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Experiences with an Augmented Human Intellect System: Computer Mediated Communication

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EXPERIENCES WITH AN AUGMENTED HUMAN INTELLECT SYSTEM: COMPUTER MEDIATED COMMUNICATION

by

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(The opinions expressed in this paper are those of the author and do not necessarily reflect official policy)

ABSTRACT

The implementation of the Augmented Human Intellect System (AHI), developed by the Stanford Research Institute, has permitted a new avenue for interaction: that of computer mediated communication. This paper is a description of experiences with this novel alternative to conventional ways of thinking and communicating in an organizational environment.

The AHI system was designed to facilitate communication among knowledge workers who may accomplish their entire job utilizing this advanced technology. The system has the capability to deliver messages or other information to geographically distributed users. It permits access to and modification of stored information by a number of persons concurrently or independently.

The effects of the system in a research and development office were an increase in the effectiveness of the individual, a higher level of consensus in teams, and a collaborative openness in the organization.

An overall increase in communication was observed as the problems of training a population of scientists and engineers were solved. The problems encountered included psychological resistance to this kind of major change in working habits, system failures, insufficient training, and hardware unavailability.

Progression toward an Augmented Knowledge Workshop was marked by a transition from system use as an automatic typewriter to use for on-line composition. In addition, the system became transparent as

the skills of operation were mastered. An unprecedented involvement with the system by individuals, especially when using the display terminal, was representative of the dramatic changes in the work methods and communication patterns within the population.

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INTRODUCTION

Background

Computer technology has evolved with an almost incomprehensible rapidity over the past two decades. Applications of this technology have changed from purely numerical programs to sophisticated scientific problem solutions to manipulation and processing of natural language. The latter application has resulted in a man-computer symbiosis where the computer system becomes an extension of man's intellectual processes. In a now classic paper, J.C.R. Licklider (1968) outlined the total system with man and computer as integral components. Parallel to the development of computer capability over the past decade has been the development of a system designed to take maximum advantage of the computer's power to store, structure and retrieve textual information in a way congruent with the characteristics of an individual.

Appropriately, the name given was the Augmented Human Intellect System (AHI), developed under the leadership of Dr. Douglas Engelbart of the Stanford Research Institute (SRI). Originally, the purpose was to "...increase the capability of man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems." (Engelbart in Lindgren, 1971) The intention was to provide an extension to man's intellect by utilizing a set of powerful computer based tools. This was gradually broadened to provide an extension to a

group's capability, to that of an organizational structure, and finally to numbers of organizations. A general overview of the system follows; detailed descriptions of the hardware and the software may be obtained from the references.

System Description

AHI is designed to take full advantage of the state-of-the-art in computer technology. It is an on-line, real time, time-sharing system with a full duplex terminal-to-system link. The result is a highly interactive interface between the computer and the user.

Upon establishing a connection with the PDP-10 at SRI through the ARPA Net, the user has available powerful techniques to create, store, structure and view written textual material.

Every user-identified unit of text is automatically numbered and assigned a user-determined level in a hierarchical structure which establishes a relationship to the text as a whole. The structure permits addressing and viewing the text by units of the hierarchy such as statements and branches.

The Viewspecification system controls the viewing of text in many different ways analogous to "windows" into the stored information. The "viewspecs" control the levels in the hierarchy and the number of lines for each statement that the user wishes to display or print.

Another structural unit is the file, integral to most time-sharing systems. Files provide a means of further structuring text. They can be combined, in part or in whole,

with any other file, and the user can "jump" between various files. Addressing between files is done with the same ease and rapidity as within files. Not only are the files in his own "directory" available to him, but all system users' files can be similarly addressed unless specifically prevented by protection codes.

The addressing and Viewspecification systems are key features of AHI. They represent some of the additional power of AHI relative to the numerous operational text editing software systems. A survey by van Dam (1971) states that AHI:

> "...embodies much more than just a text editor; their aim is to provide a new way of thinking and working by utilizing the power of the computer in all aspects of one's work." (van Dam, 1971, 110)

According to Engelbart (1973), the additional capabilities include communication among teams with joint and/or simultaneous preparation of text -- a "collaborative dialogue"; sending documents, correspondence, and coordinating work -- "documentation production and control"; and a library system for the storage and retrieval of relevant literature, etc. -- a "research intelligence".

Collaborative dialogue: There are computer aids for the composition of messages and for their subsequent reviewing, cross-referencing, modification, transmission, storage, indexing, and full-text retrieval. A "message" may be one word in length, or several hundred printed pages. In any message

there may be formalized citations pointing to specific passages in prior messages, so that a group of related messages becomes a network of recorded-dialogue contributions. There is also: automatic delivery of messages; full cataloging and indexing; on-line accessibility both to message notification and to the full text of all messages; and open-ended storage of the dialogue records. These services enable a community of people who are distributed in space and time to maintain recorded, collaborative dialogue.

Document development, production, and control: There is a rich set of computer aids for the composition, study, and modification of document drafts, and for automatically generating high-quality photocomposition output with flexible controls for font-designation and formatting, to enable the production of publication-grade hardcopy (printing masters, or microform masters). There are processes for collaboration between several writers, and with an editor, in the process of evolving a final draft. There are also aids for the people who must keep control of changes, new-version distributions, etc., and provide the indexing to complex documents or sets of documents. Most of these particular aids are presently available only at SRI.

Research intelligence: The provisions within the Dialogue Support System for cataloging and indexing internally generated items also support the management of externally generated items

> -- bibliography, contact reports, clippings, notes, etc. With these centrally supplied (therefore uniformly available) services, a community can maintain a dynamic and highly useful "intelligence" data base to help it keep up to date on external happenings that particularly affect it. Computer-generated indexes or on-line retrieval can facilitate access. Citations of external items from within the internally-generated dialogue base -- in the form of annotations, miscellaneous commentary, or supportive references -- offer computer-sensible interlinking of the external information with the internal, and considerably facilitate browsing, retrieval, back-citation searching, etc. (Engelbart, 1973)

Thus, to be augmented is to have a powerful set of tools residing in a state-of-the-art computer system that are used in every aspect of knowledge work, ie. activity that involves individual and joint preparation of communications, documentation, etc., and sharing the results with communities of knowledge workers. (Engelbart, et. al., 1967)

The Setting

We are implementing AHI in part to observe its effects. This prodigious undertaking is motivated by a number of factors: (1) the desire to determine whether or not it can be applied to this working environment, (2) the fact that it appears to be a powerful tool for the team that developed it, (3) the costs (over $10 million for development and hardware), and (4) the fascinating

technology. Realizing that those who created the system have a special motivation, we decided that implementation in our own offices would provide a more realistic test environment. Thus, certain organizational units in an information sciences research and development center are accessing the computer at SRI through the ARPA Network, and using it in the daily performance of their jobs, while a descriptive analysis is done.

At present, we have a user group of 20 persons including three levels of management. Most of the personnel are engineers, scientists or managers. We plan to double the population and to include one more level of management by the summer of 1973. There is a considerable amount of development to be done to provide the software and hardware support for such a large group, but we are gradually overcoming the current limitations.

PREDICTED OUTCOMES OF IMPLEMENTATION

This investigation is concerned with effects on the population in three areas: (1) the individual, (2) the communication amoung individuals, and (3) the organization. A statement of the effects that are ultimately expected in each area as the population becomes an "Augmented Knowledge Workshop" follows which provides a conceptual structure for the observations.

1. The individual's thought processes will be modified by the rapid availability of his own information, the ease of changing that information both in its content and structure, and the flexible control of structure viewing. (cf. Engelbart, 1973)

The rigidity of written information has a relatively unexplored effect on the development of a person's ideas, thoughts, etc. He traditionally is limited to handwriting or typing to make thoughts initially visible, and then to rewriting each time clarification, correction, up-dating, restructuring, etc., is necessary. This may require the intervention of a typist and communication of the necessary changes to this second party. The longer the paper or whatever, the greater the problem of revision. Once a lengthy paper is prepared, the thinker's ability to massage, manipulate and creatively deal with those ideas is curtailed.

When thoughts, etc., are entered into the AHI system, it is predicted that they will not lose the flexibilty inherent in the thought process, but conceivably will gain additional flexibility resulting from the visibility of written information. The capability of AHI to permit rapid changes in stored text of any kind was described in the Introduction. From this it can be expected that an individual will move through his stored ideas with great ease -- massaging, and creatively engaging words, concepts, facts, patterns, and the various nuances of recorded thought. He also has, at any time, a copy to share with whomever he chooses.

In addition to the flexibility gained, the hierarchical structure adds what may be a new dimension to computer stored thought. The structure permits verbal units to be placed at a level indicating relative importance, source, category, etc.

Thus, it is predicted that relationships can be captured or established which otherwise might be obscured by semantic limitations.

2. The communication of individuals accomplishing their work on the system will be modified by the free access permitted to all individual's work as structured into the system, by the capability to transmit messages or other information through the computer, and by the capability to simultaneously access and modify stored information by numbers of persons independently or concurrently.

Knowledge may be collected and synthesized thus maximizing the advantageous use of the resources of the on-line working group, resulting in better decisions and actions.

The result would be an "augmented knowledge workshop" promoting the collaboration and integration of the efforts of individuals to yield a new level of group creativity. Consensus would be represented by a stored record created simultaneously over time. The leaders of the Augmentation Research Center (ARC), Mssrs. Engelbart, Norton, and Watson, elaborate on the concept of the "knowledge workshop" as follows.

> "The term "knowledge workshop" is built directly upon the terms "knowledge work" and "knowledge worker", whose special use is from Peter Drucker (1969). He develops a much larger theme about these concepts, adding terms such as "knowledge technologies", "knowledge economy", and "knowledge society", and pointing out that the growing level and importance of knowledge-work activity in our society will produce a discontinuity in our cultural evolution of a scale commensurate with that of the industrial revolution.
>
> "The knowledge workshop is the specially provided

environment in which knowledge workers do their knowledge work. We can talk about a small knowledge workshop for an individual, or a large knowledge workshop for an organization. Knowledge workshops have existed for centuries, but here we consider maximizing their effectiveness by systematically evolving tools, methods, etc., with heavy dependence upon the new technologies of computer time sharing and networking. The result is the "Augmented Knowledge Worker" (AKW) which describes an individual effectively using AHI.

> "Basic workshop functions will serve the daily handling of the AKW's working information -- of their notes, things-to-do lists, memos, letters, designs, plans, budgets, announcements, commentary, proposals, reports, programs, documentation, item-control catalogs, etc. And before it can sensibly be of much value the Augmentation System has to provide for the grubby cut-and-try detail involved in the minute-by-minute, day-after-day worker's handling of this information: in the user's composition, studying, commenting upon, arguing about, modifying, communicating, publishing, presenting, etc." (Engelbart, Norton, Watson, 1973)

3. The ease of handling Knowledge Worker tasks and the openness among AKWs will have a strong impact on an organization where groups and teams are augmented, by changing the vertical communication in that organization and ultimately, the organization itself.

When the AKWs are at all levels in an organization, management and subordinates can communicate through the system with the same ease that co-workers can interact. The message transmission capability would facilitate the conduct of most of the organization's business through AHI.

The tradeoff from these increases in communication has historically been a loss of efficiency. (cf. March, 1965) However, a very important product of AHI is predicted to be the implementation of modern, "open" management techniques without loss of efficiency.

The overall effects in our organization would serve to move it toward being an Augmented Knowledge Workshop, a process this paper describes.

METHODS

Four means were employed to build an accurate description of the subjective experiences of the population, a chronicle, interviews, observations and personal account.

The Chronicle

The chronicle was established as a vehicle for recording the serendipity experiences by members of the population. Any experience that was perceived as noteworthy by a subject was recorded in a special file named CHRON. Originally, a CHRON file was established in each subject's directory to permit easy insertion of a statement or two describing the experience with AHI. The observer then could peruse the files of the population and compile a summary, collating and synthesizing similar events. In addition, a CHRON file was established in the author's directory as an alternative. This provided some valuable data along the lines of a case study. It was not expected that the subjects would be very conscientious about recording unique experiences, thus other methods were relied upon for more consistant and thorough "data".

Interviews

Interviews were conducted at intervals throughout the period that began with system availability to the population of 20

persons. A non-member of the organization was employed to conduct an unstructured interview that allowed the maximum opportunity for open-ended responses. Hopefully this enabled the respondant to introduce those things which were most important to him, while minimizing the structuring of these perceptions by the interviewer. General questions such as, "Could you tell me more about that?" were followed by more specific questions only when deemed necessary by the interviewer to gain some more detailed information from reluctant respondants. The interviews were non-directive to the point of resembling a discussion. Although the style was intended to be Rogerian, suggestions were used when certain problems were anticipated, eg. "Did you have trouble with output directives?"

The following techniques were relied upon to fill in the gaps between the voluntary responses.

Unstructured observation

There were more available data than could be collected through the foregoing methods. It shed important light on what people were experiencing as they learned and attempted to use the system for required work. This was collected as it drew the attention of the author, who then recorded the event. These events included conversations that were overheard ("eavesdropping"), random participation in conversations, sessions arising out of a request for assistance on the system, observing the process of document

preparation and the end product of system use, and reviews of the contents of subject's files.

This kind of record is highly impressionistic and is dependent even moreso than the other techniques upon the observer's perceptual set. In this case it was mitigated by the working environment in which subjects were non-volunteers involved primarily because of their location in the organization. There were no direct rewards for participation and no lessening of the workload imposed by management. A minimum of additional obtrusion into the working world of the subjects was imperative, thus supporting the use of techniques such as this one.

Personal account

The author has been a heavy user of the system for over a year and has been using the display system for about 7 months. This as well as other papers have been prepared on the system. No attempt has been made to distinguish between author and population observations although in many cases this is explicit. The author is, in fact, a member of the population whose experiences are recorded as such.

Although the subjectivity of this kind of study is high, attempts were made at all times to corroborate conclusions with the experiences of the population as a whole, in many cases directly consulting other users on the accuracy of the observations. Thus, although the personal experiences of the author played an important role, the conclusions drawn should represent the population in

general. The other techniques utilized additional observers in the form of hired interviewers, consultants, and colleagues external to this environment.

LEARNING TO USE THE SYSTEM

Becoming an Augmented Knowledge Worker

The traditional work patterns were adhered to with a great deal of persistance by the population. The methods of communicating and accomplishing daily work are habitual and consequently some extinction had to occur before new habits could be learned. This is similar to the "rejection phenomenon" frequently encountered when computer systems are implemented for non-programming uses (eg. data management).

This initial reaction was gradually overcome, aided by the managerial policy requiring the use of AHI for all appropriate knowledge work. More explicit training manuals and aids, readily available assistance, and, most important, easily accessable terminals within the users work space were vital to system acceptance. Improved instruction was recognized as needed; insufficient training seemed to result from a simple lack of teaching experience.

Initial instruction was done in small groups. Each person was given a terminal so that he could accomplish the operation as it was described by the instructor. The log-in operation, entering the appropriate subsystem, status listings, error messages, etc., were covered in the order they would normally be used. Additional

operations were described in the order of usefulness, a function of usage frequency. After two or three days, the trainees were asked to practice, while the instructors stood by to give assistance. Instructor assistance remained available on a permanent basis. In the future, a conceptual overview of the system and a discussion of its purpose as a global tool should be given prior to any attempted usage so that the neophyte may understand the new working methods available to him.

On-line composition represents the kind of working method that is difficult to grasp at first. The difference between this and use as an automatic typewriter became obvious as new users progressed. This differentiation was remarkably discrete as evidenced by the work methods employed.

On-line composition is the modis operandi for the first few persons who learned the system, and who have been "on" it for over a year. It is characterized by little use of paper, either for the original composition of new ideas or for the proofreading of drafted papers. Instead, all structuring, outlining, wording and phrasing, etc., is done while on-line.

Use as an automatic typewriter is characterized by handwriting outlines and original drafts often creating a complete draft that is typed into the system by a secretary. Corrections and revisions are then done on the hardcopy printout. These are then copied into the system on-line. Further reviewing is done in a

similar manner. There is no effort to compose ideas directly using an on-line terminal.

There are a number of reasons for this, not the least of which is the non-availability of a CRT display or inability to use the display version of AHI. Typing skill is another limiting factor, although those who have used the system for on-line composition have found that a typing ability evolves naturally.

The psychology of the situation also played an important role. Certain subjects expressed a reluctance to use a teletype because typing was beneath them. Comments such as, "what will the secretaries do," or "I wasn't hired as a typist," etc., were noted.

The transition from automatic typewriter use to intellect augmentation appears to be an important threshold in the process of becoming an AKW.

Continuing usage on a day to day basis begins to render the system "transparent", which is probably necessary for the full realization of intellect augmentation. The command language, addressing, viewing, operating the terminal, and the other control mechanisms become of less concern freeing the individual to deal directly with the subject matter at hand. None of our population has experienced total system transparency, but a few have come close. We are limited somewhat by technical difficulties such as computer crashes.

Observations of true AKWs at SRI are evidence that a transparency can be acheived, at least for a large percentage of

the kinds of work done. Those observed had been on the system for a number of years leading us to believe that full capability may take years. This is, of course, a function of what the user selects to do on-line -- little used facilities, such as other ARPA network resourses residing on other computers, would be less transparent.

Transparency is also characteristic of the rules of the spontaneous use of language, as in conversational speech. The experience and process of learning to use AHI is analogous to the acquisition of natural language and reminds one of the work of the noted psychologist, Jean Piaget. There is a definite syntax applied to the vocabulary that enables the person to combine command words to perform novel operations, thus generating new and acceptable patterns of language. These in turn facilitate different procedures and sequences of operations by the programs. It is quite obvious at the outset that there are many different ways to do the same thing. This permits a personal "style" to evolve for each individual that is supposedly most effective for him.

As with natural language, a subliminal knowledge of the basic rules is used to generate new command "sentences" from the given vocabulary that the computer will recognize. The subliminal attribute is closely related to the transparency discussed above.

We can speculate that a person's ability to generalize from the command listings will be a decisive factor in his successful

utilization of the system, especially as a tool for creative efforts.

Once a person becomes adept at "speaking the system's language", different reactions are observable as he becomes increasingly dependent upon the system.

OBSERVATIONS

Effects on the Individual

One of the most prominent experiences observed was a kind of pressure that exists on the user to work at a high capacity while he is on-line. A great deal of involvement occurs, especially when the user is on a display terminal.

One causal factor may be the automatic log-out if nothing is done for about fifteen minutes, resulting in some anxiety whenever one is distracted. This is not sufficient cause for things such as an extraordinary reluctance to engage any person who wishes to interrupt an AKW. Another possiblility is limited system availability due to "down-time" and hardware "bugs". An available system, functioning reliably and rapidly is a strong incentive to "use it while you can". These factors are influential, but the reasons appear to be more profound.

The act of creating something that will be highly dynamic, not permanent or rigid, is very attractive, albeit subliminally. A person experiences a freedom and release from the responsibility of living with a document that is set in ink. It is analogous to the process of thinking through ideas

and structuring a draft mentally. It can be altered in any way at any time, thus facilitating creative experimentation.

Not only is there an increase in the freedom to be creative with content, but there tends to be an uninhibited work rate, limited only by the present hardware devices. On the contrary, if a writer is aware that he will have to retype his paper if he makes an error or forgets an idea, the rate at which he proceeds must necessarily be restrained.

In fact, a new user may have to learn to be less inhibited about rendering his ideas visible. Perhaps more important is that he feels free to change and remould whatever he "dumped" into the system. There has traditionally been a lot of negative reinforcement associated with changing written matter, even if it is only a personal working document, which AHI minimizes.

The predicted effect on the individual was realized. AHI appears to provide unprecedented flexibility and freedom with textual information for the individual. (This is partly dependent upon the use of the display terminal (DNLS) which will be described in a later section.) This flexibility is not limited to individual usage of AHI, but extends to groups, teams, and the organization through the interpersonal communication capabilities.

Use of the Communication Facilities

There are two specific sub-systems for on-line communication (part of the TENEX Executive software) and an extensive

communication capability as part of the "Journal", a subset of the Dialog Support System.

"Send Message" permits message transmission by entering a literal and the names of any number of recipients at any node on the ARPA Network regardless of geographical location or use of AHI. The message is automatically sent to each user noting "copies to (username)", subject, and title. Notification occurs ("you have a message") upon initial system log-in.

The "Link" command ties together 2 (or more) terminals to permit "conversation" or joint operation, facilitating a shared control over the editing, viewing, etc. This is the basis for on-line conferencing and is most useful in the display version of AHI with a supplemental audio (phone) link.

The Journal System is the collection of tools and procedures to process documentation. The user may essentially send any computer based textual entity, a message, a letter, a document or a book, to any number of users in any format merely by specifying the initials (id's) of the recipients. Distribution, recording, printing, mailing, library filing, and indexing are handled completely automatically with numerous options for the author.

Use of the message sending feature is analogous to utilizing memos except that messages are transmitted more efficiently: they do not involve paper processing, a secretary-typist, or mailing. We have found that they are sent in situations where no written

communication would have been used otherwise, resulting in an increase in communication, especially vertically within the organization. A manager who is usually difficult to reach due to meetings and other preoccupations can be easily notified.

The interviews of users have surfaced an important potential disadvantage. The use of the message system can tend to depersonalize communication. This is in large part due to its ease of use as an alternative or substitute for face-to-face communication as was predicted by Turoff (1972). For example it may be selected as the mode of interaction because of a distasteful or negative content. On the other hand, face-to-face contact has resulted from a message, but this is infrequent.

The Journal System is being employed ostensibly as a computer based mailing system for handling written communication of longer lengths. A hardcopy can literally be mailed but most of our users read their "mail" on-line using the easily executed retrieval commands.

It also has a message sending capability where, unlike the TENEX Send Message feature, messages are permanently stored, indexed, cross referenced, and catalogued. This is part of the Dialog Support System which has a potential impact much beyond what we have explored.

With few exceptions, the population has not been using the Journal for dialogue support. The Journal is perceived as a

place to store items of permanent value, which is usually not felt to be the case with messages. This may represent a reluctance to store routine transactions -- they are feared in that they may return to "haunt" the originator.

The lack of understanding of the purposes and operation of the Journal may be more significant. "Dialogue Support" is definitely a clue that continuing interactions might be recorded much as are the minutes of meetings. Not only does this provide the communicators with a history of transactions relevant to certain subject matter, but it provides the using community with an insight into developments that otherwise would have remained obscure.

The Augmented Community based at SRI is facilitated by the dialogue record as we may be with additional experience. Links (addresses that may be activated to load the information specified) are imbedded in subsequent dialogue records providing cross references to previous or relevant transactions. Thus, an interested party may follow the progression of transactions at SRI and quickly grasp the meat of the issue.

The use of Link addresses may be supplemented by simply reading other's files. File read access and sharing has not been used as extensively as expected (our people tend not to be nosy....) A few of the users have perused others files to learn of their doings or to answer a pressing question in their absence. By and

large, however, this access is limited to copying information that was known of before hand or responding to specific requests. This will be described in the section dealing with effects on the organization.

Linking (note the entirely different use of the term) may be compared to a telephone conversation. The significant difference is that linking is more convenient when a user is on-line.

As mentioned above, when an AKW is on-line other interactions are resisted and interruptions are discouraged. However, it does not seem to constitute an interruption to engage in dialogue through the terminal. The novelty of this means of interacting may be partially responsible for its attractiveness.

Linking has been used extensively as an integral part of the AHI system. It is important to note that although neither Send Message or Linking are unique to AHI, usage appears to be dependent upon the design and purpose of the entire system. To wit, if the system were not employed to accomplish the daily knowledge work of groups it is doubtful that either feature would have such significant utility. Both features are available for immediate use if the AKW is on-line and the need arises. In many cases contact occurred where there otherwise would have been none, thus promoting teamwork.

The link feature is being used within the teams for short, extemporaneous questions and comments. Surprisingly, links are

utilized when AKWs are within close proximity in the same building, in neighboring rooms, or even within the same room, illustrating the ease and convenience.

Effects on Groups and Teams

The system has promoted the evoluton of teams independent of geographical location. Although this was optimistically predicted, the nature of the teams is different than expected.

The teams centered around common problems, or at least tasks of mutual interest to the members. The novel outcome was that people within the same organizational unit did NOT become more unified, or experience any of the other characteristics of group identity. The subgroups remained isolated from each other when the user population was expanded to the present size (at the outset of organizational implementation). This was the case even when the subgroups were located in the same room.

Channels of communication that did open within the organization were based on training requirements and usually consisted of help from the more experienced users to the neophytes. Of course, the observer opened channels in order to gather the reactions of up and coming users. These spurious channels are certainly not representative of improved communication.

It is unfair to judge this lack of increased interaction across task boundaries as an insufficient outcome. The task structure within the organizaton did not change. Individuals and subgroups

continued to work on problems in separate areas of specialization thus minimizing the need for horizontal communication.

It is encouraging that the consistency and quality of communcation within a priori clusters of AKWs noticably improved, especially the vertical channels, which will be discussed in the next section. The Journal was the primary vehicle for sending messages, documents, interesting articles and references, plans and programs, copies of correspondence for non-AKWs, minutes and agendas of meetings, etc. Where these written communications might have occured on a chance basis before, they were duly sent to the concerned team members and stored for usage through the Journal.

Team collaboration was very evident when an individual was in need of additional resources outside his own "information space". During the preparation of briefings, and papers on related topics, individuals drew directly upon the work of colleagues by either using their files in the briefing or by moving the appropriate information directly into their information space.

The most exciting channels opened were those with SRI, a continent away. Concerned individuals were able to collaborate on papers for conferences, proposals for funding, and the necessary support of AHI users.

Perhaps we will realize increased communication between subgroups with more time. For the present, however, satisfying

teamwork on a given task is facilitated by the ease and timeliness of AHI.

Organizational Effect: Changes in Vertical Communication

Traditional patterns of organizational communication

The patterns of communication before AHI were typical of any large business or industry where the majority of people are scientific/professional. The patterns were dependent largely upon the formal authority structure and the task assignments.

There is a "section" of about 18 persons involved with the system. They were supervised by a "section chief" who represents the first official level of management. A pseudo management level between the section chief and the "worker bee", is called the group level, and is based on a specific system development activity which is the primary function of that group.

The section chief in this population managed in an easy going way where the primary means of direction were through scheduled meetings (rare), chance meetings, and direct contact. Few if any memos were ever used. Return communication to the manager was through the same means with the addition of periodic required status reports. An open door policy (and first name informality) were the norm. Thus, a loosely knit structure existed at this level where much of the vertical interaction was by default. Directives--requirements which

came down from higher levels were usually passed on by word of mouth.

New patterns

The systems message sending capability has been used extensivily. The section chief has been using this capability to schedule meetings, respond to questions, and make requests. Message traffic has been heavy and effective, even at early stages of its use. The most important usage has been to contact a subordinate who is not available at the time, in an informal manner, without the necessity of written records. Thus, the overhead in resources is low.

Scenarios of situations in which the message feature has been used to advantage are numerous in the chronicle. Quasi-official vertical communications are occuring where they might not have been possible. The system enables messages of an informative nature, not requiring action, but increasing the effectiveness of the recipient, to be sent directly to him without the usually prohibitive problems.

The Journal System has been appropriate for document coordination through the "chain of command". It has been relegated to more formal documents in most cases. The major power has been realized when lengthy documents must be revised numerous times to satisfy managers and then stored for retrieval by other than the author. Minutes of meetings, trip

reports, effort progress reports, and development plans are notable examples.

Vertical communication has been facilitated more through the sharing of special, "open" files than through any of the other channels. "Open" refers to files that have been created with read and write permission for all members of the organizational unit. These files have become the basis for a continuing dialogue where items are entered, commented upon, and action taken, while a record is maintained including the originator and date-time of entry (automatically).

To this point we have been discussing experiences based primarily upon the teletype terminal. It is most likely that a display terminal would not appreciably change communication usage, but it is certain that it does affect individual performance as demonstrated by the few that have become proficient.

The Display On-line System (DNLS) vs. the Teletype

DNLS constitutes a separate subsystem of AHI. It includes human engineered devices that result in the ultimate ease (within the state-of-the art) for man-computer communication.

A hand held, cursor control transducer, the "mouse," enables an AKW to point to any textual entity on the TV like display. He then can perform any of the operations that were available in the teletype version without further addressing. Any editing or other changes are immediately visable. To

supplement the standard terminal keyboard, a "binary keyset" may be used to key in alphanumerics much as one would play chords on a piano.

The screen shows a number of feedback "windows" for commands, addresses, viewspecifications, literal inputs, etc., in addition to the display of an approximate page of a textual file. Commands that execute, delete, and point are actuated by buttons on the mouse. (see Engelbart, 1968)

This highly interactive and optimized interface is the raison d'etre for the particular effects of DNLS. It is through DNLS, it can safely be said, that the full potential for individual augmentation can be realized. Much of the foregoing discussion might be revised to show more positive ramifications if every user had a display terminal. A brief description of the additional experiences beyond the teletype usage follows.

No one has tried to learn DNLS without first becoming reasonably capable with the teletype. The experience of those who have learned both indicates that it would be difficult to start with DNLS, although we have yet to show this. The present cost of the display terminal ($15,000 per IMLAC with mouse & keyset) has encouraged the emphasis of teletype access until less expensive hardware is developed.

One subject, who has been using DNLS for about 6 months, describes the effect quite vividly as a "trip" that is addicting.

"When DNLS is flying so am I This causes a noticeable change in my behavior. I am extremely reluctant to break for lunch, social conversation, coffee, the 5:00PM whistle or weekends. I smoke more (unconsciously). This is making me an emaciated, constipated, emphysematous, introvert; who is neglecting his family."

He offers the following analysis using some learning theory concepts.

He states that the use of DNLS is self-reinforcing because it is immediate, happens often, and happens at the level at which the behavior occurs.

Less frequent, but perhaps more powerful reinforcment is obtained from co-workers -- "Oh I didn't know you could do that " -- which gives one a feeling of being on top of things, one-up-man-ship, superiority, etc.; and it is obtained from bosses in a similar way. In addition, the ability to respond quickly, often before the question is asked, engenders admiration.

My personal experience has been very similar to these perceptive responses from this member of the populaton (D. L. Stone).

The increased speed with which one can address, change text, and actually see the change, results in a dramatic experience for the skilled user (there are three in our population). Pointing to a link address not only displays the addressed information at the push of a button, but also

controls the viewspecification or "window" through which one looks at a body of information.

Link addresses are entered as any other text. Thus, the AKW typically enters links as he develops information units which are then linked together (cross referenced) including the specified views of the information. For example, the user may need to refer to an outline of the document he is massaging. By actuating the link he may display a top-level view. The system stores up to five views at a time which may be quickly recalled as needed, thus facilitating return to the detail and location where the AKW was originally working.

In the same manner he can refer to any information unit for reference, which includes the vast Journal documentation. Or, he can "split" the screen into up to four parts each representing a window -- textual units can be moved around between these. Searching for a topic area is easily done by sucessively showing more levels and detail in any particular file.

Displaying various windows into the information space is appropriate for briefing, etc., as visual aids: dynamic, computer generated "viewgraphs". The power is in moving quicky forward or back through the aids, and making changes at the request of the audience. Movement

is done by imbedding a hidden link to the next viewgraph/display.

A complete description would continue, but it defies reasonable brevity. Overall, it is as if the AKW were traveling through information space comprised of the work of communities of AKWs. At any point he can stop and utilize the information at that location or move it to his own information space from others.

One of the few notable limitations we have encountered is display recreate speed, which is a function of our terminals, transmission line rate, and system load. Even under slow conditions, a "page" is written on the screen in a few seconds. Improvements in computer hardware will probably remove even these few seconds.

This description is offered despite the anticipated comments about over enthusiasm and starry eyes. How fast an AKW can "travel" through information space is surely a function of the individual and the nature of the task. We have been extremely limited by our population size. However, these are in fact experiences we have had to date.

SUMMARY AND CONCLUSIONS

The Augmented Human Intellect System was developed under the leadership of Dr. Douglas Engelbart at the Stanford Research Institute over the past ten years. The purpose is to increase the capability of man to accomplish "knowledge work" through the use of a

set of powerful computer based tools that provide an extension to the capability of groups, organizations, and networks of organizations. This paper describes the experiences and effects of implementing this system on an organizational unit at the Rome Air Development Center.

Four methods were employed to gather and record data: a chronicle file maintained by the subjects, interviews, unstructured observations of the subjects at work, and personal account as the unit moved toward becoming an Augmented Knowledge Workshop. This was defined as an aggregate of knowledge workers successfully using AHI.

Knowledge work in this case consisted of research and development in computer technology for the Air Force. Individuals learning to use the system experienced certain problems before becoming Augmented Knowledge Workers.

There was a strong resistance to changing habitual work methods and communication patterns. There were psychological as well as hardware causes for the resistance which were mutually escalating. Insufficient training techniques, system failures, and hardware unavailability were some of the difficulties encountered. As the problems were overcome, thresholds were observed in the way the system was used and perceived.

AHI use tended to fall into two discrete kinds, use as an automatic typewriter and, with the more advanced users, use for on-line composition. With use on a regular basis, the skills were acquired that rendered the system "transparent", so that the individual was no longer concerned with system operation. This

tended to free him for spontaneous, creative work while the rules of operation and syntax remained subliminal in much the same way as with the use of language in conversation.

Observations of the population subsequent to training noted three areas of effect, (1) on the individual, (2) on groups and teams, and (3) on the organization.

Hypothesized effects were not entirely realized, however, they may be with additional time and system development. At present there are profound changes that point toward that realization. Individuals experienced an unprecedented flexibility and involvement with textual information through powerful features such as the link address, viewspecification system, and information structure.

This power facilitates the construction of an information space which may be easily and rapidly communicated and shared with other AKWs to promote dialogue among task teams. The communication facilities, Send Message, Linking, and the Journal System, were employed to create new patterns of communication that would not have been attained through alternate means. The resultant documented team collaboration extended to the organization.

Vertical communication improved, as new channels were opened and formal channels were modified from the traditional patterns. The system capabilities became a new management tool which increased openness without a loss of efficiency. A number of examples of this were discussed, including collaboration with

geograpically distributed groups and the sharing of special dialogue files.

Display terminals were available to a few of the population promoting a fuller realization of the impact of AHI aided by human engineered interface devices. A dynamic information visibility was achieved by utilizing "windows" into the information space. The result was like traveling through the dynamically structured information space of a community of knowledge workers with such rapidity and ease that it was almost addictive to the user.

The dramatic changes in the work methods and communication of our population in the time span of six months indicates that Peter Drucker's "knowledge revolution" will arise from the use of systems such as AHI. At least for a population of scientific and engineering personnel in the government, AHI's potential is on the way to being that which it's designers at SRI intended: a revolution in communication in the broadest sense.

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(Note: Cited references that were accessed in the on-line data base do not have page numbers; page numbers are generated by the system only for printout purposes.)

16778 Distribution

Douglas C. Engelbart, James C. Norton, Dirk H. Van Nouhuys, Richard W. Watson, William P. Bethke, John L. McNamara, Duane L. Stone, Rome Air Development Center (ISIM) , William E. Rzepka, Thomas F. Lawrence, Roger B. Panara, Dean F. Bergstrom,

PROOF and BELIEF

I couldn't resist commenting on your statement about the relationship between proof and belief. 1

Yes proof is a close relative of belief in the same sence that love is a close relative of hate, that is, one may be derived from the absence of the other. 2

For example failure to win the love of some one who is desired very much may result in intense hatred. Also failure to prove a concept may result in the extreme of belief. 2a

A classic case which may illustrate the relationship or distinction between proof and belief follows. 2b

Tycho Brache (forgive the spelling) a noted German astronomer refuted the contention of Nikolaj Kopernik concerning the position and movement of the sun and earth with in the solar system. Brache reasoned that if the earth moved about the sun then a parallax would exist between the earth and the distant stars. Brache then set out to measure this parallax and after attempting to do so found none. He further reasoned that either the stars were so distant and his instruments insufficiently precise to measure the phenomenon or there in fact was no parallax. Confronted with this dilemma in proof he abandoned the sinking ship of logic and clung to that floating haven in the sea of reason, belief, and concluded that since it was impossible to conceive that the stars were so far away as not to be able to measure parallax with his instruments there in fact is no parallax and therefore the earth resides a the stationary centre of the solar system not to mention the universe. 2b1

16779 Distribution
Duane L. Stone,

Latest Output Processor

A new Output Processor has been up since late Tuesday afternoon. The purpose of bringing up this version was to provide a debugged implementation of the new way of specifying X and Y measures as described in (ijournal,16715,1:w). Non-COM users should find everything working as before with the following addition: when specifying tabstop settings using the TabStop directive, it is not necessary to list all 20 (or less) tabstops individually if (after a possible initial list of unevenly spaced tabstops) all tabstops are spaced at equal intervals. This is done by using "..." (three periods) to specify a continued sequence: is equivalent to -- the "..." must be preceeded by a COMMA [for the perverse I have provided that will be equivalent to]. -- Walt 1

16780 Distribution

Richard W. Watson, Don I. Andrews, Rome Air Development Center (ISIM) , Xerox PARC , Advanced Research Projects Agency , Judy D. Cooke, Marcia Lynn Keeney, Carol B. Guilbault, Susan R. Lee, Elizabeth K. Michael, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Augmentation Research Handbook, Kirk E. Kelley, N. Dean Meyer, Kay F. Byrd, James E. (Jim) White, Diane S. Kaye, Paul Rech, Michael D. Kudlick, Ferg K. Ferguson, Linda L. Lane, Marilyn F. Auerbach, Walt Bass, Douglas C. Engelbart, Beauregard A. Hardeman, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Harvey G. Lehtman, Jeanne B. North, James C. Norton, William H. Paxton, Jeffrey C. Peters, Jake Ratliff, Edwin K. Van De Riet, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor, Donald C. (Smokey) Wallace

Announcement and Invitation

This message is to confirm that I will be leaving ARC, effective at the close of business on Friday, June 15, to devote my full energies to my duties as Director of the Institute for Consciousness Evolution, the organization which I have set up to conduct programs at Alderness. All ARC people are cordially invited to join me at Alderness to celebrate this joyful event on Saturday, June 16, after which I hope to be able to spend a week or so in British Columbia before returning to Alderness to help with the Wilderness Workshops. Please set aside this date if you can, and I will check with you individually in June to make final arrangements.

PEACE -- Walt 1

16781 Distribution

Richard W. Watson, Don I. Andrews, Judy D. Cooke, Marcia Lynn Keeney, Carol B. Guilbault, Susan R. Lee, Elizabeth K. Michael, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Augmentation Research Handbook, Kirk E. Kelley, N. Dean Meyer, Kay F. Byrd, James E. (Jim) White, Diane S. Kaye, Paul Rech, Michael D. Kudlick, Ferg R. Ferguson, Linda L. Lane, Marilyn F. Auerbach, Walt Bass, Douglas C. Engelbart, Beauregard A. Hardeman, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Harvey G. Lehtman, Jeanne B. North, James C. Norton, William H. Paxton, Jeffrey C. Peters, Jake Ratliff, Edwin K. Van De Riet, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor, Donald C. (Smokey) Wallace

CBIG

Bob Thomas of Bolt Beranek and Newman has asked to add Eleanor H. Warnock, Mario Grignetti, Joe Passafiume, and Mark Miller to the CBIG. Although he doesn't make it clear, it seems that all these people are from BBN. Please let me know via sndmsg (keeney@sri-arc) or journal if its OK to add these people. Thank you. Marcia Keeney. 1

16782 Distribution
Thomas O'Sullivan,

RWW 23-MAY-73 13:57 16783

Dean Full Time for Summer

Dean, There has never been any question in my mind about your working here for the summer. We'll have Dirk process whatever papers are needed. 1

16783 Distribution
N. Dean Meyer, James C. Norton, Dirk H. Van Nouhuys,

**784

1. How come Folklore isn't online anymore?
2. How come execute identification submore doesn't exist anymore?
3. How come I can't find any of this documented?
4. I am pissed off.

1

16784 Distribution
Diane S. Kaye, Harvey G. Lehtman, Charles H. Irby,

A Suggested New Journal Citation Format

A number of people, including me, have been wanting a different Journal delivery citation format. The Journal Design Team is planning to implement a new format. This note is a suggestion for a new citation format. 1

The main objective in a new citation format is to get as much useful information on one line as possible so that in examining ones Journal mail with x view spec one can decide whether to read the item or not. A second objective is to have the Journal deliver other information which the user may specify on input such as action or cc., modifies, obsoletes etc. 2

The information which seems most essential in determining whether or not one wants to read an item now are date, time, author, and title and whether or not the item is an action or cc. Time seems important given that the Journal is now delivering several times a day. Every character space is important for getting as much title as possible on the line and one could argue to not show year in date, not show time, and limit the first author field as WLB does in his reformatting program, to four or five spaces (if more space is needed even for first author the field could be filled with asterisks and completed in the substatement. What do you think out there? 3

We can not get all this information on online, therefore I would recommend that action items and cc. items be delivered in separate branches to provide this distinction and that we place on the first line, first author, date-time, and a much of the title as we can get on the line. We should strive to have well defined fields so that when looking at a screen or page of citaions things line up for easy scanning. I would recommend that messages have the title prefaced with some symbol such as # so that you would know to open up more and that message text be a substatement as now done with comment. Further I would recommend that all except basic information be delivered as a substatement successor of message text. If there are multiple authors, then this would be indicated by an asterisk after the first authors ident. 4

A list of the information to be delivered would be authors, date-time, title, distribution, link, comments, message (if message), obsoletes, updates, subcollections, keywords. 5

Because author can be a group like sri-arc 9 spaces are needed. A question exists as to whether or not the title overlapping on to the second line should be as shown below or just start immediately on the next line. What do people think? 6

Some variations - which do you prefer or have others to suggest? I would recommend 1, but do not have any strong preference. 7

A Suggested New Journal Citation Format

(1)

8

RWW 23-MAY-73 14:26 This is a sample of a new citation format showing what it would look like for the simplest collection of information. (KJournal,12345,1:w) 9

Distribution: JEW DSK JDH 9a

10

This is a sample citation with a more extensive set of information input by the user: 11

12

RWW* 23-MAY-73 14:37 This is an example of a more complicated citation. (AJournal,12345,1:w) 13

Authors Continued: DSK JEW Distribution: USC-ISI SRL PR BAH JEW
Obsoletes: (12345,) (56787,) Updates: (54321,) (65643,)
Subcollections: SRI-ARC NIC Keywords: garbage, suggestion, example 13a

(2)

14

RWW 23-MAY-73 14:26 This is a sample of a new citation format showing what it would look like for the simplest collection of information. (KJournal,12345,1:w) 15

Distribution: JEW DSK JDH 15a

16

This is a sample citation with a more extensive set of information input by the user: 17

18

RWW* 23-MAY-73 14:37 This is an example of a more complicated citation. (AJournal,12345,1:w) 19

Authors Continued: DSK JEW Distribution: USC-ISI SRL PR BAH JEW
Obsoletes: (12345,) (56787,) Updates: (54321,) (65643,)

A Suggested New Journal Citation Format

Subcollections: SRI-ARC NIC Keywords: garbage, suggestion, example 19a

(3)

20

RWW 23-MAY This is a sample of a new citation format showing what it
would look like for the simplest collection of information.
(KJournal,12345,1:w) 21

Authors Continued: SRI-ARC Distribution: JEW DSK JDH 21a

22

This is a sample citation with a more extensive set of information input by the user: 23

24

*** 23-MAY This is an example of a more complicated citation.
(AJournal,12345,1:w) 25

Authors Continued: SRI-ARC Distribution: USC-ISI SRL PR BAH JEW
Obsoletes: (12345,) (56787,) Updates: (54321,) (65643,)
Subcollections: SRI-ARC NIC Keywords: garbage, suggestion, example 25a

16786 Distribution

Richard W. Watson, Don I. Andrews, Judy D. Cooke, Marcia Lynn Keeney, Carol B. Guilbault, Susan R. Lee, Elizabeth K. Michael, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Augmentation Research Handbook, Kirk E. Kelley, N. Dean Meyer, Kay F. Byrd, James E. (Jim) White, Diane S. Kaye, Paul Rech, Michael D. Kudlick, Ferg R. Ferguson, Linda L. Lane, Marilyn F. Auerbach, Walt Bass, Douglas C. Engelbart, Beauregard A. Hardeman, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Harvey G. Lehtman, Jeanne B. North, James C. Norton, William H. Paxton, Jeffrey C. Peters, Jake Ratliff, Edwin K. Van De Riet, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor, Donald C. (Smokey) Wallace

DDSI,Billing Non-ARC Useres, Nat Ambitions,Productions Sttaatus

Walter Bass and I spoke this morning to Ernie Engle(journal,14993,) at DDSI about billing users other than ARC for their work on files that come from ARC. 1

DDSI will accept the credit standing of any ARC employee and bill him separately. 1a

Anyone at ARC who wants to be billed for COM work should put his billing address in the header statement of the file and notify Dean Meyer. The header statement should contain:

BILL TO:
NAME
ADDRESS 1a1

I suggested the same approach to network users, e.g. if BB&N's TIP User Guide goes to DDSI through us, it should contain DDSI's billing address in the header. 1b

Engle thought my proposal a good possibility and will talk about it with his boss. 1b1

Engle reported that Dean Meyer, Paul Johnson, and a member of thier staff named Freedman will talk this afternoon about production. Freedman is in their production department and his entrance into our scene indicates DDSI our work near a routine production status. 2

Engle mentioned that he had drafted a letter to Larry Roberts raising the possibility of DDSI offering services to the Network and that he would send us a copy. 3

16787 Distribution

Walt Bass, N. Dean Meyer, James C. Norton, Richard W. Watson, Elizabeth J. (Jake) Feinler, James C. Norton,

Journal Entry Citation Format

I like the concept of being able to see as much as possible on the first line. I don't care what the rest of the journal entry citation looks like as long as I can see as much of the beginning of the title as possible with viewspec t and the first line of the message with viewspec b (one level more). However, I don't like all of the empty spaces in some of your examples. 1

16788 Distribution
Richard W. Watson,

KIRK 23-MAY-73 19:55 16789

Substitution Courtesy

If you are going to change the NLS Substitute command all around, the least you could do is let yourself know how many substitutions have been made BEFORE going ahead and making them so that you can abort if you got more than you intended. -- A simple courtesy that is helplessly frustrating otherwise. Have you ever tried to undo a substitute that substituted too much? It's one of those things that keeps sno-balling. The more you try to get yourself back where you started, the more messed up your file becomes. 1

16789 Distribution
Nps Np, Richard W. Watson, Charles H. Irby, Charles F. Dornbush,

DCE 24-MAY-73 08:06 16791

Responsing to NDM (16771,) and JCN (16774,)

Very happy to have you around, Dean

DCE 24-MAY-73 08:06 16791

Responsing to NDM (16771,) and JCN (16774,)

Dean, Jim, and Dick; I vot yes, of course. No reason to have him hanging around unless we plan to keep him working. It isn't clear to me that he is doing just "development" stuff; I'd suggest that JCN and RWW put their heads together on how to divide Dean, or locate him, as far as task grouping and supervision are concerned. For instance, helping wpople do COM setup, updating the OP usrs's guide, maintining the User Program Libarary, etc. would seem to fall under Operations; while the development of some of the OP features, or UPLibrary features, etc. would be Development. Why don't you two generate a recommendation for me to review -- apply him to what, supervised by whom.. 1

16791 Distribution
Richard W. Watson, James C. Norton, N. Dean Meyer,

DCE 24-MAY-73 10:12 16792

Discussion with Wayne Girard, local Application Engineer for Tektronix

1) Specific: He'll be here to pick up his termina 1030 Tues 29 May; I and some delegated person will give him background docs and demo to communicate to his home plant;

DCE 24-MAY-73 10:12 16792

Discussion with Wayne Girard, Local Application Engineer for Tektronix

ARC is experimenting with a loaner model of a new Tektronix display terminal, the 4023, just being released. It uses refreshed video display, and generally i a very attractie terminal. For instance, it is almost completely silent, more so than any terminal, display or typewriter, that we've seen. 1

For use with our projected interface box, to allow use of mouse and keyset (and for other useful local-support functon), we'd very much benefit from a few mods that to us seem straightforward. We've asked their local Applications Engineer, Wayne Girard (321-7728) to relay the specific requests to Tektronix home plant in Beaverton, Oregon. 1a

I talked briefly with Girard, asking him for the names of people at Beaverton who were responsible for product planning, marketing, etc. in this Division. He said that he would find them for me; apparently there has been some rearrangement (enlarging the scope of the Division??), and he wasn't quite sure who had what role right now. 1b

This morning I called Girard to see if he had the names for me. He appeared a bit hesitant about it, and I guessed that he felt uneasy about shunting some customer to the home plant without knowing more abut his purpose. 2

So I spent about five minutes outlining the Workshop Utility plan to him, pointing out that it really represents an experimental test bed, over a diversity of applications that are highly likely to be the new-market applications of the next few years, and that besides having participants who are mainly after exploring their own application of the new techniques, we wanted also to involve organizatons from the industry that will ultimtely be the suppliers of this kind of service on a broad scale. 2a

I then said that we'd like to have their products people at least aware of this activity when they determined their response to our request for mods to their new product, and also we'd like to see if Tektronix by any chance would want to keep closer tabs on this experimantal Utility, and perhaps participate in it (as a sucriber to the Utility). 2b

We agreed for him to talk a bit with me when he comes to pick up hi terminal; have a date for 10:30 on Tues 29 May. I'll give him some appropriate literature for himself, and to send to Beaverton; and we'll see if he can interest someone there in talking on th phone, or in visiting us. 3

16792 Distribution

Richard W. Watson, James C. Norton, Charles H. Irby, Don I. Andrews, Stephen W. Miller, David R. Brown, Bonnar Cox, Duane L. Stone,

Suggestions for Journal Citation Form

One feature I have always wanted for journal citations is the placing of the link in the first line; really, only making the number already there into a link: (16786,) 1

2

Examples: 3

RWW 23-MAY (16786,) A Suggested New Journal Citation Format [NWG/RFC# 000]
[IJOURNAL, 16786, 1:w) 3a

WLB 23-MAY 16781 Announcement and Invitation
Message: This message is to confirm that I wlll be leaving ARC, effective at the close of business on Friday,..... 3b

Several notes: 4

This format allows scanning at one-line status, and linking without changing the viespec. 4a

The time is not shown; I agree that this is unessential to me, and can be gained from the journal file itself if it is wanted. 4b

The short link does not allow for viewspecs, and places the jumper at the origin statement which I normally find a better place to start anyway. 4c

The citation can pick up only the first author, 4d

16793 Distribution

Donald C. (Smokey) Wallace, Richard W. Watson, Don I. Andrews, Mark Alexander Beach, Judy D. Cooke, Marcia Lynn Keeney, Carol B. Guilbault, Susan R. Lee, Elizabeth K. Michael, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Augmentation Research Handbook, Kirk E. Kelley, N. Dean Meyer, Kay F. Byrd, James E. (Jim) White, Diane S. Kaye, Paul Rech, Michael D. Kudlick, Ferg R. Ferguson, Linda L. Lane, Marilyn F. Auerbach, Walt Bass, Douglas C. Engelbart, Beauregard A. Hardeman, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Harvey G. Lehtman, Jeanne B. North, James C. Norton, William H. Paxton, Jeffrey C. Peters, Jake Ratliff, Edwin K. Van De Riet, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor

Proposals relative to host names

I'm sure there are others who will want to see this, but I can't remember all the participants in the earlier dialogue.

Proposals relative to host names

Some modest suggestions concerning the host list question 1

It seems to me that the host/site/IMP/... name question can properly be divided into several separate subproblems, some of which can have non-controversial solutions. 2

(I) Existence of IMPs and connected hosts. 3

The existence of IMPs and hosts can be inferred from the monthly traffic statistics published by BBN, but it seems to me that the principle should be established that the NIC always have correct information in this area independent of the question of what the site or hosts should be called. 3a

Accordingly, I propose that one of BBN or RML be charged with notifying the NIC promptly when an IMP is installed, giving IMP number and physical location; that the NIC note the existence of the IMP and send a letter to the location of the IMP, requesting the network addresses, natures, and names of planned hosts; that if the site does not respond within a modest period such as two weeks, that the NIC create names of its own for as many hosts as BBN says the site has ordered host interfaces, and that the burden of correcting such names be on the site thereafter. (If the site fails to respond, BBN, RML, or some other party may have some idea of their intentions and may be able to supply host names.) 3b

(II) Official names for hosts 4

As many people have remarked, this matter should be left to the individual sites. Sites should recognize that they have the responsibility for keeping the NIC informed of their current status vis-a-vis host names, network addresses, and responsible individuals. 4a

Accordingly, I propose that ARPA send a letter to each site when its IMP is installed, making it clear that the site has an obligation to the network as a whole to keep the NIC informed. Beyond this, I am not the proper person to suggest the precise mechanism that the NIC use for dealing with problems like changes of name, separation of site name from affiliation, etc. 4b

(III) Distribution of official names 5

There are numerous programs around the network, of which TENEX is perhaps the most visible, which need up-to-date lists of host names and network addresses, and in some cases further information such as whether a host is a TIP, an externally accessible server, etc. The NIC should not delay the incorporation of timely information into such programs. 5a

Accordingly, I propose that the NIC define a new group called the "Host List Distribution Group", to be notified in the best way available when changes occur in the host list (SNDMSG, on-line Journal, or hard-copy Journal); that the host list be maintained on line at the NIC in a published format, as well as in hard copy; and that either a TXT copy of the list be kept on line, or that a server be constructed to allow on line access to the list by programs as well as people. 5b

(I would note that this would set an important precedent relating to on line availability of NIC information, and to the principle that such information should be easily accessible by programs as well as, say, TIP users.) 5c

16794 Distribution
Jeanne B. North, Michael D. Kudlick,

MGM 24-MAY-73 11:53 16795

WE NEED A COPY OF NIC DOCUMENT 7103, WHICH I BELIEVE IS NOT ON-LINE.
CAN YOU HELP? THANKS. 1

16795 Distribution
Jeanne B. North, Dale H. Stern, Martin G. Morris,

RWW 24-MAY-73 12:22 16796

Meeting for Command Language Review

There will be an important meeting of the command language review team to review CHI's proposed changes in (16717,) at 8:30 on Tues May 29. With the Utility about to come and training increasing we must get any bomb shell type changes in now if we want to avoid a lot of flack. The goal of this meeting is to approve, disaprove, or recommend conrete changes to each proposal. There may need one more iteration on a subset of stuff , but hopefully a minimum. All people in attendeance should study (16717,) carefully before the meeting. I will ask each attendee before the meeting starts if he has done so and those who haven't will be asked to leave. This drastic measure is required because there will be alot of people there and it is a subject where there are strong feelings. If everyone comes in having thought through his recommendations on each issue we can probably have a productive session. 1

16796 Distribution

Douglas C. Engelbart, James C. Norton, Paul Rech, Michael D. Kudlick, Marilyn F. Auerbach, Walt Bass, Elizabeth K. Michael, James E. (Jim) White, Dirk H. Van Nouhuys,

whereisit

Where is my copy of the proceedings of COMPUCON73? Could you get it to me soon? j. pickens 1

16797 Distribution
David L. Retz,

AAM 24-MAY-73 13:59 16798

Test of submitting a message which is too long

This is an attempt to repeat the difficulty I had last week with the Journal. I am submitting a message which I will intentionally make "too long". I will continue to type lowercase x after the meaningful text until the system tells me the message is too long, then wait to see what gets delivered to me and to others. This message will be addressed to Nancy Neigus (so I can see what a recipient's copy looks like), Jim White , and JDH.
Here goes

GROAN, SIGH, WHY DO PEOPLE DO THINGS LIKE THIS TO ME? ENOUGH PLEASE DESIST. I HAVE TOO MANY PROBLEMS AS IT IS.
YOU'RE RIGHT, LONG MESSAGES SCREW ME UP. I DON'T KNOW IF ANYONE IS EVER GOING TO FIX ME. HAVE MERCY.
(SIGNED) YOUR FAITHFUL JOURNAL SYSTEM 1

16798 Distribution
J. D. Hopper, James E. (Jim) White, Nancy J. Neigus,

ken,
please come to nic and after logging in do the following;[ ]indicate system promptsResponses to you:

[@]nic
-[system types a lot of stuff, please ignore and wait for next -]
[-]b[ring]<mitre-tip>help

the system will let you know what to do after this point. these are the files i promised you. if you need further help, or have suggestions, please let me know either to ji through the journal or to iseli@usc-isi.

enjoyed the last few days with you and look forward to our on-going dialog.

warmest regards, ...jean 1

16799 Distribution
Kenneth L. Bowles,

plan of attack for getting DNLS into the world

This document will present our current plans for getting DNLS into the "REAL WORLD". At this point in time, we are not prepared to address any of the legal problems involved and will leave any such problems for fututre discussions. 1

Our basic plan of attack for getting DNLS out into the world consists of the following approach: 2

- getting all IMLACs on the network running DNLS 2a
- getting "cheap" terminals running DNLS on the network 2b
- getting "sophisticated" terminals running DNLS on the network 2c
- getting DNLS running on other TENEX machines 2d
- getting DNLS running on other machines 2e

GETTING ALL IMLACS ON THE NETWORK RUNNING DNLS 3

This has been an ongoing effort and is near its completion. However, the following tasks remain to be done: 3a

- Get a list of all network IMLACs. 3a1
  - This includes finding out what IMLACs are out there and in what configuration. 3a1a
  - We already have most of this information, but it remains to be coordinated and placed in a single document. 3a1b
  - KEV will do this. 3a1c
- Final cleanup of IMNLS, the IMLAC program that supports DNLS. 3a2
  - What remains to be done in this area is the supporting of TTY simulation windows in DNLS. 3a2a
  - DCW, CHI, and KEV have been working on this and are almost done. 3a2b
- Final cleanup of IMLOAD, the TENEX program for loading IMNLS into IMLACs. 3a3
  - What remains to be done in this area is to check out the program on various IMLAC configurations, most notably the BBN, XEROX, and ARPA IMLACs. 3a3a
  - KEV has been working on this and is almost done. 3a3b

plan of attack for getting DNLS into the world

Write an IMLAC users guide. 3a4

This is to be a document primarily for use by local "systems programmers" that will describe how to get an IMLAC up and running DNLS. 3a4a

This document will describe the protocol used between TENEX and the IMLAC and thus will be useful in getting other smart terminals running DNLS. 3a4a1

This has not yet been started, but will be done by KEV. 3a4b

GETTING "CHEAP" TERMINALS RUNNING DNLS ON THE NETWORK 4

This effort is primarily concerned with our using an MCS-4 computer as an interface between inexpensive alphanumeric display terminals and TENEX. 4a

There are three areas involved with this: 4a1

Performing the neccessary hardware modifications to the "cheap" terminal and installing the MCS-4. 4a1a

MEH is working on this. 4a1a1

Writing the needed software for the MCS-4. 4a1b

DIA is working on this. 4a1b1

Performing the neccessary software modifications to NLS to support a new terminal type. 4a1c

This involves changes the NLS display formatter and the post-processing routines. 4a1c1

DSK, CHI, and DIA are working on this. 4a1c2

It is expected that we will have the first such running terminal in about 2-4 months. 4a2

There is a secondary effort involved here and that is getting a version of DNLS itself to support "cheap" alphanumeric display terminals without the use of a MCS-4. 4b

This involves performing the neccessary software modifications to NLS to support a new terminal type. 4b1

This involves changing the NLS display formatter, the

post-processing routines, the input routines, and the bug selection routines. 4b1a

DSK will work on this. 4b1b

GETTING "SOPHISTICATED" DISPLAY TERMINALS RUNNING DNLS ON THE NETWORK 5

This effort has not yet begun. 5a

However, we foresee the following approach as being useful: 5b

finding out what types of terminals and capabilites exist 5b1

using the IMLAC protocol (and the IMLAC users guide) as the basis for a protocol for all smart terminals 5b2

interfacing with systems programmers at other sites with smart terminals and working with them to develop software to support DNLS 5b3

GETTING DNLS RUNNING ON OTHER TENEX MACHINES 6

There are two major tasks involved for this effort: 6a

Modifying the way we deal with displays within TENEX 6a1

This is necessary to isolate the basic display machinery from the code that deals specifically with our local displays, i.e., tasker. 6a1a

CHI, DCW, and KEV will do this. 6a1b

After task 1 is completed, we will put the basic display handling code into standard TENEX. This will make it possible for all TENEXs to run DNLS. 6a2

DCW and KEV will do this in collaboration wth BBN. 6a2a

We anticipate that the first TENEX to take advantage of this new capability will be the utility. 6b

In the event that this does not happen before the utility goes into operation, we will make the necessary modifications ourselves to the utility TENEX to run DNLS. 6b1

GETTING DNLS RUNNING ON OTHER MACHINES 7

We have not yet thought much about this area. Our initially impressions are that we should wait for MPS for this and will use

the modular capabilities of the MPS compiler in acheiving this goal. 7a

MISCELLANEOUS EFFORTS 8

We should investigate the feasability and desirability of setting up appropriate user groups of remote DNLS users. 8a

We have to address the problem of shared mouse tracking when using shared screens within DNLS. 8b

KEV, DCW, and CHI are involved in this. 8b1

We will continue to participate in the network graphics protocol efforts to ensure that DNLS will be able to survive within any protocols that are developed. 8c

KEV and CHI are involved here. 8c1

There are some basic questions which we have to address: 8d

what type of terminals will we support? 8d1

Will we support light pens? joysticks? tablets? 8d1a

Will we support terminals without any pointing devices? 8d1b

Do we wish to get here a light pen? joystick? tablet? for experimental work with our IMLAC. 8d1c

what is the minimum baud rate reasonable for a DNLS termnial? 8d2

16800 Distribution
Richard W. Watson,

SSP 24-MAY-73 18:13 16801

NCP SURVEY DATA

HI,CSK HOW IS YOUR SURVEY ON NCP GOING ? I NEED THAT INFO. BADLY
.WOULD PLEASE SHARE THE DATA YOU COLLECTED WITH ME ? 1

16801 Distribution
Chuck S. Kline,

IWC 25-MAY-73 08:39 16802

Microeconomics and the Market for Computer Services

I thought you might be interested in reading the enclosed paper which I recently wrote for a graduate economics course. The figures are not enclosed, but they should be easy to deduce -- or I can mail them on request. Since I plan to submit the paper for publication, I would greatly appreciate your comments. Please feel free to use mail, telephone or network mail. THANK YOU

INTRODUCTION 1

The computer services industry provides an excellent environment for the study of microeconomic principles. (SH69) Even a single computer installation may be viewed as a closed economic system wherein may be observed all the forces of supply and demand. In this paper we offer the results of such an observation, both for individual installations and for the industry as a whole. We follow the general textbook approach to microeconomics, and consider in turn the topics of supply, demand, costs and pricing. The emphasis will be on relating microeconomic theory to the practical management of computer services. 1a

Pricing is the key, and the objective of the entire discussion. Indeed, microeconomics is often referred to as simply "price theory." Too few computer center directors realize that they are operating in a marketplace. An understanding of supply and demand relationships as they exist in the computer services marketplace and an understanding of the economic effects of a pricing policy should lead to a more reasoned approach to setting prices. This will work to the advantage both of the computer center and its users. 1b

SUPPLY 2

The computer services industry is a subset of the entire computer industry. Under a definition suggested by Selwyn (SE71b), computer services includes all of the computer industry except hardware manufacture and maintenance. It includes service bureaus, time-sharing firms, consultants, software producers, and data bank organizations. It also includes in-house computer facilities, encompassing their operation, programming, systems analysis and systems management functions. In an economic sense, firms that operate their own computing systems are in effect suppliers of computing services, although they may limit the sale or provision of these services to themselves. At the present time, in-house computer facilities produce the overwhelming majority of computing services in this country. Service bureaus and time-sharing suppliers represent a very small fraction of all such services produced. 2a

Types of Services 3

Basic computer services are provided by the execution of a program or predefined sequence of instructions on a hardware complex of a CPU, main memory and peripherals referred to as a computer system. The basic service is the action of this program on a set of data which is provided for the particular execution. A basic service supplier will offer the use of the computer system for the time

necessary for the particular program to be executed. Since the execution of the program does not consume or in any way harm the computer system (except for the infinitesimally small amount of aging of active electronic components) and since for any given configuration capacity is strictly limited, payment for the use of the computer system may be considered as a true rent. (Strictly speaking, if we consider that system capacity may grow over time through the addition of new equipment in response to high demand, then we would have to speak of a quasi-rent). 3a

Such "raw computation" is not, however, the only service generally offered. Organizations engaged in the provision of computer services tend to be vertically integrated in that they supply computer time, application software, systems analysis, consulting, training and other services to users. As Selwyn (SE72b) points out, these services are characterized by significantly different production functions, thereby providing opportunities for specialized suppliers, operating on a scale different from that of the integrated supplier, to produce certain services more efficiently. 3b

Economies of Scale 4

The production of raw computation has been shown to exhibit increasing economies of scale over the range of currently available machines. In the 1940's, Dr. Herbert Grosch asserted that the power of a computer system increased as the square of its cost. Although unpublished by Grosch at the time, this part of the computing profession's early oral tradition has become firmly entrenched in subsequent articles as "Grosch's Law." (SO66) 4a

Grosch's Law has been empirically tested by a number of investigators, including Knight (KN68) and Solomon (SO66). Both of these studies found that the law generally held, although results were more in conformity for processor-bound tasks than for I/O-bound tasks, reflecting the more rapid drop with increased size in the average costs of main memories and logic elements than in mass storage devices and communications. More recently, Hobbs (HOB71) has claimed that the law was more a reflection of the pricing policy of a major manufacturer than an inherent law of computer systems design. Basing his argument on a perceived change in the relative costs of different parts of a computer and communications system, Hobbs states: 4b

> "To the extent that Grosch's Law could be considered a law, it has been limited by the Software Amendment of 1964 and the Integrated Circuit Amendment of 1967 and has been repealed by the LSI Act of 1970." 4b1

While Hobbs does not present any empirical evidence to support his assertations, the implication is clear. Grosch's Law is essentially a statement about central processing units, and gradually loses its validity as it is extended to the other components of a computer system. 4c

The economies of scale evident for raw computation do not extend to other types of computer services. Solomon's study of personnel costs for commercial (non-governmental) installation (SO70) did reveal smaller average costs for larger installations, but this was because larger hardware installations were being supported, not because there are economies of scale in personnel per se. Indeed, if anything the reverse is true. The effective span of control for programming managers is limited, resulting in larger managerial overhead for larger projects, and the complexity of a programming task is commonly acknowledged to grow (perhaps even exponentially) with size. 4d

Product Differentiation 5

Selwyn (SE71b) has argued that computing services, taken as a whole, are relatively undifferentiated from one another since, providing that the relative scale of hardware is selected properly, and assuming intelligent system designs, the development of most types of computer applications can be accomplished with almost equal success on any general purpose computer. Thus, prior to the actual commitment of resources to software development, the application developer is relatively indifferent among the alternative hardware configurations that may be available to him. However, as Selwyn recognizes, the services of a general purpose computer become highly differentiated when they are provided in conjunction with access to a specific application program. Users with a heavy investment in not-easily-converted software are often locked-in to a specific system. Given this observation, it would seem desireable to restate the original argument to be that only raw computation is a relatively undifferentiated product. Furthermore, even raw computation may not even be so undifferentiated as Selwyn believes. Computers are not, in general, compatible with one another, and brand loyalty does exist based on real or perceived differences or simply which system the buyer was trained to use. 5a

The other types of services which have been considered along with raw computation -- software development, systems analysis, consulting, training and user services -- are already highly differentiated. Most buyers demand more than just raw computation, so that even if raw computation is completely undifferentiated, through the other services the supplier may establish for himself an oligopolistic (for example, offering the

services of a particular operating system or compiler) or monopolistic (for example, offering proprietary applications software) position. 5b

Economies of Integration 6

A production function usually applies to one activity or to a closely related group of activities. A firm that produces several different types of products is said to be an integrated supplier and is subject to all of the production functions that apply to the individual products. If these are parallel and not directly related to one another, the firm is said to be horizontally integrated. If, on the other hand, all the products are related in that they represent intermediate stages of the production of some final good or service, then the firm is said to be vertically integrated. Most firms in the computer services area are vertically integrated, offering services comprised of raw computation, specialized application programs, contract programming, consulting, and user services. 6a

The advantages of vertical integration to a supplier of computer services are the protection to the supply of factor inputs it affords, the internal demand for intermediate outputs it creates, and the economies which often result from control over the entire production process. So attractive are the advantages of vertical integration, that in the computer service field it has occurred by growth in both directions -- hardware manufacturers have integrated upwards by the creation of service bureau subsidiaries and service firms have integrated backwards into hardware manufacture (as University Computing Company did for its line of COPE remote batch terminals). 6b

Against the advantages of integration must be weighed certain disadvantages. As Selwyn (SE71b) explained, each activity of an integrated firm is characterized by its own production function. Software production, for example, is more efficiently done by smaller firms, in contrast to the economies of scale associated with raw computation. Each function is likewise characterized by a most efficient scale of production. Thus, a single integrated firm of any given size is not likely to be the most efficient size for the production of all its products. When this occurs, other firms, competing with the integrated supplier, may be able to produce similar goods or services more efficiently, and hence capture a large share of the market. Of course, even an inefficient component of an integrated firm may be protected from competition by the more efficient components. 6c

Market Structure 7

As we have noted, the market supply pattern for computer services has been torwards integration. Disintegration, where it occurred, was generally limited to the labor intensive portions of computer services -- principally software development (where a form of economy of scale results from the negligible marginal cost for additional copies of a program), but also consulting, facilities management, and training. Disintegration for basic computer services was hampered by technological difficulties. 7a

Recently this has changed. The development of computer networks has provided a marketplace for the widespread sale and distribution of basic computer services. (HER73,HOO72) Users with nothing more than a terminal and access to the telephone may select from a large number of potential suppliers. Since geography is no longer of concern, the economies of scale which were observed to exist for basic services makes practical the disintegration of such services. Thus, a large complex located somewhere may offer basic services to users anywhere in the country at prices lower than they can obtain locally. Since personal services are still important and are still most efficiently offered by local concerns, wholesaler-retailer relationships have developed. (GR072,ST72) Large computer centers act as wholesalers of basic services to local retailers, who resell them to users along with the other services necessary for their productive use. It appears that this will be the characteristic industry pattern for the future. 7b

DEMAND 8

The demand for computer services is a derived demand. Computer services are not required for their own sake, but are used for accounting, inventory control, market forecasting -- in short, for all the myriad business problems to which the computer has been applied. As a derived demand, the demand for computer services on the whole could be expected to be somewhat inelastic. While this may be true for existing applications (the automation of a particular function is rarely reversible), it does not appear to hold for new applications. For new applications, the reduction in the unit cost of computer services which has been characteristic of the industry has been a major factor in promoting the continued development of these applications. 8a

The cross elasticity of demand for services from different vendors varies according to the homogeneity of the particular service. Homogeneous or undifferentiated services such as raw computation as a rule have high cross elasticities, reflecting the easy substitutability of products from different vendors. (Perhaps it would be more correct to simply say that the market for undifferentialted computer services is highly competitive). The

cross elasticity of highly differentiated services such as specific applications programs will be lower, perhaps even zero. (Thus, as has been explained, a firm can establish itself as a monopolist through the development of proprietary software.) Negative cross elasticities of demand between different types of services might also be expected; e.g., a decrease in the cost of raw computation could stimulate increased demand for programming or consultation services. 8b

In contrast to many other industries where industry-wide demand characteristics are well known but the demand facing an individual firm is not, in the computer services industry the demand facing individual suppliers has been most thoroughly investigated. Many computer service suppliers face captive markets, so that the aspect of the demand facing the firm which has been most intensively studied is the regular variation in demand which often occurs on daily, weekly and annual cycles. 8c

Computer installations are frequently faced with wide cyclical variations in the quantities of service demanded by users. (JO71) Typically, demand for service is greater during prime shifts than at night. Demand may be greater one day a week when a payroll program must be run, or at the end of a semester, when student projects must be finished. Quantity demanded may be estimated by the length of service queues at different times in the cycle. The demand function itself may fluctuate, since the users may be drawn from different populations at different times in the cycle. A major objective of computer center managers should be to level out these fluctuations so as to make more efficient use of the system and reduce the disutility to users who cannot obtain service at times of peak loading. As will be demonstrated later, the price mechanism provides the means to accomplish this. 8d

COSTS 9

The providing of computer services is characterized by a high ratio of fixed to variable costs. This is most true for the supplying of raw computation, since for the most part, machine rental accrues whether or not the system is running production jobs. For this reason, considerable attention has been devoted in the literature to the equitable allocation of these fixed costs among the various users. (BA67, DI68, GRA72, HO069, KR72, SE70, ST68) We shall refer to this cost allocation as "billing", rather than "pricing", since pricing has other objectives which will be discussed later. For a modern computer system, the design of an equitable billing algorithm is not simple. (Other types of computer services such as contract programming and consulting present less of a problem since variable costs are a more

significant portion of total costs, and fixed costs may be allocated as overhead in proportion to variable costs). 9a

The earliest computers were operated in a sequential batch processing mode, wherein each job occupied the computer fully for the length of time necessary to run to completion. Accounting was simple, as each user could simply be charged according to elapsed or so-called "wall clock" time. Time-sharing and multi-programming changed this, since multiple jobs could occupy the computer simultaneously. The elapsed time for any given job was no longer a function only of that job, but was also a function of the job mix. Timing was not a problem, since most advanced operating systems could determine actual running time for each program. More serious was the fact that each job used a different set of machine facilities. Depending on the job mix, conflicts could occur, resulting in less than optimal use of the total computer system. Thus, a given system could take different times to run a set of jobs, depending on the order in which they were loaded. 9b

Despite this inherent variability, billing algorithms were insisted to conform to the principles of reproducibility (result in the same charges for the same job, no matter when run) and equitability (be a function only of the resources actually used by the job). (KR72) Additional suggested attributes of a billing algorithm were auditability, understandability, and demurrage (charging for resources which, though they may not be in active use, cannot be used by others -- for example, dedicated peripherals or memory space). (HO69) There is no general solution which satisfies all these requirements. Most approaches have been to charge average costs which are determined from analysis of a past "typical" time period. This results in repeatability by using constant billing factors for all identifiable resources used (e.g., CPU time, memory space used, lines printed), and approximates equitability, since users are charged in proportion to resources actually used. (HET71, KR72) However, such an approach ignores fluctuations in true cost resulting from job mix idiosyncrasies, inevitably results in inequities as average factors for resources may change over time, and may fail to encourage efficient use of the hardware. 9c

PRICING 10

Any economic system must solve the problem of how to use scarce resources. The price system is the vehicle by which economic units express their preferences in a market context. When these preferences are uniformly expressed in terms of price, the strategy of allocating resources to those willing to pay the

highest price insures the maximization of total utility realized by the use of these resources. 10a

It has been observed that computer services are among today's scarcer resources. (NI70) However, prices are not presently the dominant allocative mechanism for these services. Pricing has been used for a number of other objectives (OL71), and other mechanisms have been used to allocate resources (SM68a). In this section we review some of the uses to which pricing has been put, and some of the alternative mechanisms for the allocation of services. We conclude with an exposition of the proper relationship of pricing to the provision of computer services. 10b

Pricing Objectives 11

It is well recognized that organizations operate according to many different objectives, be they stated explicitely or not. Naturally, the pricing policy of an organization will bear some relationship to the organization's objectives. Selwyn (SE71a) has identified some of the different objectives, and indicated how they are expressed in pricing policy. 11a

Profit Maximization 11b

One approach to maximizing long term profits is to work torwards maximizing short term profits. Total short term profits are maximized by increasing production (and accepting a continually lower price, in accordance with normal supply-demand considerations) up to the point where marginal costs equal marginal revenue (see Figure 1). For firms in the computer service industry, the bulk of the costs in the short run are fixed, so that virtually all marginal revenue represents a contribution to profit. There is thus a strong motivation to establish prices so that all machine time is sold (this is the point in Figure 1 where the marginal cost curve becomes vertical, indicating that any increase in capacity in the short run is impossible). However, this is most frequently accomplished by setting the price according to the average demand. 11c

For firms in the computer service business, adherence to this policy may be far from optimal in terms of the long term profit maximization objective. First, it ignores temporal variations in demand. This may result in all prime time being sold, but none at night. Second, the policy ignores the monopoly potential of specialized computer services. We have already discussed how a firm may establish itself as a monopolist by differentiating its products. Third, by selling to capacity during the peak hours, the quality of service may become substantially degraded (particularly important for time-shared systems), which may result

in the loss of customers dissatisfied with the service they are receiving (see Figure 2). 11d

Market Penetration 11e

A policy of market penetration in the short term may accomplish more than mere profit maximization in achieving long term objectives. By possibly foregoing current profits, the firm may be able to capture a much larger share of the market than would be possible without this policy. Since demand is less elastic for established users than potential users, the firm may then be able to alter its policies with respect to short term profit and still retain a major portion of its customer base. 11f

Tie-in With Other Services 11g

As has been discussed, integration is presently typical of most firms in the computer services industry. The appropriate pricing policy must consider the impact on all of the firm's products, not just the one for which a price is being established. For example, a time-sharing firm may establish a very low charge for initialy connecting to its system in the hope of stimulating usage for which it can charge. 11h

Optimal Use of Computer Resources 11i

For any given computer installation there is an absolute limit to its capacity to offer service. However, this limit is rarely approached, due to imperfect matching of demand for use of the individual resources to their availability. A gross example might be the idle time occuring at off-peak hours. A more subtle example is provided by a system whose printer is saturated. A pricing policy which for the first example encourages off-peak utilization, and for the second example discourages excessive use of the printer, may dramatically increase the total throughput of the system. 11j

Pricing Alternatives 12

Having determined the (set of) goal(s) of its pricing policy, management must then examine the tools available for the establishment of rate plans and policies. 12a

Pricing for Cost Recovery 12b

One alternative for a pricing policy is to estimate utilization over a given period and set prices so that they cover all costs of operation, including profit if a commercial installation. However, such a policy assumes demand to be perfectly inelastic

and, as Smidt (SM68b) has shown, can often be self-defeating. The best example of this is provided by the case of the newly installed computer system which has considerable excess capacity available which is expected to be gradually used up as demand increases. The cost per unit time of owning and operating the computer is fairly constant over its life and depends only slightly on the amount of work done. From a common sense point of view, it is clearly advisable to encourage users to make full use of the available capacity early in the life of the computer system when excess capacity exists, and to discourage usage (or encourage more efficient utilization) later, when usage approaches the capacity of the system. 12c

However, if charges for the computer are determined by allocating its total cost over the total usage for a given time interval (usualy a year), the charges provide incentives that are exactly the opposite of what is desireable. When the computer is new, the fixed costs are allocated over a small volume of work, leading to a high cost per unit of work. When the computer is old and nearing capacity, approximately the same fixed costs are spread over a much larger volume of work, leading to a low cost per unit of work. Insofar as users respond to the costs charged, they tend to economize on the use of the computer in the early days when excess capacity is available and to be liberal in their use of it later on when capacity is being approached. 12d

The only way out of this dilemma is to recognize that the price at any point in time need not bear any relation to the cost of production at that time. If demand for a good is low, its price may well fall below average cost, but thereby eliciting greater utilization. So long as marginal costs are covered, such operations will make a contribution to profit. Unless price is permitted to fall below cost, the proper information about demand may never be obtained, and the allocation of resources can never adjust to the unprofitability of that good. Smidt (SM68b) and Neilsen (NI68) have recognized the shortcomings of average cost pricing, and advocate the use of "flexible" pricing schemes where the price is allowed to vary to adjust to demand at any given time so that the quantity sold will be close to the quantity available. 12e

Pricing According to Value 12f

The characteristic negative slope of a demand curve arises in part from the fact that the value of a product or service -- perceived or actual -- will vary substantially from one buyer to another. In order to sell a larger quantity, it is normally necessary to lower the price to all buyers, even those who would be willing to pay more than is being asked. 12g

Price discrimination is a technique by which groups of users are isolated and charged prices which are closer to the maximum price which they as a group would be willing to pay. As shown in Figure 3, this has the effect of increasing total profit to the vendor. The larger the number of individual segments that can be isolated, the more profitable the technique will be. The requirements for price discrimination are that it be possible (practical and legal) to segment the market and that users in low-cost segments not be able to resell services to users in higher-cost segments. The ideal may be achieved by selling each unit of service at auction, so that the maximum price possible is always obtained. Sutherland (SU68) described a bidding technique for computer time, though he intended it as an efficient alocation mechanism rather than as a means to maximize profit. 12h

Selwyn (SE71a) discussed a number of bases for market segmentation applicable to the sale of computer services: 12i

> Segmentation by type of customer - for example, by offering discounts to educational customers, who would not purchase services were they priced according to their value to commercial firms. 12i1
>
> Segmentation by type of application - for example, a software supplier can price individual program products according to their value to users, rather than their cost of production. User isolation is obtained by definition, since they are using different products. 12i2
>
> Segmentation by time of day - this has been suggested by a number of authors as a means of more evenly spreading the overall load on a computer system over the total time available. 12i3

Priority Mechanisms 12j

Priority mechanisms have received wide attention in the literature on managerial and operations research research problems. In contrast, they have been virtually ignored by economists. One group of authors (SI68) suggest that the reason for this is that priorities are simply a surrogate set of prices that may in some instances work as well as a true price mechanism but will almost never be superior. For their part, operations analysts seem unaware that priorities are a form of pricing; thus Kleinrock (KL67) discusses "bribes" which are merely prices, and Greenberger (GRE66) tries to minimize the cost of delay, a cost which can never be known except in terms of the price users would pay to avoid the delay. 12k

Two types of priority rules are recognized (SI68): one which determines the access pattern for a given set of users, and another which offers incentives to potential users in determining their demands for computer time. The problem with the first class of rules is that an implicit assumption must be made about the value placed on computer time by each user. In general, users will not value time equally, nor consider waiting equally costly, so such rules will not allocate time properly. The second set of rules often suffers from inflexibility in the face of changing user requirements, and may discourage efficient substitution of other resources for computer use. 12l

In defense of priority mechanisms, it is recognized that they may serve to reduce the level of disutility that users cause each other through their presence in service queues -- a function attributed by Marchand (MA68) to "advisable" pricing mechanisms. Priority mechanisms are also inexpensive to administer. 12m

The Dual Role of Price 13

The controversy regarding the proper function of price has centered around whether it is a mechanism for the recovery of costs (including profit) or for allocating resources. Singer, Kanter and Moore (SI68) are quite emphatic: 13a

> "This point should be stressed: prices are a rationing device, not a mechanism for recovering cost." 13a1

On the other hand, as Oliver (OL71) recognizes: 13b

> "It is a sad fact of life that pricing is generally the only way a center has to recover costs. Someone has to pay for the center." 13b1

How are these opposing views to be reconciled? 13c

A possible reconciliation may be achieved by recognizing that price has a dual nature and satisfies dual objectives. Any pricing policy will serve as an allocation mechanism. As Nielsen (NI70) observes, "if resource allocation is not done explicitely, it will be done implicitely; there is no such thing as 'no allocation'." The concern of those who insist that pricing be viewed purely as an allocation mechanism is that this allocation be optimized for some set of criteria such as total user utility or system throughput. 13d

The main thrust of the criticism torwards the cost-recovery objective sems to be that it often focuses on the short term to the detriment of the long term, and is frequently inflexible in

its implementation. Such objections are well taken, but can be met by aiming to cover costs for a more appropriate period of time and by adjusting prices in response to cyclical fluctuations in demand. 13e

It should be possible to establish a pricing policy which satisfy both objectives of price. The overall result of the policy must be to achieve some cost recovery objective (maximize profit for a comercial installation, recover actual costs for an internal corporate installation, limit losses to a budgeted amount for a university center) as well as allocate resources on an equitable basis. Such a flexible pricing scheme can serve to promote more efficient use of the hardware and may even result in greater total revenues if the center had not been saturated at all times. 13f

Microeconomic theory offers no prescriptions guaranteeing that costs can be recovered for a particular product or service. What it does offer are tools with which to analyze the level of production necessary for all costs to be recovered. One such tool is the so-called "break-even" chart (figure 4). 13g

Break-even analysis assumes that all costs can be represented as either fixed or variable costs (or some combination of these two types), and that all units are sold at the same price so that marginal revenue is the same from each. The break-even chart graphically illustrates the level of production required -- at a given price -- for the excess of revenue over variable costs to equal fixed costs. 13h

Two problems can arise from this analysis. First, the break-even level of production may exceed capacity. If this is the case, cost recovery is impossible at the given price. So raise the price -- but this gives rise to the second and more serious problem: the analysis ignores supply-demand considerations. 13i

Raising the price will indeed steepen the total revenue line -- but there is no guarantee that the quantity sold (at the new given price) will be as great as the break-even point. Indeed, even the quantity which could have been sold at the old price (had capacity permitted) might have fallen short of the break-even point. If the equilibrium between supply and demand yields a quantity less than that required to break even, cost recovery is truly hopeless. 13j

The effect of raising or lowering price, of course, depends on the price elasticity of the particular product or service under consideration. For products with high elasticity, a small change in price results in a large change in quantity demanded. In this case, increasing the price will not aid in recovering costs. (If however, the break-even point is below capacity, lowering price

may aid in cost recovery by substantially increasing the quantity sold). For products with low elasticity, raising prices may indeed aid in recovering costs. It is for this reason that firms seek to differentiate their products or establish monopoly positions for themselves. Differentiated products tend to have lower price elasticity, enabling the firm to manipulate price more freely without wide variations in sales. 13k

The discussion should now be sufficient to indicate how a firm should undertake a pricing policy to satisfy both objectives. The firm must have some knowledge of its own cost functions and of the nature of the market in which it is dealing. Any requirements for "normal" profits can be treated as an additional cost. Possible "excess" profits cannot be determined in advance. The firm can then examine its break-even point for several different levels of price. This analysis, in conjunction with the realities of capacity limitations, will permit the firm to rationally manipulate price to recover costs (including profit) and control the allocation of resources. Cost recovery and the possibility of earning excess profits will normally be acomplished through commodities with low price elasticity. Where elasticity is high, pricing will be more directed at controlling allocation and restricting usage. Hopefully, a greater understanding of the underlying economic principles by computer center managers will lead to policies which better satisfy both goals. 13l

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MICROECONOMICS AND THE MARKET FOR COMPUTER SERVICES

by

Ira W. Cotton

Institute for Computer Sciences and Technology

National Bureau of Standards

15

Microeconomics has much to offer the computer services manager. This article reviews some of the traditional topics in microeconomics and shows how they can be applied to the market for computer services. The topics covered include supply, demand, costs and pricing. The most significant application of microeconomics is in setting prices -- so much so that microeconomics is frequently called "price theory." Accordingly, the thrust of the article is torwards providing a sound framework for the pricing of computer services.

15a

16802 Distribution

Kenneth L. Bowles, Bert R. Sutherland, Robert M. Dunn, Thomas N. Pyke, Douglas C. Engelbart,

TO 25-MAY-73 06:56 16803

cbig

please check with bob thomas at bbn and see if they can appoiny t
a cbig agent there so you dont have to send out as many mailings,
or dont you care? 1

16803 Distribution
Marcia Lynn Keeney,

TO: MDK DCE JCN RWW 1

FROM: Mil Jernigan 2

SUBJECT: Information Resulting from Arrangments for TNLS Class 3

This is somewhat of a clean up of tags of information you four should be aware of that resulted from contacts made during arrangements for the recent TNLS Class. 4

(1) Lt. Col. Bruce Fowler, USAF, AFDSC/XMX, The Pentagon, Washington, D. C. 20330, Phone (202) 695-2810. 5

Col. Fowler has visited ARC and others in SRI before several times. He was through here last when we were just getting our video equipment, he saw the conference room, (probably) had a demo in the conference room by JCN (because he talked about how impressed he was with the set up there for visitors), knows Dean Brown and is interested in AI. Col. Fowler will be visiting in San Francisco and environs, including other groups at SRI about July. He wants to come out and talk to ARC then. 5a

Some of his group and some of the other groups in The Pentagon generally under and with Col. Fowler and Major Robert Logan's group (the latter are the ones now listed in the IDENT file as USAF) have already been online using TNLS, very inexpertly, using Execuports borrowed from Rome. They logged in under RADC although one said they came in under "ARPA". 5b

The MITRE TNLS class had 3 from this general group: Abraham Balak, John E. Kohl, and John M. Punches. 5c

According to reports from MDK and MFA they were really interested in the system and were making a real effort to use it. This was the attitude as expressed also during my phone contacts by Col. Fowler and Major Reder (who was taking Major Logan's place during vacation). Both stated that their groups had used TNLS in a small way, exploratatively, for such things as memos, small reports, and would like to know more about it since its possibilities intrigued them for such concepts as the online office. 5d

John Punches will be in San Francisco during July and would like to visit ARC. He would appreciate very much having someone show him the system, and our general bootstrapping community approach. I suggested that he call in advance to be sure that someone would be here to show him around. 5e

(2) Col. Louis F. Dixon, U.S. Army War College, Carlisle Barracks, Penn. 17013 Phone: (717) 245-4304 -- His secretary: Joan. 6

Information Resulting from Arrangements for TNLS Class

Col. Dixon called Marcia about a month ago or a little more, asking about "this thing called a Nic Catalog". He had been left with the Station Agent's collection and wanted to know what "the stuff was". Marcia called me to the phone to tell him about the catalog and how to use it. 6a

During the discussions of the hard copy and online catalogs, where the material came from, a little something about the methods of inputing and output, and the reasons behind what NIC is doing for the ARPANET, he got very turned on and intrigued about TNLS, ARPANET, and the possibilities of using NIC actively. He took the Catalog into his office to study how it was set up. He wants to automate his office, memo, report set up, have what we call an automated or online office, a method of easily finding information and correspondence....he wants to come out with his secretary and both take the TNLS class instruction. He talked to Joan, his secretary, about it. She seems from talking to her to be a smart gal and a really good sort. She is also interested. 6b

Col. Dixon sent two of his immediate staff to the MITRE class: Lt. Col. Frank E. Owens, soon to decide if he is getting out of the service or not, MFA describes him as having the makings of a real ARPANET hack, who stays online practically all the time and really gets involved. Lt. Ronald Parker was supposed to attend, but at the last minute a Lt. Peter Osborne was substituted. Don't know him, no personal contact. MFA said that he was a completely different type from Owens. 6c

Col. Dixon also is going to be in the San Francisco area in July and would like to come by and see ARC if he can. I told him it was a good idea to phone in advance to be sure someone is going to be here that could discuss the things he would be interested in. 6d

16804 Distribution

Michael D. Kudlick, James C. Norton, Douglas C. Engelbart, Richard W. Watson,

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16805 Distribution

Michael D. Kudlick, James C. Norton, Richard W. Watson, Douglas C. Engelbart,

Information Resulting from Arrangements for TNLS Class

(J16805) 25-MAY-73 09:39; Title: Author(s): Mil E. Jernigan/MEJ;
Distribution: /MDK JCN RWW DCE; Sub-Collections: SRI-ARC; Clerk: MEJ;
Origin: <JERNIGAN>A-VISITORS.NLS;1, 25-MAY-73 09:24 MEJ ;

BAH 25-MAY-73 10:47 16806

May 15-19, 1973: A WEEK IN REVIEW

There is data for a partial week again due to the consequence of the system crash mentioned in last week's comments...bah

May 15-19, 1973: A WEEK IN REVIEW

WEEKLY ANALYSIS REPORT:

WEEK: MAY 15 - 19, 1973 (24 HOURS/DAY)

TOTAL SYSTEM CPU: 31.663

(ARC)

IDENT	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1
(STAFF)					
(MFA)	.046	3.203	.014	.145	69.630
(DCE)	.444	16.604	.027	1.402	37.396
(BAH)	.810	22.170	.037	2.558	27.370
(SRL)	.524	16.473	.032	1.655	31.437
(JCN)	1.052	29.116	.036	3.322	27.677
(DVN)	.494	15.452	.032	1.560	31.279
(PR)	.163	9.291	.018	.515	57.000
(RWW)	.051	6.232	.008	.161	122.196
	-----	-----		-----	
(TOTAL)	3.584	118.541		11.318	
(PSO)					
(KFB)	.152	12.769	.012	.480	84.007
(MEJ)	.509	21.018	.024	1.608	41.293
(KIRK)	1.765	45.262	.039	5.574	25.644

(LLL)	.451	26.453	.017	1.424	58.654	6a4d
(NDM)	.550	19.240	.029	1.737	34.982	6a4e
	-----	-----		-----		6a4f
(TOTAL)	3.427	124.742		10.823		6a4g
						6a4h
(NIC)						6a5
(EJF)	.246	7.927	.031	.777	32.224	6a5a
(MLK)	.164	11.031	.015	.518	67.262	6a5b
(MDK)	.172	12.419	.014	.543	72.203	6a5c
(JBN)	.199	10.075	.020	.628	50.628	6a5d
	-----	-----		-----		6a5e
(TOTAL)	.781	41.452		2.466		6a5f
						6a5g
(HARDWARE)						6a6
(MEH)	.948	27.945	.034	2.994	29.478	6a6a
(JR)	.011	.335	.033	.035	30.455	6a6b
	-----	-----		-----		6a6c
(TOTAL)	.959	28.280		3.029		6a6d
						6a6e
(TENEX)						6a7
(DIA)	.255	12.425	.021	.805	48.725	6a7a
(DCW)	1.297	31.105	.042	4.096	23.982	6a7b
	-----	-----		-----		6a7c
(TOTAL)	1.552	43.530		4.901		6a7d
						6a7e

May 15-19, 1973: A WEEK IN REVIEW

(NLS)						6a8
(WLB)	.680	33.610	.020	2.148	49.426	6a8a
(CFD)	.479	15.284	.031	1.513	31.908	6a8b
(JDH)	.396	13.694	.029	1.251	34.581	6a8c
(CHI)	.208	10.246	.020	.657	49.260	6a8d
(DSK)	.474	10.949	.043	1.497	23.099	6a8e
(HGL)	1.106	10.949	.101	3.493	9.900	6a8f
(JEW)	.338	20.712	.016	1.067	61.278	6a8g
	-----	-----		-----		6a8h
(TOTAL)	3.681	115.444		11.626		6a8i
						6a8j

(GROUP) TOTALS 6b

GROUP	CPU HRS	CON HRS	CPU/CON	% SYS		
						6b1
						6b2
(STAFF)	3.584	118.541	.030	11.318		6b3
(PSO)	3.427	124.742	.027	10.823		6b4
(NIC)	.781	41.452	.019	2.466		6b5
(HARDWARE)	.959	28.280	.034	3.029		6b6
(TENEX)	1.552	43.530	.036	4.901		6b7
(NLS)	3.681	115.444	.032	11.626		6b8
	-----	------		-----		6b9
(TOT)	13.984	471.989		44.163		6b10
						6b11

(STATS) 6c

HIGHEST CPU: KIRK 1.765 hrs LOWEST CPU: JR .011 hrs 6c1

May 15-19, 1973: A WEEK IN REVIEW

HIGHEST CON: KIRK 45.262 hrs LOWEST CON: JR .335 hrs 6c2

HIGHEST CPU/CON: DSK .043 HIGHEST CON/CPU:1: RWW 122.196 6c3

6c4

(OVERHEAD) 6d

(JCP)	2.709	49.579	.055	8.556	18.302	6d1
BACKGROUND	1.594	79.358	.020	5.034	50.000	6d2
CAT	1.428	6.058	.236	4.510	4.242	6d3
DOCB	.013	.606	.021	.041	46.615	6d4
GILBERT	.004	.092	.043	.013	23.000	6d5
NETINFO	.003	.477	.006	.009	159.000	6d6
SYSTEM	7.178	170.941	.042	22.670	23.815	6d7
	-----	-----		-----		6d8
(TOTAL)	12.929	307.111		347.944		6d9

6d10

(XEROX) 6e

6e1

NAME	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1	
						6e3
(LPD)DEUTSCH	.037	.757	.049	.117	20.459	6e4
(CMG)GESCHKE	.122	2.714	.045	.385	22.246	6e5
(JGM)MITCHELL	.026	2.030	.013	.082	78.077	6e6
(EHS)SAT-WTE	.604	14.719	.041	1.908	24.369	6e7
(RES)SWEET	.668	13.191	.051	2.110	19.747	6e8
	-----	-----		-----		6e9
(TOTAL)	1.457	33.411		4.602		6e10

6e11

(RADC) 6f

6f1

NAME	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1	DIR	
							6f2
							6f3
BAIR	.044	2.360	.019	.139	53.636	256	6f4
BERGSTRM	.027	.569	.047	.085	21.074	56	6f5
BETHKE	-	-	-	-	-	15	6f6
CAVANO	.017	.733	.023	.054	43.118	42	6f7
IUORNO	.021	4.567	.005	.066	217.476	22	6f8
KENNEDY	-	-	-	-	-	25	6f9
LAMONICA	-	-	-	-	-	61	6f10
LAWRENCE	.144	8.389	.017	.455	58.257	121	6f11
MCNAMARA	.010	1.972	.005	.032	197.200	124	6f12
PANARA	.051	2.257	.023	.161	44.255	98	6f13
RADC	.022	2.742	.008	.069	124.636	85	6f14
RZEPKA	-	-	-	-	-	83	6f15
SLIWA	-	-	-	-	-	21	6f16
STONE	.261	10.506	.025	.824	40.253	258	6f17
	-----	-----		-----		---	6f18
(TOTAL)	.597	34.095		1.885	1267.000		6f19
(PER CENT TOTAL DISK CAPACITY)						2.602%	6f20

6f21

(NETUSERS) TOP FIVE 6g

6g1

May 15-19, 1973: A WEEK IN REVIEW

NAME	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1	6g2
						6g3
GUEST	.680	105.222	.006	2.148	154.738	6g4
MITRE-TIP	.480	26.446	.018	1.516	55.096	6g5
NSRDC	.279	12.387	.023	.881	44.398	6g6
NBS-TIP	.262	12.197	.021	.827	46.553	6g7
UCSB	.191	5.449	.035	.603	28.529	6g8
	-----	-----		-----		6g9
(TOTAL)	1.892	161.701		5.975		6g10
						6g11
(NET)	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1	6h
						6h1
TOTAL	2.720	227.488	.012	8.590	83.635	6h2
						6h3
						7

16806 Distribution

Susan R. Lee, Beauregard A. Hardeman, Douglas C. Engelbart, Don I. Andrews, Marilyn F. Auerbach, Walt Bass, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Diane S. Kaye, Kirk E. Kelley, Michael D. Kudlick, Elizabeth K. Michael, Jeanne B. North, James C. Norton, Jeffrey C. Peters, Paul Rech, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor, Donald C. (Smokey) Wallace, Richard W. Watson, James E. (Jim) White, Duane L. Stone, Thomas F. Lawrence, James H. Bair, L. Peter Deutsch, James G. Mitchell,