchronous use increases, so does the use of private messaging in organizational contexts (Miller, 1980). Synchronous use may lead to greater information overload, funnelling through one participant, more structured roles, yet better integrated information.

Although there is a high correlation between the number of private and group messages one sends (Johansen et al., 1978), these modes appear to be distinct, being preferrred differentially as users gain experience. Average group or public messages are 150 percent longer, and have four times the received/sent ratio, than private messages. Even several conference types have distinct received/sent ratios (Hiltz and Turoff, 1978b; Johansen et al., 1978). In general, these types include:

1) notepad (small group with no agenda)
2) seminar (a moderate-sized group with a strict agenda and a strong leader)
3) assembly (some real-time interaction within and among a series of seminars)
4) encounter (synchronous interaction of small group with time and crisis pressure)
5) questionnaire (for polling opinions, etc.)

The content threads of conversation or conferencing increase in a c.c. environment (Hiltz and Turoff, 1978b); and more threads are generated by messages directed to individuals (as opposed to undirected comments). Directed messages seem to receive slightly more responses. The number of entries per user is lowest, in general, for middle-sized groups (Johansen et al., 1977).

Not surprisingly, but importantly, users' attitudes to such systems change with use: satisfaction increases, sense of tediousness decreases, and impersonality of work environment decreases with increasing usage (Conrath and Bair, 1974; Hiltz, 1978d; Irving, 1978; Johansen et al., 1978.) It may be that new users view computer-mediated conferences as simple substitutes for familiar messaging media (such as a letter or a meeting), but develop an understanding that c.c. has its own advantages, uses, and constraints (Hiltz, 1979). With increased usage, perceived usefulness of features that facilitate long-term group communication, active control, tailoring of the system, and composition also increases (Hiltz and Turoff, 1980). A review of organizational use of teleconferencing arrives at a similar conclusion—once a work unit has established its coordination pattern, it first carries similar patterns over to a newly-implemented system (Shulman and Steinman, 1978) rather than seeks new applications.

In addition, users seem to need a "real" task to motivate use and favorable perception. Perhaps related to the professional priorities mentioned earlier (and the approach which professionals and researchers have toward tools of their trade), this importance of a cohesive group task explains usage amount far more than do costs, system characteristics, typing speed, or prior computer experience (Hiltz, 1979).

An important policy implication of this section is that a computer-based message/conferencing system should allow (and be allowed, by regulatory policy, to provide) different modes of communication precisely because the above modes receive demonstrably different emphasis by users. Implementors should also allow longitudinal development of system design because user behavior evolves and simple message systems become insufficient for regular, experienced users (Hiltz and Turoff, 1980). Regular applications should see c.c. as a different, but complementary, medium.

C. Comparisons: Capacity and Participation

As far as potential capacity is concerned, mathematical formulations show that c.c. word exchange can be about twice the level of face-to-face interaction (for about twelve people) (Hiltz and Turoff, 1977b). Because of the multiplicative effect of using a messaging system with a number of users, the number of characters passing through a user's account may be several times greater than possible through continuous typing to separate individuals

requires (or allows) fewer words (or less messages/time) than does face-to-face (Chapanis, 1975; Hiltz and Turoff, 1978a; Johansen et al., 1977), although the systems used by Chapanis and Johansen et al. were very restricted and would produce conservative figures.

Computer conferencing reduces the inequality of participation usually present in other forms of group interaction (Hiltz, 1978b; Hiltz and Turoff, 1978a, b; Johansen, 1977). Synchronous messaging reduces the inequality even more than does asynchronous mode (Miller, 1980). Participation inequality may be a natural characteristic of group discussion, and is clearly related to the stable personality trait of latency (and even more to duration) of verbal response (Koomen and Sagel, 1977). Thus more reserved group members may finally gain access to discussions and decision-making, while any one individual may have a harder time gaining the group's attention. In fact, the emergence of group leaders is different, and simply less likely, in teleconferencing (Williams, 1978). This has implications for decision-oriented applications of teleconferencing, as inequality of participation may be functional for such tasks, which require coordination and direction of comment flow by a leader. If, as Schwartz (1978) suggests, "*social organization is itself a network of interlocking queues. . . . a way of organizing obligations*" where "strategically placed delays are the preconditions of organizational efficiency," the resultant dequeuing by amorphous participation using immediate input with asynchronous response has major implications for social order. Inevitably, some tasks will fail, and in other instances new forms of gatekeeping will arise. Consensus may be harder to reach as the group gropes for organization (see below). An important issue is that shared or increased information is not the same as increased understanding of that information; indeed, understanding may even be masked by torrents of input (Lipinski et al., 1979).

D. Comparisons: Written Text

The form of c.c. communication is (presently) written text, whether by CRT or printer. The retrievability, associability, and indexibility of this text in a c.c. environment has major implications for decision- and judgement-oriented groups. Kaplan and Miller (1977) showed that "*in cases where all group members are exposed to the same information, differential memory* [and perceptions] *may be a mechanism for producing variety in the information shared during group discussion, and thus for affecting discussion-induced judgment shifts.*" In particular, more, and a different variety of, facts are recalled from one's most recent information sessions. With training, group members could retrieve and utilize past discussions and information to minimize such biases. Thus, some research comparing written communications, teletype, etc. provides a precedent for more specific c.c. studies.

Counter to most people's expectations, written media (as well as audio forms) can introduce more attitude change than face-to-face (or videotape) (Johansen, 1977), perhaps by masking cueing behavior and allowing unobtrusive shifts in opinion. Written material such as by teletype can be more effective for the communication of factual information than face-to-face, perhaps because of its preciseness and the greater comprehension gained from rereading text without pressure to overcome response latency. On the other hand, simulations involving the Prisoner's Dilemma show that the likelihood of a cooperative, as opposed to competitive, solution increases as the medium is altered from written through the more nonverbal media to face-to-face (Short, et al., 1976).

Most people in organizations tend to prefer face-to-face interactions to interactions over telephone or written channels (Conrath, 1973), yet Dewhirst (1971) suggested that perceived information-sharing norms were intervening factors. Perceptions of fellow-workers as sharers of information associated highly with preferences for the face-to-face channel (and the opposite relation for written). Perhaps to make up for missing interpersonal interaction, those who preferred written channels inside the organization tended to prefer face-to-face channels outside. International contexts for teleconferencing lead to a market preference for hardcopy—because text is much easier to translate than is voice (An electronic mail and message system primer, 1978)!

E. Comparisons: Direct Communication, and Decision Tasks

Many opponents of computer-mediated communication emphasize its loss of nonverbal communication and social presence. Certainly the channels wich c.c. does not provide typically allow cues for sequencing interaction rules, nonverbal feelings, intentions, physical relationships, etc. Immediate feedback is usually missing, and public or rhetorical questions often go unanswered. However, synchronous cnferencing does allow immediate response, and personal cues often appear in new forms, whle direct questions are almost always answered—even when addressed to strangers (Johansen, 1977). The absence of visual and nonverbal cues may be an advantage to some users—those with visual or speech handicaps, those usually intimidated by turn-taking conventions or rapid cross-fire. However, there are cases where the loss of such cues, mixed with rapid responses in synchronous mode, led to iteratively escalated misunderstanding (Uhlig, 1977). For those who object to delayed response, there are others who appreciate the break from eye contact so they can compose a thoughtful response (Hiltz and Turoff, 1978a). The face-to-face channel, when compared to c.c. (Johansen, 1977), does allow or provide

1) increased bandwidth and information types
2) more variance in message length
3) more questions
4) interruptions
5) ability to digress and lose thread
6) quicker adjustment to changes in interaction

A considerable amount of research has considered group decision processes in c.c. Using small groups given simple or complex group decision tasks, researchers have attempted to compare the effects of different communication media (usually face-to-face and c.c). In general, c.c. groups take longer to reach agreement (Hiltz, 1978a, b; Johansen, 1977), perhaps because more time is spent in noncommunicative acts, fewer items are exchanged, group problems are injected into the task, or a leader is less likely to emerge as quickly, if at all. There may be less consensus in c.c. groups for complex problems, or human-relations-oriented problems (Hiltz, 1979). For reasons of group coordination, mentioned earlier, it seems that unstructured problems require a strong leader, which c.c. suppresses somewhat. Interestingly, females change their opinions more easily in face-to-face contexts than do males, although there is no difference in c.c. groups.

Proponents of Delphi analysis claim it can improve results by structuring communication patterns dynamically and iteratively to exploit differential levels of expertise, although some evaluations are not excessively convincing (Brockhoff, 1975). The application of HUB (Lipinski et al., 1979) to the problem of quantitative modelling showed users' preference for asynchronous comments and the free formation of subgroups whose activities would still be accessible by others: capabilities possible most easily with c.c.

The comprehensive review and analysis by Short et al. (1976), although not involving c.c., provides good evidence that the level of "social presence"—how "real" the other person seems—a particular medium allows, interacts with the mix of interpersonal and task content a communication event requires. As the authors (Short et al., 1976, pp. 109, 156) write, the outcome of meetings, such as "the likelihood of reaching agreement, the balance of success, the nature of the settlement reached, the evaluation of the other side and the individual opinions after the discussion..." can be "significantly affected by the medium of communications used.... Some tasks are more sensitive than others: in particular those meetings involving conflict between the participants (e.g., attitude change or negotiation) or involving the function of impressions of strangers or slight acquaintances..." or in coalition formation. This latter may occur via the process of interpersonal "liking", as liking (and overt disliking) may decrease in media which transmit

fewer nonverbal cues. For example, one simulation (Vallee, 1976) revealed significantly more within-group interaction for the winning, than the losing, coalition; in another example, people at the same teleconferencing nodes supported each other in a persuasion and decision task more than they supported individuals at other nodes (Short et al., 1976).

F. Comparisons: Generalizations and Appropriate Applications

Using a typology of group activities developed by Short et al. (1976), several researchers have arrived at very similar conclusions about the appropriate (or at least (modifying "uses"; qualifying "appropriate) positively evaluated) uses for c.c. In general, c.c. is at least as good as, and sometimes better than, face-to-face (in some experiments, video) for the following tasks:

1) exchanging (especially technical) information (especially for short bursts)
2) asking questions
3) exchanging opinions or orders
4) staying in touch
5) generating ideas
(Hiltz, 1978c, 1979; Hiltz and Turoff, 1978a; Infomedia, 1979; Johansen et al., 1978; Short et al., 1976; Williams, 1978)

There are interactions which do not demand high interpersonal involvement and may be typified as cooperative in nature. C.c. is not nearly as satisfactory as face-to-face or video for

1) bargaining
2) resolving disagreements
3) getting to know someone
4) tasks requiring constant focussed discussion

However, for very embarrassing or conflictful interactions, c.c may be the medium of choice precisely because it minimizes the interpersonal dimension. The earlier point about changing attitudes with increasing use holds here as well: new users generally rate face-to-face higher on all group processes or tasks, while experienced users develop the ability to discriminate the appropriate uses listed above. Also intriguing is that users feel more confident in their perceptions gained from face-to-face meetings than by nonverbally poorer media, but they are in fact no more accurate (and sometimes less so) when using face-to-face (Short et al., 1976). Thus c.c. may be less favorably evaluated than face-to-face, and may create less favorable perceptions of others, even though it allows equally (or more) accurate transmission of behaviors and information.

G. Transferability, Substitutability and New Uses

Can an electronic system substitute for a centrally-located institution or laboratory? A promising set of results (reviewed in Hiltz and Turoff, 1978a), based on energy researchers' use of conventional and c.c. interaction in alternating periods, involved more flexible working hours, greater colleague contact, more efficient use of other media, and more precise text in the computer conferencing environment. The comprehensive EIES project included participant surveys which also indicated that respondents felt that c.c. increased their quality of work, variety of ideas, and contact with others' work (Hiltz, 1979). Researchers dispersed in "invisible colleges" tend to evaluate their use of c.c. positively, as contact with distant and extra-disciplinary members increases (Freeman, 1979; Freeman and Freeman, 1979; Johansen et al., 1977, 1978). However, some structural changes in communication patterns may be dysfunctional or divisive. The Freeman studies of their EIES group used network analysis (Rice and Richards, 1980) to show that communication links increased, c.c. had more effect than several face-to-face meetings, and for some people c.c. was substitutable for the kinds of experience upon which close friendships develop. However, inequalities in strengths of "friends" and "close friends" increased (perhaps a sign of intimate stratification) and interdisciplinary collaboration tended to force members of each discipline into defined stances, away from other disciplines.

There are a few studies which consider the effect of the introduction of a c.c. system on other media or communication activities in an organization. Johansen et al. (1978) report slight decreases in mail usage and work-related reading, but no decrease in telephone usage (although Conrath (1978) found a very small reduction). SRI's use of NLS, not explicitly a conferencing system, did result in increases in total communication and reductions of face-to-face and telephone, but not written, communication (Conrath and Bair, 1974). This type of change is also reported by Edwards (1978), Leduc (1979), McNurlin (1978), and Stanford University (1980). Williams (1978) suggests that teleconferencing might provide a reasonable substitute for 50 percent of current face-to-face meetings. Short et al. (1976) see a majority of meetings theoretically allocatable to a variety teleconferencing media, but the percentage is reduced by the favorable evaluation people have of face-to-face and video and the poor cost-effectiveness of video systems. Much lower figures are suggested by other researchers (in Williams, 1978; and see Edelstein et al., 1978). For example, analysing communication flow characteristics, Dormois et al. (1978) conclude that only 7 percent of meetings

and 14 percent of telephone uses could be transferred to teleconferencing. This study involved 2000 respondents and 33,000 interorganizational communications in 60 organizations, generalizable to France! The exhaustiveness and sophistication of this study lend considerable credibility to the authors' conclusions. Factors involved in such substitutability in group contexts include the nature of the group task, the need for a leader, the sense of group task and cohesion, the importance of getting to know the other members, and, to a lesser extent, cost.

The impacts of word-processing systems, computerized conferencing, and "automated offices", from this communication perspective, are evaluated quite favorably in a series of papers (Bair 1973, 1979 a, b; Carlisle, 1970; Conrath and Bair, 1974; Uhlig, 1977). Their basic premise is that the potential economic and worklife benefits of "automated offices" are greatest for professional and managerial tasks, of which 75 percent involve communication (mostly oral and in meetings, however). For the most recent and comprehensive review since Mintzberg (1973) and Stewart (1967, 1976) of how managers allocate their time, media use and tasks, see Carter (1980). In the study of an Air Force secton's use of SRI's NLS, for example, the greatest organizational changes occurred in the users' communication patterns—increased connectivity, effectiveness, and productivity. At SRI itself, subjective analysis of 4 years' usage of NLS concluded that individual effectiveness, team consensus, intraorganizational collaboration, and overall communication increased, and time savings amounted to nearly two hours a day for a typical professional (in a very supportive environment for information augmentation).

Other general findings are a preference for using NLS for upward-flowing message (bridging authority links) and increased breadth of contact. A subtle but potentially consequential finding was that interruptions from outside the terminal were resisted, but not from within the terminal (as, immediate messages from other terminal users). Bell Canada's use of NLS resulted in better projected-oriented communication, and greater external links but little improvement in problem-solving. Other Bell results reported by Leduc (1979) are very similar to those of SRI's. Price (1975) refers to a study which explained that a computer messaging system dramatically altered the structure of a widely-dispersed information-intensive consulting and computer company. The very strong democratizing and flexible communication system allowed/required a shift from a hierarchical organization to one consisting mostly of constantly changing sets of teams.

The kinds of payoffs these authors foresee include: fewer kinds and number of transformations between media required, less nonproductive "shadow functions" such as redialing busy telephone lines, automation of manual processes (although the job enrichment of creative text-editing is offset by a factor of three to four increase in number of text revisions!), improved scheduling, and increased control (of information neeeded, span, etc.) Some

of these studies claim that "no negative consequences of computer-mediated communication that would be cause for limiting usage have been uncovered.... no evidence to support fears of increased depersonalized communication, alienation, or loss of privacy..." (Bair, 1979b) and therefore their favorable cost-benefit analyses are sufficient justification for full implementation. Perhaps their respondents were too close to the change, or the environments were atypically supportive, but such statements are too all-encompassing for this author's taste.

Some new uses develop as well (Conrath, 1978), and these may be additional justifications for transferring some tasks (Short et al., 1976, Chapter 10). For example, over 50 percent of messages by the members of the U.S.-Canada Satellite project using the PLANET conferencing system occurred during times when telephone usage would have been impractical due to costs or scheduling (Infomedia, 1979). These new uses create new communication behaviors and habits. When one can work at home by computer-mediated communication media, what will become of the traditionally clear-cut distinction (in most occupations) between work-hours and leisure-hours (Johansen et al., 1978)? The very nature of information work, less dependent on material transformations and physical access to resources, makes such occupations quite amenable to flexible scheduling. Some preliminary experiences show that the transition between these activities can be very difficult and frustrating to family members and neigbors (American Association for the Advancement of Science, 1980).

V. CONCLUSION

This chapter has provided a basic introduction to computer conferencing, described several major systems, and summarized the empirical research on its usage and impacts. What are some of the future directions of this medium? Miller (1980) and others suggest that the next breakthrough is a collision, convergence, or wedding (perhaps shotgun) of technologies and approaches for data processing, telecommunications, human communication, and information retrieval. The variety of human communication functions (of which c.c. can only provided some) will be facilitated and integrated in such an approach. The developing "office of the future" is a large step toward this end. In Sweden, the telecommunications ministry is already experimenting with comprehensive interconnection of teletypes, telephone exchanges, computers, etc.

The 1980s have been predicted as the "interactive" decade. In communication systems, the goal will be to develop interactive systems for humans who may have no knowledge of computers, systems which can flexibly delegrate various tasks to humans or machines according to the user's experience and skills. Thus the second breakthrough will be to design systems

that bend with people. To promote this breakthrough, much emphasis needs to be placed on research into the behavioral factors of computer-based communications, to understand how users evolve with and react to particular systems. In addition, work needs to be directed toward supporting access to and knowledge of these new communications media, in order to enable people's attitudes toward computer-based communications to evolve in positive directions.

As we have seen, the research so far points to a very complicated mix of factors in some cases, and quite clear-cut responses in others. C.c. is a unique, but complementary, communication medium which has useful and positive attributes for appropriate tasks; in other uses it may be detrimental. For some of the appropriate tasks, c.c. may substitute for other media or even provide new applications. As Short et al. (1976) suggest in their chapter on "The Decision to Telecommunicate" the goal is a proper "communications diet" which mixes media usage for given organizational, task, and individual contexts. Carter's analyses (1980) and the EIES evaluations (Hiltz and Turoff, 1978a) are some of the very few cases where research results are used explicitly to guide computer-mediated technology design.

The issues surrounding this new medium are numerous and complex (see Bezilla, 1978; Hiltz and Turoff, 1978a) and policy decisions should be informed so that some potentially beneficial developments are not prevented. The equity of access—both input and output—to these information resources by all social segments is also a critical factor. Will computer-based conferencing replace physically-centered organizations and face-to-face meetings? Will they unilaterally reshape social and work communication behavior? How will the ability to discuss several topics simultaneously, to use delayed electronic messages to defuse negative reactions, or to process greater amounts of interaction (of a very particular sort) affect social communication rules? What will the effect on spelling standards by frequent informal messaging be? There are many questions yet to be answered, and many of them are important.

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7 Applying a Holistic Framework to Synthesize Information Science Research*

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