The Evolution of User Behavior in a Computerized Conferencing System

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Data from 18-month operational trials of the EIES system indicate that the range of features considered valuable in a computer-based communication system increases with the amount of experience gained by using this medium of communication. Simple message systems alone are not likely to satisfy the communications needs of long term, regular users of computerized communications systems. Among the capabilities which long term, regular users find valuable are group conferences, notebooks for text composition, and self-defined commands.

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Introduction

Computers are increasingly being put to work in the processing, storage, and transmission of text to facilitate human communications. The most widespread proliferation is taking place in the areas of electronic mail and word processing. Uhlig [25] comes to the same kind of optimistic conclusion about the future importance of electronic mail as the majority of those who have studied this technology:

> During the next 50 years computer based message systems (CBMS's) will have as great an impact on the way business is done in our society as the impact that the telephone had on business practices during the last 100 years. This, at least, is what our organization has come to believe after two and one-half years of experimenting with them.

Electronic mail is usually designed with a minimal number of features, so that it can simply replicate electronically the delivery of "mail" and internal memoranda. For example, this limited set of functions is assumed implicitly in the recent paper by Levin and Schroeder on the design objectives of message systems [12, p. 29] when reference is made to "message systems that communicate memoranda among members of a community." Word processors are also being designed as specialized, single purpose systems to be used only by secretaries acting as intermediaries between the originators and the recipients of text.

An analysis by Bair [1, p. 733] concludes that "the greatest leverage for the benefits of office automation is in supporting the communication activities of nonclerical personnel." Based on this analysis, computer mail is judged to be cost effective for managerial communication. However, the data on managerial communications which serve as the basis for the analysis [16] indicate that top managers spend the majority of their time in scheduled meetings, not in writing and receiving memoranda. Thus it would seem that a design objective for a computer based communication system should include structures and features that support the kinds of communications that normally go on in face-to-face meetings, not just in mail and memoranda, in order to optimize cost effectiveness.

In his review, *The Outlook for Computer Mail*, Panko [17] concluded:

> Computer mail has a great deal going for it: apparently favorable economics, a huge potential market, and weakening postal opposition. To tap this market, a fair amount of design evolution will be required.

We agree that both "design evolution" and "policy evolution" will be necessary in order to maximize the role of the computer in the facilitation of human communication. Furthermore, we believe that such evolution should be based upon feedback from the experiences of users in current systems. We [9] also believe that the terms "computer mail" and "message systems" may imply the mere automation of what people are now doing by other means (e.g., mail and telephone), rather than considering the full range of options made available by this technology.

This paper summarizes some of the results of a two-year study of the operational trials of the Electronic Information Exchange System (EIES). It looks at changes in the behavior and attitudes of users in relation to specific features of the system, changes which have some design and policy implications. There are many other aspects of changes in the behavior and attitudes of

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both individual users and user groups over time which are not treated here, such as changes in perceptions of the usefulness of the system for various purposes (e.g., [6]), subtle changes in the style and richness of the written communications, and changes in the social organization and productivity of user groups. The entire range of observed and measured changes is included in the full report on the results of this project ([7]; see also [3] for observations on the development of paralinguistic behavior styles.)

Limitations of the Data

Since the earliest observations, those who have studied computer-based communication have recognized that "initial uses of teleconferencing systems often serve as a poor basis for generalizing about future uses" [10]. The data presented here provide, for the first time, detailed empirical evidence about changes in user behavior and preferences related to the features or capabilities of computer-based communication systems as a function of experience (hours on-line).

The reported results are limited to a single system and a single type of user (scientists). The users for whom we have survey data were members of five scientific research communities whose "operational trials" of EIES were sponsored by the National Science Foundation [7, 8, 24]. Until similar measures are replicated for other systems and other types of users, the generalizability of the specific results obtained for EIES is unknown. However, the users of EIES studied were voluntary users in the sense that their employing organization did not require them to use the system. Use of the system can be considered a valid measure of its acceptance, but nonuse does not necessarily imply rejection. (On the contrary the main reason given for nonuse was that the on-line activities were peripheral to the person's job; see [7].)

Another limitation is that the data currently available for analysis are cross-sectional (attitudes and behavior measured at a single point in time) rather than longitudinal (which would measure each user's amount of experience and present his or her opinions about the system at many points in time.)[1] The basic generalization to be drawn from the data is that there is indeed an evolution or pattern of change towards greater complexity and specialization and diversity of user behavior over time. This thesis is consistent enough with studies of other teleconferencing systems that it is not likely to be an artifact of the limitations of this study.[2]

Before presenting our results, we will describe the EIES system that serves as the source of the observations. We then examine two types of data which support the evolution hypotheses: monitor data on the behavior of users, and questionnaire data on their attitudes and opinions.

The Structure of EIES

EIES provides four general purpose structures for all its users:

(1) *Messages*: The delivery of messages to individuals and/or defined groups. This facility includes confirmations of delivery, a central message file, editing, retrieval, searching and resending, as well as historical analysis of message traffic by individuals.
(2) *Conferences*: Linear time sequential transcripts of group discussions on a particular topic with status information on readership. This facility includes voting, text searches, automatic delivery of new material to individual conferees, and other communication support functions.
(3) *Notebooks*: A text composition and word-processing space that may be private to an individual or shared among a group of users. This facility provides features for organizing and distributing documents as well as automatic notification to users of edits and modifications.
(4) *Directory*: A membership directory containing both individuals and defined groups with self-entered interest descriptions and numerous search options. A defined group may be treated as a single individual for purposes such as sending a message.

Messages are either private or group messages, and conferences and notebooks may either be private, group, or public. Private conferences and notebooks are controlled by an individual user, who determines the participants. Group conferences and notebooks are controlled by defined groups on EIES, while public conferences or notebooks are available to anyone on the system for reading. Public notebooks have a defined set of authors (restricted writing), but anyone can read in them.

All the text items in the above subsystems are compatible and readily transferable, i.e., a message may be transferred into a conference comment or notebook page. All of the subsystems exist within the context of a single user interface that provides four different modes of user interaction:

(1) *Menu Selection*: The user selects an option from a list included on the one-page guide to the main set of EIES menus.

[1] We attempted a longitudinal analysis, but did not have enough cases in the critical ranges to obtain significant results. In total, 78 cases answered some of the same questions on the value of features on a first follow-up questionnaire at approximately 6 months after starting to use EIES and on the 18-month post-use questionnaire. However, a total of only 20 were in the range which evolved from fairly new users to experienced users during this time period. Regression analysis and Pearson's correlations on the relationship between change in hours on-line and change in ratings of featues showed weak positive correlations that were not statistically significant. We think that the fairly weak relationships are due to the inability to capture measures on the users at critical points in their learning behavior when relying on two questionnaires a year apart, and we have chosen not to report this analysis.

[2] See Elton [5] and Johanson et al. [11, pp. 136–137] for similar generalizations based upon other teleconferencing systems.

(2) *Command Driven*: All the menu selections are available as commands. In addition, approximately 200 advanced features not available in the menus can be utilized.
(3) *Answer Ahead and Command Streams*: The user can anticipate questions and answer ahead or trigger a sequence of operations. The EIES interface is fully predictable to the user and all commands are usable at any point in the interaction.
(4) *Self-Defined Commands*: The individual user or a group coordinator can define commands unique to the individual or group. There are facilities for defining commands that will accept input control at the time they are executed.

In addition to the above, EIES has a general purpose language (INTERACT) that can interpret any input stream from a user or from EIES as an executable program. INTERACT programs are stored in EIES text items. This capability allows selective tailoring of the interface and communication features of EIES by individuals or groups. With INTERACT, specialized subsystems are tailored for specific applications [23]. Access to a specific EIES program is given by readership privileges on the text item in which it is stored.

EIES operates on a dedicated minicomputer—an INTERDATA 7/32 with half a megabyte of core and two 300 megabyte disks. It currently supports up to 32 simultaneous users. EIES is implemented in Fortran, with modifications to the compiler and to the executive system [9].

Within the basic structure of EIES are many specific system features. Many of these have been subjected to user evaluation, which is reported later. Table I provides a brief description of various system features and indicates which have evolved over the operational period of the system from late 1976–1980. The fact that the system was constantly evolving, partially as a result of feedback from this study, greatly complicated the problem of getting comparable data from users and user groups who joined the system at different times.

The Design Philosophy of EIES

The subsystem representing the CONFERENCE component of EIES is similar to the original OEP DISCUSSION system [22] and to other computer conference systems now in operation such as PLANET [14], CONFER [27], and CBIE [20]. While these systems have many specific differences, they all provide a mechanism for a group to record and utilize a transcript of a group discussion over varying lengths of time. The design of EIES as a whole has its roots in the earlier EMISARI system developed in 1971 at the Office of Emergency Preparedness [19, 26]. Whereas EMISARI was designed as a special purpose system for management and staff reporting in a crisis management situation, EIES was designed to study and explore the use of computers to facilitate human communications across a wide variety of applications. The EIES design and operation is intended to allow user groups to evolve features tailored to the nature of a group and its application.

EIES Usage Patterns

EIES has been active since October 1976. The period through October 1977, represented a pilot test phase during which a great deal of development of the system was taking place. During this pilot period the users were largely people who had an interest in the technology and its application as opposed to users who were employing EIES for some specific purpose. The first formal National Science Foundation (NSF)-sponsored field trials began with four groups in November 1977. The period through October 1978, is termed phase 1. Phase 2, beginning in November 1978, signals the addition of three more NSF-sponsored groups and the gradual building of 150 users paying their own way. With the termination of NSF sponsorship on April 1, 1980, EIES has converted to being entirely supported by paying users (approximately 400 at present).

Tables I–VI present data accumulated by the system's monitor during the two phases of the NSF-supported field trials. These data represent lower limits on actual usage for a number of reasons. Various checks for bad records were used to purge potentially invalid data. Second, the system's monitor does not record the delivery of text items indirectly addressed in other text items. A typical example is the delivery of papers indirectly referenced by an abstract so that the reader can choose whether or not to print out the entire paper. Finally, various EIES-tailored subsystems (e.g., TOPICS, which deals with inquiries and responses) utilize an index-oriented file system different from the main EIES free text files. The text in these systems is usually of a more structured nature and each usually has its own monitor. The results reported here do not contain the activities in these subsystems. Based upon the amount of purged data records, no more than 5 percent of the data were lost. The loss due to the lack of counting indirect text references and tailored subsystems should also be well within 5 percent. The regularity of the data shown below also supports the view that the losses were not significant for determining patterns of usage.

Table II provides an overview of EIES usage and the total level of activity. The figures for the user base and groups are roughly estimated from manual records and include invited users who may have had only very short term and limited access. Table II serves mainly to illustrate that EIES usage provides a sizable sample from which we can extract some significant behavior patterns based upon the finer details of the data as characterized in Tables III and IV.

These tables reflect a very rich and diversified set of behavioral patterns. There are significant differences related to hours on-line spent in the utilization of messages, conferences, notebooks, and the private, group,

Table I. Brief Explanation of EIES Features.

Features in the Original Design

Private Messages: Can be sent to any individual or list of individuals. Confirmation of date and time of delivery is given.

Group Messages: Delivers the message to all members of a predefined group. No confirmations are provided, but sender can request status list showing who has received it.

Membership Directory: Self-entered short description and address for all groups and members. Specialized searches are incorporated.

Private Conferences: Any member may initiate and moderate a conference on any topic. Member has right to involve whatever participants he or she chooses and decides whether or not to advertise.

Group Conferences: Each group has a permanent general conference to which all group members belong.

Public Conferences*: Conferences in which anyone on the system may read or write without having to be granted access.

Private Notebooks*: Each member has a notebook for composing and storing items. The owner of a notebook may give other members privileges to either read only or write as well. Owners may also establish read-only windows to portions of the notebook. New items as well as modifications of existing items are reported to all members in a notebook.

Group Notebooks*: Same features as private notebooks, but associated with all members of a group.

Public Notebooks*: Anyone on the system may read in a public notebook, but only the designated authors may write in the notebook.

Menus: The standard form of person–machine interface taught to new users via the written documentation they initially receive.

Commands*: Systemwide commands allowing the complete replacement of the use of menus and adding other unique capabilities outside those available through the menu.

Explanations: An on-line searchable file containing specific explanations of all system features.

Retrieval: The ability to recall any text item previously read by a unique identifier. For messages this is limited to the last 30,000 sent on the system (about three months traffic); for conferences or notebooks this is based upon owners of these spaces deleting items when they are outdated.

Searches*: Messages, conference comments, and notebook pages may be searched by author, editor, dates, item identifier, free key words, full text, associations among items in either a nested or combination process.

Anonymity and Pen Names*: Any text item may be signed anonymously or with a unique secret pen name. Messages may be sent to Pen Names.

Synchronous Conferences: The ability to hold a conference when all members are on-line at the same time by supplying status indications of everyone's position in the conference at any time.

Voting*: The ability to choose any one or two of nine alternative voting scales that can be attached to a conference comment. The computer collects and displays the vote distribution for the members of the conference.

Direct Text Edits*: A line-oriented editor for use in the scratchpad, where individuals compose text items for entry into the system. Edits are accomplished immediately.

Copy, Get, and See: Methods of indirectly referencing other items of text within a given text item or of transferring text items among messages, conferences, and notebooks. In the case of See, the printout of an item is conditional on whether the receiver has already seen it.

EVOLVED FEATURES: Those added to the EIES system based upon feedback from users.

User consultants: Volunteers who help others to learn to use the system and who also serve as information brokers on activities taking place on EIES. A number of special purpose software features exist to facilitate the tasks of the user consultants.

CHIMO (newsletter): A weekly summary of events taking place on EIES.

? or ??: Entering a ? or ?? as an answer to any question or choice on EIES results in a short or long explanation, respectively.

?word: Will retrieve an explanation of the "word" or system feature named from the explanation file.

SEN, ???, or LINK: Sending one line messages which are delivered the next time the recipient does a carriage return, with or without confirmations or continuous exchange of one liners with a group.

Defined Commands: Any user may define a sequence of operations or commands as an individually tailored command. Facilities exist for the more sophisticated user to make these conditional.

Indirect Edits: Edit commands stored within the text providing such things as centering, paging, text justification, and tabulation. Indirect edits are executed at output time and are based upon the specifications the receiver has indicated for his terminal or local interface device.

Storage Areas: A set of six temporary scratchpads in which users may store fragments of text undergoing composition.

Terminal Controls: The ability of a user to control margins and page size.

Switches: Special controls needed to regulate the output for those interfacing through microcomputers and intelligent terminals.

Reminders: A personalized file of one line reminders kept by any member which may also be "alarmed" by date and time.

Interests: A file of key words such as "ham radio" which users may enter and associate with so that messages can be sent to all those on the interest list.

Submit and Read: The ability to provide abstracts to others via messages or conference comments which are active keyholes, upon demand, to larger documents stored in notebooks.

Subaccounts: The ability of a group of users to share a single membership slot where only one of the group may be active at any one time.

Games: Various computer games incorporating the ability of players to contribute material to the game or having a communication component (e.g., bridge).

Graphics: The ability to specify simple diagrams through a size-independent specification of figures, together with an ability to move windows around in a text item and insert text in windows horizontally or vertically.

Special Programs: Tailored routines for specific purposes. For example, "Terms" collects votes on alternative definitions for tasks such as standards setting. "Respond" administers surveys with multiple choice questions.

Special Communication Interfaces: Tailored communication structures such as TOPICS to deal with inquiries and responses within a group and to allow members to set profiles of their interests for self-filtering of the incoming material.

INTERACT language: A programming language allowing the imposition of special communication or data structures on the basic EIES facility.

* This feature has undergone extensive additions or modifications over the four year operation of the system.

Table II. EIES Summary Statistics.

	Pilot Phase	Phase 1	Phase 2	Total
Period	10/76–10/77	11/77–10/78	11/78–3/80	10/76–3/80
Months	13	12	17	42
Totals				
hours of use	9,837	24,317	63,562	97,716
items composed	40,552	70,851	155,813	267,216
items received	123,479	298,416	690,495	1,109,390
Estimated				
user base	150	500	800	1,100
groups	33	61	89	NA
Number of activities				
Conferences				
private	93	161	281	NA
group	21	53	61	NA
public	X	29	71	NA
Notebooks				
private	X	124	205	NA
group	X	26	34	NA
public	X	7	18	NA

and public versions of these activities. There are also significant changes in behavioral patterns with respect to experience. For instance, the length of the average session increases. The pattern of utilization of this technology appears to be a strong function of the characteristics of and alternative structures provided by a specific system as well as of time on-line. A system which provides a very limited set of capabilities is not likely to show such patterns of evolution of user behavior [15].

Table III breaks down various measures of user behavior based upon accumulated monthly averages for phase 1 and phase 2. The average over the total 29 months is shown as well as the standard deviation in both absolute and percentage figures. Table IV takes the same measures and breaks them down for a typical month into usage ranges, e.g., the value of a measure for those individuals using between five and ten hours during the month. The comparison of the same measures for the total system over all months and for users at various levels in a single month illustrates which measures exhibit significant regularity over the period of the field trials. The month used (October 1979) had the following activity levels:

4115 hours of usage
10,988 items composed
48,537 items delivered
464 active users
30 active groups
149 active conferences
59 active notebooks.

With the steady growth of the membership during the period of the field trials, October 1979, is typical of the last six months of activity levels on the system.

We note in Table III that over two-thirds of the measures have a standard deviation of less than 20 percent and only two are above 30 percent. On a systemwide basis many of the measures of performance are very consistent month-to-month and show little or no correlation with the total activity levels, which range from 100 active users the first month to over 500 in some of the last few months of the trial period.

From Table III we note that the average time per user per month varies between eight and ten hours consistently on a systemwide basis. However, in Table IV the hours per user follows an exponentially decreasing curve when one plots a frequency curve for the number of users within increasing ranges of hours used. Doing a regression analysis for any particular month results in correlations of over 0.9 on a logarithmic curve. This type of behavior is typical of many interactive systems. This same behavior is illustrated by the number of sessions in a month and the length of the sessions. However, when one looks at the items composed and delivered in a session and the resulting total transactions per session we can infer a rather significant behavior pattern. While the systemwide averages stay relatively flat on a month-to-month basis, the amount of composing goes up and the amount of receiving goes down with increasing usage by an individual. Total transactions per session is relatively flat except for the user with less than one hour per month. What seems to be occurring is that the system conditions users to adjust both their frequency of sign-on and their length of interactive session so that they do not encounter more than about six items that they have to deal with in terms of receiving or composing items. This is often confirmed by the anguish expressed by a user who has been away from a terminal (e.g., on vacation) and comes back to the system only to find a large number of items waiting. The number of transactions a user desires to deal with at one sitting seems to be related to the "magic number seven" and the concept of the

Table III. Summary Statistics by Monthly Averages (means).

	Phase 1	Phase 2	Overall Average	Standard Deviation	Percent Deviation
Monthly averages					
users	206	408	326	123	37.7
hours used	9.8	9.2	9.3	1.5	16.1
Session averages					
number per user	25	23	24	3.5	14.6
length (minutes)	24	24	24	1.8	6.3
items composed	1.2	1.0	1.1	0.2	18.2
items received	4.8	5.0	4.9	1.1	22.4
transactions	6.0	6.1	6.1	1.2	19.7
Size (lines) of					
messages	9	11	10	1.1	11.1
comments	18	15	16	3.1	19.3
pages	16	20	19	5.3	27.9
Percent of items composed which are					
messages	72.8	68.4	70.4	7.4	10.5
comments	18.4	22.7	20.8	6.3	30.3
pages	8.8	8.8	8.8	3.2	36.4
Percent of items received which are					
messages	46.1	34.2	39.5	11.1	28.2
comments	50.8	62.1	57.1	10.5	18.4
Exchange ratios by items*					
Messages					
private	1.8	1.8	1.8	0.2	11.1
group	16.3	17.6	17.2	3.3	19.2
Conference comments					
private	8.3	8.0	8.1	1.4	17.3
group	16.3	18.6	17.1	4.6	26.9
public	33.6	24.9	26.9	14.5	53.9
Overall exchange ratios by					
item	4.1	4.4	4.2	0.6	14.3
text line	5.2	5.2	5.1	0.8	15.7
Average throughput measures					
Percent of time spent composing	84	83	84	3.4	4.0
Time (minutes) to compose a 10-line item	16.2	16.1	16.2	2.7	16.6
Effective input rate (words per minute)	7.5	7.7	7.6	1.1	14.5
Effort (minutes) spent per received item by					
item circulation	4.0	3.7	3.9	1.1	28.3
text circulation	3.1	3.1	3.2	0.9	28.1

* Exchange ratios are the number of items received or read divided by the number sent or composed. When considered by subsystem (e.g., conferences), rather than by individuals, they can be considered to be "circulation ratios" reflecting average readership of an item.

short term memory. Here is one clear example of the influence, through the system, that the communication activity of the user's group or of those with whom he is communicating can have on the individual's behavior. Though the number of transactions per average session tends to hold at under seven regardless of total amount of time on-line, the more experienced users do spend longer times on-line per session. One can infer that they are spending more time on the system composing rather than reading, and/or that the items with which they deal are longer or more complex.

Also reasonably constant and insensitive to the systemwide averages or to the user level of activity averages are the proportions of items composed that are messages and conference comments. Once again the exception is the very low level user who seems to confine his or her activity to the message function. The use of notebooks is a much stronger function of the amount of usage by an individual. However, the distribution of the proportional use of notebooks from month-to-month is extremely flat. Considering the fourfold increase of active users over the period of the field trials, one can infer that, on the average, the number of people writing reports or short documents is a fairly constant percentage of the popu-

Table IV. Usage Distribution for October 1979 (means by ranges of hourly use).

	Range of Hours (average measures)							
	0–1	1–5	5–10	10–20	20–50	50–100	100+	Average or Total
Number of users	124	173	78	37	35	14	3	464
Average time used (hours)	0.5	2.5	8	14	31	70	151	8.9
Percent of usage time used (hours)	1.4	11.1	13.5	12.8	26.4	23.8	11.0	4115
Session averages								
number per user	4	12	25	44	79	169	124	25
length (minutes)	6	13	17	19	23	24	72	21
items composed	0.3	0.5	0.6	0.8	1.0	1.5	3.0	0.9
items received	2.5	4.1	3.4	3.1	4.5	4.6	2.9	4.1
transactions	2.8	4.6	4.0	3.9	5.5	6.1	5.9	5.1
Size (lines) of								
messages	12	10	12	11	11	11	10	11
comments	0	16	15	27	24	16	21	18
pages	0	0	0	37	22	19	27	23
Percent of items composed which are								
messages	100	79.8	79.9	80.8	72.6	71.0	67.9	74.1
comments	0	20.2	20.1	12.8	20.2	20.8	17.4	19.1
pages	0	0	0	6.2	7.0	8.0	14.6	6.8
Percent of items received which are								
messages	62.1	25.5	29.0	29.9	31.3	32.9	40.2	31.8
comments	36.8	74.5	70.7	65.5	65.5	60.2	52.3	64.8
Exchange ratios by items								
Messages								
private	3.9	1.5	1.3	1.7	1.3	2.0	1.6	1.9
group	69.7	26.9	48.2	X	15.9	14.1	11.1	24.4
Conference comments								
private	0	15.5	10.9	8.5	8.3	6.1	9.5	8.7
group	0	64.8	33.1	41.2	14.3	17.5	11.7	25.8
public	0	42.2	31.3	X	23.9	22.3	X	29.3
Average throughput measures								
Percent of time spent composing	70	70	79	81	81	81	87	80
Time (minutes) to compose a 10-line item	12.9	15.5	17.3	14.5	13.4	10.6	17.7	13.8
Effective input rate* (words per minute)	9.4	7.7	6.9	8.3	9.0	11.3	6.8	8.7
Effort (minutes) spent per received item by								
item circulation	2.3	2.3	4.1	5.2	4.5	4.4	5.9	4.1
text circulation	2.1	1.6	3.0	3.8	3.6	3.3	4.6	3.1

* Effective input rate is calculated by taking out the time needed to deliver the text at 30 characters per second and assuming that all the time remaining was devoted to inputing text. Since this remaining time actually includes all user interaction time it is a conservative estimate of typing rate.

lation within most professional groups typical of the EIES community during this period. We suspect that this result would extend to managerial usage as well, although the actual proportion of notebook writers might be very different.

While the curves for conferencing and notebook usage are flat, they do have fairly large standard deviations. From direct observations, activity in many conferences tends to oscillate significantly as a function of specific subject matter and the time allowed for the group to accomplish something. For the professional and academic groups on EIES the cycle times for dealing with particular topics often run longer than a month, which would account for the degree of fluctuation. In many managerial environments these cycle times may often be less than a month and one might expect less fluctuation.

While the system as a whole, in terms of the measures presented here, shows no critical mass effects at the current levels of usage, relative comparisons among conferences do exhibit such effects. For example, the larger the number of participants in a conference, the greater the degree of equal participation, as measured by the decreasing slope of the participation curve. This effect is

not evident in either private or group messaging behavior. Large conferences as well as small ones do tend to have a facilitator and a core group of contributors who write more than other members. However, with more participants in the conference, their proportion of the total decreases relatively. One possible explanation is that the effort spent composing comments by any one individual is largely regulated by individual time constraints and is not a function of group size.

While the conference comments represent about 20 percent of the items written, they represent over 50 percent of the items received. On an individual usage basis there is slightly less conferencing for both very low levels and the very high levels. This is consistent from month-to-month. At low levels of use this results, of course, from the more immediate impact of a message and the usual need to take care of a message before doing other things. At high levels of usage this results from the fact that a significant number of the high level users are involved in the management and operation of EIES and that they have a disproportionate amount of message traffic with which to deal.

The differences between messages and conferences are also reflected in the exchange ratios. On the monthly data (Table III) the exchange ratio (the number of items received divided by the number sent per activity) can be viewed as the average number of participants in a particular activity such as a private conference. In this case the exchange ratio may also be viewed as a circulation ratio. The usage distribution (Table IV) uses the same ratio, but is calculated by individual. It reflects how much a person receives in proportion to what he or she writes. At low levels of usage the exchange ratios reflect that these users receive a greater proportion than they contribute, while at high levels users proportionally contribute more, but still receive a greater amount than they compose.

For both tables, comparing line size and circulation or exchange ratios illustrates that there are significant differences in the utilization of messages, comments, and notebooks. The distinctions between private, public, and group versions of messages, conferences, and notebooks also seem to be distinctive. It appears, therefore, that all these facilities have their role and function in the computer augmentation of human communications. We feel that messaging or conferencing or notebooks alone are not sufficiently flexible to satisfy the requirements of cooperating human groups. All of these facilities are provided by EIES within one consistent interface. This is important when dealing with user populations who do not have the time or interest to learn a great deal about the operation of an interactive system.

While the exchange ratios differ considerably by individual type of activity the curves reflecting overall ratios on a month-to-month basis are very flat. Another regularity is that the circulation ratio by text line is always larger than that by text item. One infers that when people are writing items they know will go to larger groups they tend to write longer items. While it is not obvious from the data it is also usual that more editing effort goes into the longer items in conferences and notebooks than into shorter, transitory messages. The user, of course, is also aware that his conference and notebook item will be a permanent part of the transcript and may be read later by new members of a conference. One would hope, of course, that more thought goes into the longer text items as well.

The percentage of time spent composing is derived by subtracting the estimated time to deliver items from the total time. As a result, the figure for composing time also includes the time spent interacting. Currently EIES has about 30 users with microcomputers for off-line composing, and these users report saving about 50 percent–70 percent of their interaction time as a result. Microcomputers also allow the user to automatically offload waiting communications and to deal with them later at 9600 baud. The use of microcomputers will greatly alter both the time on-line and also, one suspects, the number of items dealt with in an EIES session.

The time to compose a ten-line item and the effective input rate are essentially the same measure shown two different ways. While six–eight words per minute is not secretarial typing speed, these rates incorporate all interactions, including the editing of the text items. In terms of business typing, when one incorporates editing and review of material, these rates per finished text item are probably very competitive. This results because the actual typing seems to be a small part of the total time relative to the think time for composing and editing. The majority of users seem to do their initial drafting on-line. From Table IV one sees there is considerable variance possible among users regarding this, although the systemwide average is relatively constant.

The final factor, labeled "effort," is the average time to compose an item divided either by overall item circulation (exchange) ratio or by the text circulation ratio. The result is a measure of the time one expends in interacting or composing per item received. We suspect it is a parameter one would like to see in the range of two to five minutes on the average and comparable in some sense to the average time of a phone call. It is a measure that can be used to compare systems and their performance for user groups.

The use of computers to augment human communications is a relatively new application of computers. It is quite clear that it introduces a number of new measures with which one can evaluate the performance of such systems. They differ considerably from the standard measures used to assess the general purpose type of time sharing system. However, the full interpretation of these measures and their relative importance requires, at this point in the evolution of these systems, the merger with direct inputs from the users themselves. The remainder of this paper is based upon that portion of the data obtained directly from EIES users dealing with the system features.

Table V. Reactions to Specific Features of the EIES System and Correlation (Gamma) with Time-On-Line.

Feature	Extremely Valuable (percent)	Fairly Useful (percent)	Slightly Useful (percent)	Useless, Cannot say (percent)	Gamma	P*
Private messages	68	22	10	1	0.50	0.09
Text editing (direct) (e.g., /old/new)	51	18	6	25	0.23	0.47
User consultants	50	21	7	22	0.32	0.02
System commands (e.g., +cnm)	40	27	7	26	0.49	0.01
Group conferences	39	33	13	15	0.40	0.04
Group messages	35	31	25	9	0.06	0.48
The directory	34	35	17	14	0.21	0.04
Private conferences	33	25	8	35	0.44	0.01
Retrieval	31	31	9	30	0.30	0.48
Searches	27	16	18	38	0.38	0.01
User-defined commands (i.e., +define)	21	15	5	59	0.29	0.001
Text editing (indirect) (e.g., .text)	20	16	3	61	0.17	0.16
+SEN and ???	18	21	10	51	0.58	0.001
CHIMO	17	23	24	36	0.34	0.20
Private notebooks	14	23	7	56	0.42	0.001
Use of ?,??	12	25	16	47	0.11	0.24
Explanation file	10	20	19	51	0.00	0.82
Terminal control features (e.g., +left,+page)	10	17	7	66	0.22	0.19
Anonymity or pen name	10	13	16	61	0.32	0.25
Synchronous discussions in conferences	9	12	16	63	0.17	0.65
Group notebooks	7	15	6	72	0.03	0.39
Special programs (e.g., +terms, +respond	9	9	6	76	0.40	0.12
Graphics routines	7	5	2	86	0.42	0.21
Interact Programming	5	3	6	86	0.20	0.16
Tailored interfaces (e.g., +Legitech)	4	6	3	87	0.41	0.03
Games (e.g., +story)	3	6	21	70	0.55	0.002
Voting	2	12	7	79	0.18	0.15

Source: Post-use questionnaires, $n = 102$.
* Probability that relationship could be due to sampling error, chi square test.

Evolution of User Behavior

After approximately 18 months of use of the EIES system, members of the scientific user groups on-line were asked to rate the perceived usefulness of a number of specific system features. If they had not used a feature at all, they were instructed to check "cannot say;" otherwise they were to rate each one as "extremely valuable," "fairly useful," "slightly useful," or "useless."

The data in Tables V and VI show the relationship between amount of time spent on-line and the ratings of the usefulness of the system features. Let us look at Table V first. The first column serves as the basis for ordering the features and is simply the proportion of the total of 102 users answering these questions who rated a feature as "extremely valuable." The responses at the other end of the scale, "useless" and "cannot say," have been combined to form a more nearly ordinal scale, since very few checked "useless." "Cannot say" was the response that was checked by respondents who felt so little need for the feature that they did not ever try to use it. Some of this is accounted for by poor documentation of the newest of the features, which are not included in the user manual.

Column 5 of Table V reports a statistic which shows the relationship between the subjective rating of the value of the feature used and the amount of use of the system at the time the questionnaire was written. Gamma, the statistic used, is a correlation coefficient which varies between −1.00 and +1.00, with zero meaning no relationship. It is the most commonly used measure for ordinal scales. It is a proportional reduction in error (PRE) measure. A gamma of 0.50 can be interpreted to mean that if you pick any two pairs of observations in the sample, it is 50 percent more likely that the person who is higher in hours on the system also has the higher rating for the feature, than that the two pairs of observations vary in the opposite direction. It can also be interpreted to mean that, overall, knowledge of time on-line improves our prediction of system feature rating by 50 percent. (See [4] for discussion of measures of association for ordinal variables.)

Table VI. Growth of Features Perceived as "Extremely Valuable" or "Fairly Useful" as a Function of Amount of Experience Using EIES.

Feature	Percent	Percent shift
Users with 1–19 hours on-line (n = 26)		
Private messages	81	
User consultants	71	
Group messages	68	
Direct edits	63	
Membership directory	59	
Group conferences	58	
Users with 20–49 hours experience (n = 32)		
Private messages	84	+3
Group conferences	66	+8
Direct edits	65	+2
System commands*	64	+21
Group messages	62	−6
User consultants	59	−11
Membership directory	56	−3
Retrieval*	53	+5
Private conferences*	53	+17
Users with 50–99 hours experience (n = 25)		
Private messages	96	+6
Group conferences	80	+14
System commands	75	+11
Membership directory	72	+16
Retrieval	68	+15
User consultants	67	+7
Direct edits	67	+1
Group messages	54	−8
Searches*	52	+26
? and ??*	52	+10
Private conferences	51	−2
Send, link, and ???*	50	+26
Users with 100 hours and over experience (n = 19)		
Private messages	100	+4
Membership directory	95	+23
User consultants	95	+28
Direct edits	90	+13
Group conferences	90	+10
System commands	90	+15
Retrieval	84	+16
Group messages	84	+30
Private notebooks*	74	+44
Send, link, and ???	79	+29
User-defined commands*	68	+31
*CHIMO**	63	+42
Indirect edits*	63	+34
Private conferences	55	+4
Terminal control*	53	+46

Source: Post-use questionnaire and monitor data on accumulated hours.
* Additions have been made to the list over prior usage class.

The last column shows the level of statistical significance of the relationship between time on the system and subjective ratings of the value of the features, based on a chi-square test. We have adopted the 0.05 level of probability as a rough guide to the extent to which the observed patterns of association are based on numerical differences too large to be attributed to sampling error.

The most universally appreciated features are the private message, the direct text editing necessary to make typing corrections, the user consultants employed to help a user find his or her way around the system, and the system commands employed to replace a menu-driven interface when users understand the options available. These are the types of features which are built into most electronic mail systems, with the exception that most such systems do not include the "friendly human helpers," the user consultants. However, high overall popularity ratings are also received by many features which are not usually part of electronic mail systems: group and private conferences, and the public directory of members to facilitate the formation of interest groups. In addition, we notice from gamma statistics that appreciation of many features appears to be related significantly to the amount of use of the system.

This becomes clearer in Table VI. Here we see that beginning users do indeed see the need for only a relatively small number of features in a computer-based communication system. However, the more experience they gain, the more they come to feel that a wide variety of communication spaces and capabilities is necessary, and the less likely they are to be satisfied with a simple message system. The group-oriented and conferencing features become much more important, as do the features that are necessary for storage, retrieval, and manipulation of text for documents.

EIES is not very well documented for users. As a research and development system with a small number of operational staff, there is no regular documentation effort. New features arise from user feedback via the user consultants and evaluators to the implementors. When a new feature is added, it is exposed to the user consultants, who test it and write documentation for the on-line file. Major new features are announced in *CHIMO*, the on-line newsletter. After that, a user must either search the explanation file or ask a user consultant whether a feature exists to fill a perceived need. There is no regular mailing of updated documentation to users. As a result, a user must feel motivated to seek out new features and to learn to use them without any face-to-face training. We think that the users themselves, seeking out new features after gaining experience on-line, make our results more significant than they would be if the users were simply responding to pushes from advanced training seminars or to published training manuals on the features which they ought to learn when they feel comfortable with the basic system.

Though the likelihood that a person will find a system feature necessary or useful is generally positively correlated with use, there are a few exceptions. Some of the features for which perceived usefulness seems to be a direct function of the amount of use of the system are group messages, group conferences, private conferences, system commands (as compared with the menu selection interface), search routines, and indirect editing for formatting of output.

One interesting drop is in the perceived value of group messages, at the intermediate levels. We think that

new users perceive the feature from the point of view of the sender: a convenient way to communicate with a large group. With a little more experience, however, they become aware of unwanted group messages from the recipient's point of view. Group conferences, in which receipt of an item is governed by self-selection on the basis of topic, is then seen as a more valuable, self-filtered mechanism for group communication within the context of the EIES design.

An interesting curvilinear pattern occurs for user consultants; appreciation of them is high at all levels, but the newest and the most experienced users find them most valuable of all. This is probably because the user consultant is asked for help and human response ("Somebody talk to me!") by neophytes and then becomes the source of advanced knowledge on features that are too new or complicated to be automatically retrievable by the short explanation request (? and ??). This tends to occur when the user masters the basic system and is ready to move on to preparing large documents in notebooks and to defining his or her own commands.

Another complementary explanation, partially verified by observation, is that the user consultants also take on gatekeeping and information brokerage roles. They are often asked by advanced users for information on whether particular topics might be discussed and who else on the system might be interested in them. In a sense, the user consultant represents a new type of human facilitation role for the electronic information exchange environment. They also offer advice on effective styles of leadership for users who wish to establish a conference or other activity on-line.

Looking at the pattern of changes, one can interpret them as showing that new users appreciate a system that replaces communication media with which they are familiar. These are the letter and the telephone call (replaced by the private message,) and the meeting (replaced by the group conference.) However, as they gain experience with the new medium, their perceptions of useful applications and their preferred styles of using the medium change. As users gain more experience with the medium, they tend to find more valuable the unique kinds of functions which the computer can provide for asynchronous group efforts. They need features which help them to deal with information overload, which can result from intensive daily interaction with a large number of people and groups. They also begin to use other advanced features that can be provided by a computerized conferencing system.

One can classify those features for which there is a substantial increase in perceived usefulness as a function of experience as follows:

1) Features that facilitate long-term group communication are perceived to be more useful than one-to-one communication (the group conference and the private conference) as experience increases.

2) Features that allow a user to actively control the system rather than to passively react to menu choices and new items automatically presented (system commands, user defined commands, searches) are perceived to be more useful as a function of experience. It should be noted, however, that EIES members feel that the menu is the optimal interface for the beginning user.

3) Features to support composition and the preparation of larger text items and documents (notebooks, indirect editing, and terminal controls for formatting output) are perceived to be more useful as a function of experience. Note that it is only at 100 hours or more of experience that most users arrive at the point where they want to produce their large documents on-line, rather than to have them typed.

4) Features that permit tailoring of the system to individual and group needs (user defined commands, special routines, and the INTERACT language) are perceived to be more useful as a function of experience.

Phases of User Behavior

One classical model of user behavior in interactive systems with which one can compare our data was developed by Bennett [2]. He generalizes user behavior into the "uncertainty" phase, during which the learner has to overcome hesitancy and anxiety; the "insight" phase, during which the user understands the general concept of the system and can make at least limited use of it for his or her own purposes; the "incorporation" phase, when the mechanics of the interaction become second nature; and the "saturation" phase where the system is perceived as inadequate for meeting new requirements users evolve as a result of experience.

EIES users report a median of 2.4 hours to learn the basics, but there is quite a wide variation (the mean is 6.4 hours). Reaching the insight phase seems to be related to getting comfortable with the writing style and multi-strandedness of conferences, where many topics tend to be discussed simultaneously. A median of 5.1 hours is reported before users feel comfortable using the system. The incorporation phase appears to have occurred by 50 hours. To date, we have not observed any signs of the saturation phase, except in the form of a desire to learn the INTERACT programming language and to construct one's own subsystems, or to have another person do the programming to specifications of the users.

However, there is a phenomenon of information overload, which seems to occur in all regular users sooner or later. EIES provides many conferences and activities which users are free to join, far more than the number with which any individual can cope. The growth in publicly available conferences and the fact that a new user can then go back and read a conference transcript that has been accumulating for a year or more makes the accumulated material in EIES appear as a database. The plethora of available material creates a need for searches, retrieval, and the ability to select material of interest from all that is stored on-line. This overload

phase is now receiving considerable attention in the evolution of the EIES system design.

Conclusions

The design implications of these observations are fairly obvious. Short term pretests of inexperienced users on small scale systems cannot be generalized to predict the preferences of experienced users on operational systems. Given that this technology is likely to be heavily regulated nationally and internationally, the design also has policy implications.

Users cannot tell you what they need prior to using this technology. Attempts to predesign fixed systems, which are common in the standard database area, are doomed to failure, unless the persons setting the requirements are experienced users of the technology. The difficulty in validating this statement is that people in dire need of improved communications will utilize anything that they are given which provides increased efficiency. Simple message systems will do this, but they also leave the user in ignorance of other opportunites which this technology can offer.

In the United States in particular the field of computer science is unique relative to the more classic sciences, in that use of the technology often precedes our understanding of the impacts of applications upon users and organizations. In this atmosphere the scientific process is often at odds with the commercialization of the technology. We tend in many cases to substitute observations of what *is* rather than considering what *ought to be* in our investigations of user impacts. One of the best examples of this is the current commercialization of electronic mail. Such an application is usually sold on the basis of automating the existing internal mail system, thus making it faster and cheaper. While this is admirable in the short term, the limited design of such systems will in the long term prohibit the potential users from discovering the new approaches to human communications that this technology makes possible. We believe that the real future of this technology lies in rather rich systems that allow the tailoring of communication structures and features for specific groups and specific applications and the integration of these structures into other forms of computer augmentation [13, 21].

As a simple illustration consider that many electronic mail systems were evolved by watching current secretarial behavior. As a result these systems require the sender to fill in all the heading information before the text is composed (to whom the message is addressed, its subject heading, and who should receive copies). This is fine for a secretary working from a finished draft but very poor for a manager who wants to compose the message online before knowing all who should see it. A *flexible* system should allow these steps to be executed in any order. Once we open the door to direct use of these systems by those who first *create* the information, it is easy to visualize the need for special structures in communications and data to handle such operations as budget planning, project management, contract negotiations, etc.

With respect to utilizing the computer as a direct aid to human communications, we are in a situation that is quite similar to that described by Bennett [2, p. 160] for interface design for interactive systems:

> ... the lack of significant, directly applicable theory to serve as a basis for design forces the reader to provide his own interpretive framework as he studies the literature on the emerging interface-design technology.

The use of computers to support human communications is extremely new with respect to actual applications and is as yet largely unexplored in terms of the options it presents. Therefore we must be very careful not to confuse usage with either acceptance or effectiveness. All the current use of electronic mail systems implies to date is efficiency over other noncomputer alternatives. It provides no valid knowledge relative to other computerized options.

In many European countries we have an even worse situation with respect to the ultimate evolution of this technology. Post Telephone and Telegraphs (PTT's) have jurisdiction over all forms of communication. Many are severely limiting or even prohibit the use of sophisticated computer-based communication systems that include such features as text editing, filing, and conferencing. This seems to be part of a general national concern about a kind of "computer-based imperialism." For instance, a representative of the French government (Louis Joinet, quoted in Pipe [18, p. 118]) states,

> Information is power and economic information is economic power. Information has an economic value, and the ability to store and process certain types of data may well give one country political and technological advantage over other countries. This, in turn, leads to a loss of national sovereignty through supranational data flows.

By "rich" systems we mean systems which offer a variety of features integrated into a single system for regular, experienced users. One very probable barrier to the development of rich systems is that national governments are liable, for protectionist reasons, to institute a legal monopoly over computer-based communication systems, with a very simple system provided by the PTTs and no competition allowed. This would be unfortunate from the point of view of fulfilling the full range of communication needs for the managerial or professional worker.

We are no longer in an environment, like a telephone or satellite system, which requires very large capital investments in hardware to create new communications capabilities. A single computer system can offer hundreds of alternative features and communication structures, tailored to individuals and applications. All of these structures reside in software, which can be easily changed to evolve with the users. While people speak of the high cost of software, this is usually the result of not making the initial investment during the design and development phase to incorporate facilities for change

and evolution into the software. Trying to start with the cheapest system possible usually ends up costing more in the long run, when you have to abandon the original system and start over again. If one designs for change and gives up the idea of fixed systems, the total life cycle costs can be significantly lower.

If there is to be a single computer communications system to satisfy societal needs, then it should be one where the individuals and groups which use it can develop their own features and their own structures. EIES has demonstrated this concept in microcosm, with many groups having their own special subsystems. EIES is, in fact, a single software package that can reside on minicomputer technology. Purchase costs for hardware and software range from approximately $150,000 to $350,000 as a function of whether one wishes to support under 1000 users or somewhere over 3000 users. The resulting system, when plugged into a nationwide digital network such as TELENET, is a nationwide system that could cater to any particular user population. A capital investment of only a few hundred thousand dollars could thus enable anyone to offer a system nationally. With this low an investment, there is no need to create monopolies. It is also clear that we do not know enough about the ultimate evolution of these systems to impose standards for one single kind of system that can meet the needs of all users.

We are entering an information age, in which we will see new marketplaces for information and the communication structures necessary to guide the flow of information. Until we understand the full implications of the social and technological changes that we are now part of, the only desirable policy is to make entry of people, groups, services, and innovations as much of a free market as possible. The concept that all communication common carriers should be regulated, which is perhaps true for the telephone system, the mail, and the broadcast media, does not fit this new technology, where there is no large capital investment required, no limit such as available frequencies to the variety of systems which can coexist, and no danger of depleting any natural resources.

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