1981-09

Enhancing Technology Transfer of Computer Hardware and Software Architectures Using Human Factors in Initial Design

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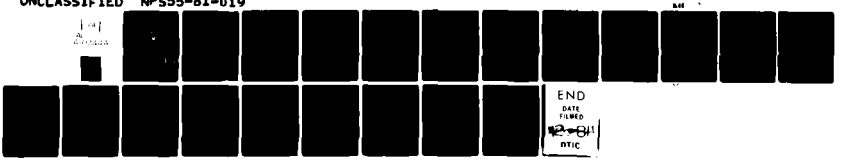
SEP 81 G K POOCK, R J ROLAND
UNCLASSIFIED NPS55-81-019



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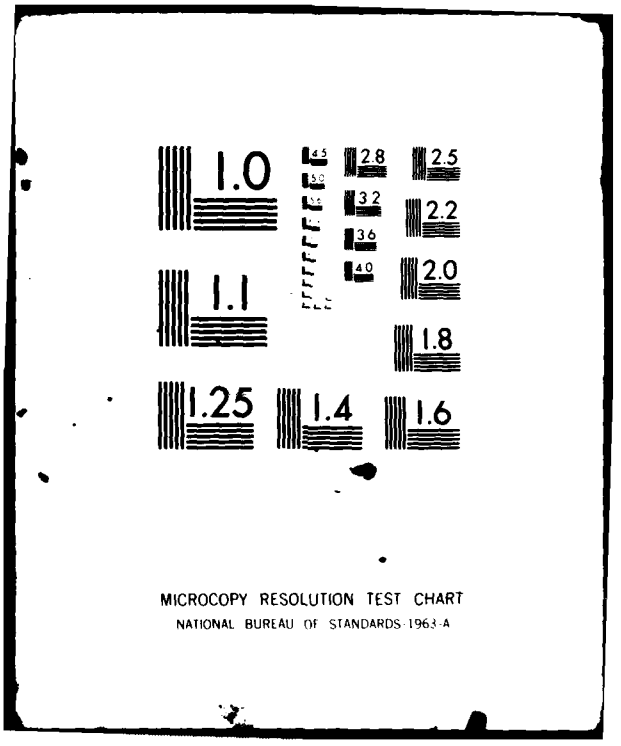
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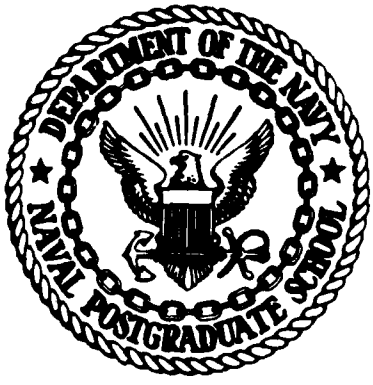

ENHANCING TECHNOLOGY TRANSFER
OF COMPUTER HARDWARE AND SOFTWARE
ARCHITECTURES USING HUMAN FACTORS
IN INITIAL DESIGN

by

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and

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September 1981

Approved for public release; distribution unlimited.

Prepared for:

Naval Electronic Systems Command
Washington, D.C. 20360

NAVAL POSTGRADUATE SCHOOL

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Dean of Research

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (14) NPS55-81-019 / 2. GOVT ACCESSION NO. AD-A107444	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Enhancing Technology Transfer of Computer Hardware and Software Architectures Using Human Factors in Initial Design •	5. TYPE OF REPORT & PERIOD COVERED (9) Technical rep-t.
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Gary K. Poock, Ronald J. Roland	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, CA. 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62721N N0003981WRDX008
11. CONTROLLING OFFICE NAME AND ADDRESS (11) Naval Electronic Systems Command Washington, D.C. 20360	12. REPORT DATE Sep[illegible]81
	13. NUMBER OF PAGES (12) 21
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) None	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Human Factors, Human-Computer Interaction, Computer Networks, Natural Languages

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This paper describes an experiment which attempted to subjectively measure the transfer of technology directly from the research arena to operational application. Areas of technology included recently developed computer software "natural languages" based on artificial intelligence (AI) concepts, computer networking technology and automatic message handling systems. Exposure to this technology was accomplished over a 12 week period where the experimental group was provided

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with the tools and understanding to use the various research products. Data were collected from this experimental group prior to and after the 12 week period. Analysis of the data revealed interesting aspects concerning a user's perception of the value or utility of computer systems and computer software designed specifically to enhance the human-system interaction.

ENHANCING TECHNOLOGY TRANSFER OF COMPUTER HARDWARE AND SOFTWARE ARCHITECTURES USING HUMAN FACTORS IN INITIAL DESIGN

BACKGROUND

Technology advances, particularly in the field of automation, have far outstripped the capacity of operational users to recognize and assimilate all the possible benefits. The research community has produced a large variety of capabilities which may be categorized as "decision aids" and/or "operational aids" and has concurrently experienced considerable difficulty in effecting technology transfer, i.e. acceptance of the research by the user or operational community.

In October, 1977, the Naval Postgraduate School (NPS) in Monterey, California, established a new curriculum in Command, Control and Communications (C3). This curriculum, as described in the Command, Control and Communications (C3) Program section of the Naval Postgraduate School Catalog (1978), includes within its objectives, a major goal "... to provide the students with enhanced capabilities to operate effectively in such diverse areas as military decision making, current and future C3 systems design, crisis management, ... ". Two courses within the C3 curriculum, OS 3671: Man-machine Interaction, and CS3750: C3 Exercise Laboratory, are specifically designed to introduce research that is directed toward future C3 systems. As such, they represent unique vehicles for studying the relevance of research products in that the C3 student body, composed of professional military officers, experienced in operational requirements, is exposed to the various research products and then provided the class time and equipment to use, experiment with, and evaluate each research product.

The C3 curriculum has received support from the Defense Advanced Research Projects Agency (DARPA), a Department of Defense (DoD) agency specifically tasked to conduct exploratory research in advanced technology. Much of the research in command, control and communications is a product of DARPA's Information Processing Technology Office. These research products fall into a variety of areas such as graphics languages and protocols, distributed data base concepts, production rule systems, and natural language query systems as examples. However, it is often difficult to evaluate research products like these from an

operator's perspective and when this is done, the product is often so far developed that it is infeasible to change it ... once again, a reminder of the need to consider human factors in initial design stages of any computer hardware or software development.

With the establishment of the C3 curriculum and the close association with DARPA, a unique situation had developed in which military officers in the C3 curriculum would be able to use and evaluate emerging technologies as they develop and provide operational user feedback to the research community. To enable this to occur, each officer in the C3 curriculum has been provided with a portable, hardcopy producing, computer terminal. A local telephone call allows the officer to connect into the ARPANET, a distributed network of over 100 different large scale computers. The geographically separated host computers are linked together by a communications net to form an operational, resource sharing network of a wide variety of DARPA sponsored research centers and other DoD activities in the continental United States, Hawaii, Norway and England.

Originally implemented in 1969 under a research and development program sponsored by DARPA (then ARPA) to advance state-of-the art computer internetting, the NET's use has experienced growth in many unplanned directions. The ARPANET's communication system uses the technique of "packet switching" where each message is separated into small packets and each packet is then switched to its destination via the fastest communications path available at any instant. Upon arrival at the destination, the packets are reassembled in the proper order.

Since DARPA's Command, Control and Communications research products reside on host computers around the ARPANET, the officers in the NPS C3 curriculum can therefore access these research technologies at any time. For example, a student officer can work with a given research technology at a computer in California and within seconds be working on a real time, interactive basis with a different research technology which may reside on a host computer in Pennsylvania.

OBJECTIVE

The authors had both encountered a variety of computer systems before but one outstanding feature of the ARPANET and most of the Command, Control and Communication technologies on it is that they have been designed with much consideration for the operational user. (Finally human factors consideration in the design stage!) This was one of the primary reasons for deciding to introduce the new C3 class to the ARPANET and its C3 technologies.

Many students find most computer systems too detailed and exacting, e.g., if a dollar sign, slash, asterisk, etc., is not entered in exactly the proper format, the job will fail and the students become very frustrated and "turned off" because the system is not friendly. This feeling is further accentuated in military officers, especially those in the C3 curriculum, who represent the Army, Navy, Air Force and Marines, and who may be operational users of computer systems but who have no desire to worry about system details like dollar signs. They want to be able to get their operational answers from the computer system as quickly as possible, and then get back to their operational duties.

It was therefore the objective of this study to introduce a group of relatively naive computer users to a computer network system (the ARPANET and its technologies) which was very user oriented in design. The question to be addressed was would an educational exposure to such a system change the students' perceptions and attitudes toward computer systems, and if so, how?

METHOD

Subjects

The subjects were members of the first class in the C3 Curriculum at NPS. All branches of the U. S. Armed Services were represented with ranks ranging from a Navy Ensign to a Marine Corps Lt.

Colonel. Prior to this study, each student had just completed an introductory computer programming (FORTRAN) course and an introductory computer graphics course, typical of those found in many universities. In those courses they had done the usual types of tasks such as writing specific programs, setting bits to adjust vectors on cathode ray tubes (CRTs), and doing term projects. In general, they had a very common computer oriented background. Most of them thought what they had learned so far was "nice to know" but they really had no desire to work with automated systems and learn more of the nitty-gritty details.

Procedure

The subjects were all given a questionnaire prior to the beginning of the experiment and prior to receiving their personal, portable, computer terminals or any information about events or topics coming in the future related to this experiment.

Subjects received no monetary rewards for participation in the following activities.

Standard background information about operational experience and previous computer experience, ages, rank, etc., were obtained from the questionnaires. In addition, 30 questions were asked beginnning with the phrase "To What Extent ... " with responses A through E ranging from

A. None, or very little

to

E. A great deal

These 30 questions tried to determine the subjects' perception of the value or utility of automatic data processing and automated decision/operational aids. The questions covered a broad area and were similar to the following:

"To what extent do you feel you could have effectively used a computer or computer network in your past jobs?"

Questionnaire responses were received from all subjects and not examined until the end of the experiment.

The subjects were each then given a portable, hard-copy, computer terminal to take home in addition to a small introductory pamphlet (Holg, 1977) explaining the ARPANET in general, and one of its message handling systems. They were told a class would begin in four days in which they would make use of the terminals on the ARPANET.

The actual experiment then began in which the students were exposed to the ARPANET and its command and control research technologies for a period of eleven weeks in a course called "Man-machine Interaction", which met three hours per week. During class, video monitors were installed around the room so the students could see the professor actually working on a real-time, interactive basis with the ARPANET and various computers around the country. Students were given specific assignments which they would then work on at home on their own computer terminals. Since each user on the ARPANET has an individual electronic "mail-box", students transmitted their finished assignments to the professor's mail-box at anytime they wished. In addition, the professor also worked on the NET three nights a week from home. Because the ARPANET provides a teleconferencing feature between users, when a student had a question, he/she could simply link with the professor and receive immediate feedback on any question. Furthermore, if the professor noted several students with the same questions or problems, he would have them all link together and then go to the particular host computer around the country where the students were having questions. He would run through a short demonstration to illustrate the answers to their questions, and during this time, each of the students' terminals would be printing out an exact copy of what the professor was doing.

Some of the specific research products and some of their human engineering features which the students were exposed to are listed below:

1) The ARPANET and some of its general features. A small pamphlet showing how to access the ARPANET and use one of its mail handling systems was given to each student. The pamphlet showed the user how to access the network and then how to go to his own host computer on the network. The pamphlet explained in simple terms what was happening and the user entered given commands through his terminal and saw comparable results coming back from the system as those shown in the pamphlet. The ARPANET protocol makes extensive use of an escape character wherein the user can start to enter (log in) to the system and by typing one or more escape characters, the system knows who is logging in and therefore automatically fills in account data, etc., for the user.

(NOTE: The human engineering features and user designed interfaces of the ARPANET were quickly re-emphasized to the authors after they had handed out the terminals and the small introductory pamphlet to the students several days before class began. Within thirty minutes after they left one of the authors' offices with their terminals, the authors were also logged in to the system and noticed students starting to log in and use the mail handling system. That was impressive considering that the host computer they were using was some 400 miles away and they had received no instruction.)

2) A message handling system (MSG) - which basically transmits pages of information from one user to other users' electronic mailboxes in the form of messages or letters. Particular features which make this system especially useful are its flexibility and its automatic recognition mode. If one wants to send a message, one simply types an "s" for the command SEND and the system automatically fills out the word and asks for the addressee and the host computer name on the network. In addition, it asks for addresses of people you may wish to send "carbon copies". The pressing of one key, after the message is composed, starts the mailing system which sends the message to all addressees specified and the system shows the status as OK when each user has been sent the

message. If a communication link is down, the message will be listed as queued, so the user knows its status. Other features of the mail system require only one key to be typed to invoke them such as "d" for deleting a message, "f" for forwarding a message to someone from someone else, "a" for answering a message, "u" for undeleting a message which the user may have marked for deletion by mistake, etc. All messages in the user's mailbox are numbered, so to answer message 23, the user simply types

a23

and the system fills in the addressee because it knows whose message the user is answering.

3) A text preparation and editing system (XED) - which is used for preparing pages of text for longer letters, reports, etc. The system makes use of automatic recognition by letting the user type "a" for example, and the system fills out the word "append" meaning the user wants to add more text, etc. By typing one key, the user can also format his text into neat pages with right and left margins aligned. If the user wishes to save the text, he simply types "w" and the system fills in "write to output file" where the user fills in the file name.

4) Multi-host computer networking (TELNET) - a system for going from one's host computer to another on the network, obtaining some information, and subsequently returning to one's own host. For example, one may be working at his own host computer and decide he needs information from another computer, thousands of miles away. Instead of having to terminate operations at one's own host, go log in at the other to get the desired information and log out and then log back into one's own host again, this system allows one to type two words and a connection is made to the remote host from the user's host computer. The user can get the desired information and return to his own host in exactly the same place he left it. The speed and procedure with which one can interconnect several computers is incredibly easy to the naive computer user.

5) File transfer between host computers (FTP)- a system for allowing one user to retrieve or send files of information from or to another user. For example, one user wants a 50 page computer program which someone else has at a host computer thousands of miles away. By typing three words, a connection is made from one host to the other and the 50 page computer program at location X can then be transferred to location Y in seconds. The user at location Y can now execute that program immediately on his host computer.

6) Search and rescue demonstration (SAR) - a program which allows users to specify a disaster site and subsequently initiate search and rescue operations. With mostly YES and NO responses, plus some numbers entered to specify distances, the user actually sees automatic connections being made around the computer network to notify specific people of the simulated disaster, to obtain weather data in the vicinity of the disaster from other computers, and to determine which ships might be in the area to help in this search and rescue on the high seas.

7) Inquiry programs - to determine what ships are at sea, where they are, what they have onboard, etc. Two inquiry systems were actually used. One was a "natural language" query system which approaches the ultimate in man-machine interface by some standards. It allowed the user to ask questions in his own words and the user could then see the program trying to parse or understand his question. If unsuccessful, the program replied with reasons why it didn't understand. If successful, the user would see the program connect to other distributed data bases around the country to obtain the answers. In many cases, this system also corrected user typing errors in input. From a man-machine interface viewpoint, this system is very flexible in that one user can ask "Where is the John F. Kennedy?" and another user can ask "What is the position of the JFK?" and both users will get the same answer.

The students also used another query system which was somewhat

in contrast to the natural language system and built on a different philosophy of the best man-machine interface. In this system, a tree structure is used in which a user learns certain key words and tree branches. The system then uses automatic recognition to help fill in the user's request. For example, a user might wish to say,

"Show Russian submarines within 350 nautical miles of Honolulu". The user would actually type the following letters: S R SU W 350 N Honolulu and the system would fill in the words to make the sentence appear on the terminal as written above in the quotes. With a few hours training, the user can basically use this system in a sort of short hand way by just entering the first letter of words and the system automatically types out the rest of the words plus some others, i.e. if the user types N, the system prints

"Nautical miles of...".

The above descriptions are brief but intended to show some of the types of research products the subjects were exposed to, and to give an idea of some of the man-machine interface characteristics which had been designed into the original product.

It is important to note here that the authors, in using the above systems and research products, had attempted to take these systems to the user, who as a naive computer expert, could exercise and run them successfully with few problems. The systems introduced were realistic products which the subjects could relate with, versus typical introductions to computers in which a certain example is used and the user is required to imagine and translate this into how it could be used in his/her daily tasks. In addition, these were systems which had been designed initially with the user in mind, versus many systems designed to do a task, and then the user must find out all the small details to make them run. For example, in almost every system described above, typing HELP or a question mark will provide general assistance on the system or answer a user's specific questions.

RESULTS

The same questionnaire that was administered before the experiment was given at the conclusion of the course with all subjects responding. The purpose was to determine if the exposure to these user designed systems had positively influenced the subjects' perceptions and if so, in what direction.

The responses to the questions had been on a scale from A (None or very little) to E (A great deal) and were therefore considered an ordinal measurement. Since the magnitude of the change in responses was not considered meaningful (a change in response from C to E was not necessarily equivalent to a change from B to D), the authors evaluated the subjects' responses to each question with the Sign Test (Siegel, 1956). This test basically showed if a significant change had occurred in the group's opinion during the experiment. A significance level of .10 was used since the authors were looking for general trends in the subject group's opinion.

Subjects showed a significant, positive change in response to the question "To what extent are you interested in personally working with computer systems?". After the experiment, they were more interested in personally working with such systems. The reader will remember that before the experiment started, the subjects had no desire to really get in and work with such systems, even though they had previously received a course in FORTRAN and a course in elementary graphics.

The subjects also showed a significant positive increase in their perceptions of how they could have used computers in their past jobs and in future jobs. After the experiment they felt more strongly that they could have effectively used a computer in past jobs, and further they now felt more strongly that it would be practical to expect future military commanders to use personal computer terminals. On a

related question, they also had a much more significant positive attitude after the experiment that they would prefer to use interactive terminals themselves rather than having a subordinate perform this function.

When asked "To what extent do you view the utility or value of computer systems?", the subjects showed no change of opinion. This was rather perplexing until the group of subjects was interviewed a few weeks later and they replied "We always thought computer systems were valuable and we still do...but now we want to be involved with them whereas before we really didn't."

Subjects also showed a significant increased perception of the benefit of computerized decision aiding systems. This was probably because they had been able to experience such systems and gain confidence in the ease with which the systems could be used. They also probably gained confidence in the reliability of the systems.

There was only one question in which the subjects' perceptions significantly decreased on the rating scale. The subjects now felt it was less likely for them to possibly misunderstand someone else's written message. Although the experiment did not include any information on how to compose or understand a written message, the subjects may have thought they understood messages better because on the few times when they did have a question, they could often link up with the message sender, wherever that person was on the ARPANET, and get an immediate clarification of any question they had about the sender's message.

After the experiment, the subjects also showed a significant increase in their responses to the question "To what extent do you find it easy to quickly send the same information to many different people". Indicating it was now easier was probably due to the fact that in previous experiences, they used the typical business approach of having information typed, then copies made in some fashion, and finally

envelopes addressed and sent through normal mail channels. With their experience on the ARPANET, the subjects had been able to prepare information and electronically send it within minutes to multiple addressees simultaneously, anywhere on the network, thousands of miles apart.

The other questions dealt with more specific areas of interest and are not of importance here. For example, one question asked "To what extent are you familiar with artificial intelligence applications?" and obviously most showed an increased familiarity since they were introduced to some artificial intelligence applications during the experiment. One similar type of detailed question was revealing from a man-machine interface viewpoint. That question asked "To what extent does the ability to type enhance your ability to communicate?". After the experiment, the subjects showed a significant, positive increase in their responses, indicating that they now felt the ability to type was even more important. This has significant implications for the future if the current trend continues toward the use of more computer systems in our daily lives. Current trends are toward more interactive use via computer terminal, and if other modes of data entry are not developed, the acquistition of typing skills in ones's earlier schooling years will be extremely valuable in later years.

Typically, after students in a computer type class have finished their course, their use of computers and computer systems will drop to practically zero, if in the following weeks and months, they are not taking more computer courses or working on thesis research. A further verification that the subjects in this experiment had been motivated or "turned on" by the experimental experience they received, is indicated in accounting data for the following two months after the experiment had ended. Although these subjects were taking no courses requiring use of a computer and none of them were working on thesis research, they have averaged 8 hours per week per subject using the facilities and research products provided them during the experiment and this has continued for

two months up to the time of this writing.

Another interesting aspect revealed in the subjects' responses was a significant change in their attitude toward deleting files of information. After the experiment, they felt much more comfortable in creating and destroying files of information. This is probably due to their previous experiences in which most computer system users are told very specifically how to delete information, because it will be gone forever if one deletes it. The ARPANET has been designed however, such that a user may delete information, but if the user realizes at anytime before he logs out, that he made a mistake and really needs the file of information, he can simply undelete it and he will have it restored in its original form. This is a nice feature for the user and certainly had an influence on the subjects during this experiment.

A purely subjective observation by the authors also revealed that subject interest levels started out very high and remained so throughout the experiment. This observation is based not only on accounting data, but on the enthusiasm and excitement exhibited by the students in daily contacts with them.

At the end of the experiment, the subjects were also asked to indicate which of the query systems they preferred ... the natural language query system or the less natural, tree structured, query system described earlier. Their preference was to be based on the man-machine interaction with the two systems and on how they could formulate queries. Their preference was not to be based on what type of information they could obtain from the system. The subjects were divided into two groups called OPERATORS and SUPPORT. OPERATORS means airplane pilots, ship drivers, etc. SUPPORT refers to individuals in communications, intelligence, etc., whose main function is in support of the operational areas. This is analagous to the staff function in any large organization. Six OPERATORS chose the natural language system and two OPERATORS chose the tree structured query system. However, seven of

the SUPPORT group chose the tree structured query system and two of the SUPPORT group chose the natural language system. Arranging this data in a 2 X 2 matrix, the Fisher Exact Probability Test (Siegel, 1956) was applied and showed a significant difference ($p < .05$) in the two groups' preferences. The OPERATORS definitely preferred the natural language type query system, and in reality, they would usually be flying planes, etc., i.e. performing the "command" functions, and only occasionally have need to go into a command center and enter their own query into a system. As such they would prefer to not have to remember details of a system but rather enter their own "natural" query. The SUPPORT group definitely preferred the tree structured query system which allowed them to use a "shorthand" version of query entry, and thus enter queries much faster. In reality, the SUPPORT group would use such systems on a daily basis. This revealing aspect of query system preference indicates that although the current trend today is toward development of natural language systems in many fields, one should carefully examine the daily user to determine if the additional cost of a natural language system is really worth the amount of use the system will receive, or would a less natural language system in fact serve the users' purposes better?

CONCLUSIONS

The transfer of technology from designer to user is often a difficult process and many times the transfer does not occur because the technology designer did not consider how the technology would be used by the end user. In this experiment, a broad range of research technology products were presented to users. However, the research technology products were all ones that had considered human factors in their initial design stages, and as a result, subjects found the products easy to use. Consequently, user perceptions of computer systems and computer software projects were greatly enhanced, and in addition, user motivations and interest levels in working with these systems were greatly elevated and have remained so.

Two comments might be made in closing. Since the subjects in this experiment were professional military officers, with current operational experience, they provided timely, real-world comments to designers on how to improve their products, with such improvements being made immediately in several cases. Finally, a side benefit derived from providing each subject with his own portable terminal at home, was that the subject could work at home at night and still be with his family, as opposed to the more typical situation in which the student spends many nights at the computer center and the family begins to wonder if he doesn't really live at the computer center.

An overview of this experiment strongly suggests that a viable method of technology transfer may be through special programs which "invite" the subject or user to become familiar with the technology and evaluate it. It might also be suggested that the human interface with automated systems, expecially decision support systems, can be substantially enhanced through a properly designed exposure to the technology and an opportunity to use it without fear of failure.

NOTE: Follow on observations of the 2nd and 3rd C^3 classes also indicated the same trends and results as found in this study.

REFERENCES

Holg, C., THE ARPANET/TENEX PRIMER and the MSG MESSAGE HANDLING PROGRAM. University of Southern California, Information Sciences Institute, Report ISI/TM-77-4, 1977.

Naval Postgraduate School Catalog. Command, Control and Communications Curriculum, Monterey, California, 1978, 38-39.

Siegel, S. Fisher Exact Probability Test, Nonparametric Statistics, McGraw-Hill, 1956, 96-104.

Siegel, S. Sign Test. Nonparametric Statistics, McGraw-Hill, 1956, 68-75.

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