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ABSTRACT

A policy study was conducted in four rounds to assess the anticipated payoff of investment by the Advanced Research Projects Office in the development of a new family of terminals for use by the military in computer-assisted instruction. Members of the panel of experts proposed features, rated them, and reacted to the resulting ratings. Of the 24 features, those rated as most needed were seen by these experts as likely to be in commercial production five to ten years from now in a form usable by the military. Experts generally agreed that investments in innovative pedagogical software and in innovative course writing are likely to have greater payoff than an investment in terminal development. Of 14 software features, those rated as most needed were ones for particularizing instruction online to the course-related needs of individual students. The report is a thorough description of the conduct of the study. (EMH)

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A Policy Assessment of Priorities and Functional Needs for the Military Computer-Assisted Instruction Terminal

Prepared jointly by

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20. ABSTRACT

A policy study was conducted in four rounds to assess the anticipated payoff of an investment by ARPA in the development of new terminals for use by the military in computer-assisted and computer-managed instruction. Members of the panel of experts (11 civilian, 9 military) proposed features, rated them, and reacted to the resulting ratings. Of the 24 features, those rated as most needed were seen by these experts as likely to be in commercial production five to ten years from now in a form usable by the military. Experts generally agreed that investments in innovative pedagogical software and in innovative coursewriting are likely to have a greater payoff than an investment in terminal development. Of 14 software features, those rated as most needed are ones for particularizing instruction online to the course-related needs of individual students.

The report is a thorough description of the conduct of the study.

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Abstract

A policy study was conducted in four rounds to assess the anticipated payoff of an investment by ARPA in the development of a new family of terminals for use by the military in computer-assisted and computer-managed instruction. Members of the panel of experts (11 civilian, 9 military) proposed features, rated them, and reacted to the resulting ratings. Of the 24 features, those rated as most needed were seen by these experts as likely to be in commercial production five to ten years from now in a form usable by the military. Experts generally agreed that investments in innovative pedagogical software and in innovative coursewriting are likely to have a greater payoff than an investment in terminal development. Of 14 software features, those rated as most needed are ones for particularizing instruction online to the course-related needs of individual students.

The report is a thorough description of the conduct of the study.*

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* A companion report by Louis Gallenson, An Approach to Providing a User Interface for Military Computer-Aided Instruction in 1980, ISI/RR-75-43, discusses effective utilization of forthcoming commercial terminals in military computer-aided instruction.

Executive Summary

- A panel of experts (11 civilian and 9 military) was selected from the computer-assisted and computer-managed instruction (CAI/CMI) community.

- Panel members were polled in order to determine what features they felt should go into innovative military CAI/CMI terminals and what payoffs they anticipated would follow from these features.

- The four rounds of questionnaire and feedback included: (1) general stance probing, (2) open-ended soliciting of features and payoffs, (3) ranking of features and payoffs, and (4) eliciting reactions to resulting rankings.

- Participants rated investments in either innovative pedagogical software or innovative coursewriting as having higher potential payoffs than investments in terminal technology or large-scale use of existing systems.

- The features felt to be most necessary in all CAI/CMI terminals are likely to be in commercial production by mainstream terminal vendors in a form usable by the military by 1980-1985.

- With respect to pedagogical software, the features felt to be most necessary are those that facilitate tailoring of interaction with a student to his particular course-related needs, interests, and difficulties.

The report is a thorough description of the conduct of the study.

Introduction

This report deals with one of many activities in a project attempting to provide functional specifications for a family of new CAI (Computer-Assisted Instruction) and CMI (Computer Managed Instruction) terminals for the 1980-1985. The purpose of the activity was to survey CAI/CMI experts in order to determine what features they felt should go into innovative military CAI/CMI terminals.

The rationale for the survey was that innovative terminal design could be informed by sampling the projected needs and uses of the CAI/CMI user and research communities. It was assumed at the outset of the study that representatives of these communities could provide descriptions not only of desired terminal features, but also of anticipated payoffs from use of these features.

The goals for the querying were to

1. (1) Discover what features are desired in the military CAI/CMI terminal (or family of terminals) in 1980-1985.

2. (2) Determine what the anticipated payoffs are for implementing and using these features.

3. (3) Determine the importance of military CAI/CMI terminal development relative to developments in software, large-scale demonstrations, etc.

4. (4) Determine the projected value of stand-alone versus networked systems.

In order to carry out the survey, a panel of experts was selected by the study group working in conjunction with the ARPA Project Officer. The panel members were surveyed using an iterative questionnaire technique described below. The procedures and materials used in the study are also described in a separate section below. Finally, the conclusions and recommendations resulting from the survey are reported.

Problems of Need Assessment

Modern technology is best characterized as immensely complicated, expensive to develop, and requiring long lead times from initial specification to mass production. Often the cost of developing a new device is so high that potential users can afford it only if they are willing to guarantee a certain minimum order to the producer. Even without an agreement, the market ceases to act as a testing ground for determining user needs when demand is low relative to high initial development costs. Customers are forced to take what is available and like it. With long lead times and many innovative ideas that cannot be pursued profitably, it is not surprising that producers often fail to perceive the market correctly. It is in the best interests of all parties that representatives of the potential user communities be involved in specifying the needs to which new technologies are supposed to respond.

This report describes a methodology similar to Turoff's Policy Delphi which user communities might employ when establishing their needs.* It has been refined during a study of features of computer terminals necessary for CAI or CMI.

Before attempting a need assessment study, one should understand what is involved. The task is amorphous. Partly, it is an attempt to define the appropriate community. Partly, it is an attempt to discover the directions that the technology is taking. One hopes by shifting back and forth to discover the needs of a set of people which it appears to be feasible and extremely beneficial to satisfy. One can rarely go into the marketplace and survey needs, because consumers do not know what is or is not achievable by technology. In rapidly evolving technological fields, even those professionally involved have difficulty assessing what is achievable in a given time frame. An effort to determine needs is likely to be as much an educational process as it is an opinion-probing process. One of the greatest dangers is in assuming too much. User representatives are likely to possess widely differing competencies, interests, and skills. While there might be some advantage to having a randomly selected set of individuals rank order their needs, it seems most reasonable that the user community representatives should be carefully selected for their knowledge and commitment. They should be allowed to interact over a period of time until they know enough about each other that they can work out compromises. While it takes time, the process is likely to lead to recommendations that users can live with and to which they can feel committed.

The issues to be resolved are typically too complex and the number of factors to be represented is typically too great for a face-to-face confrontation to be productive. The individuals who should be involved in the discussion are busy people who are rarely in the same place at the same time, and the priority-setting process takes more time than they can comfortably spare. For the process to work, the user representatives must perceive that they have a great deal of influence over the final product without having to become

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* (M. Turoff, "The Design of a Policy Delphi," Technological Forecasting and Social Change, 1970, 2, 149-171)

involved in the mechanics of the process. When their advice is asked, they should feel that the questions asked are answerable and pertinent to the final recommendations. If they feel important points are being slighted, they should be able to alert the group. Unlike technology forecasting studies, it is more important to accurately represent and assimilate the opinions of group members than to strive for consensus.

Turoff (1970) points out that at least three different participant roles exist in this type of policy polling -- the individuals seeking policy advice, the small team that designs questions, compiles feedback, coordinates the effort, and writes the final report, and the larger group chosen to represent the various interests of the user community.* In our case, the Advanced Research Projects Agency's Human Resources Research Office requested a study of what features should go into innovative military CAI/CMI terminals. The small group that administered the study included a terminal designer, two experts on computer-assisted instruction, and three human communication researchers who acted as intermediaries between the large and small groups. The large group included twenty experts or teams of experts -- educational researchers, CAI/CMI developers, instructional technologists, computer scientists, and CAI/CMI courseware authors.

In the following section, the procedures used for eliciting opinions during the various rounds are described. Slightly different approaches were used in each round. Questions were derived from responses and/or unresolved issues. We did not presume that statistical measures of significance could be employed in analyzing results. Instead, responses were condensed and organized in a way that merged similar opinions while preserving distinctive ones. It is unlikely that this group of participants would reach conclusions much different from the ones reported here if queried again. The reader will have to decide for himself whether the participants' preferences can be generalized to the entire CAI/CMI community.

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* Turoff, op. cit.

Procedures and Materials

The basic procedure followed in this study was an iterative query and feedback technique using three questionnaires mailed to participants. Other materials provided to participants included working papers and scenarios, summaries of results from each round of questionnaire responses, lists and biographical sketches of participants, and miscellaneous administrative correspondence. These materials are contained in the appendixes. The materials and specific procedures are described below.

Selection of Participants and Initial Mailing

Potential participants were selected by the authors working in conjunction with Dr. William Mann, the principal investigator of the overall project at the Information Sciences Institute, and ARPA project officers, including Col. Austin Kibler and Dr. Thomas O'Sullivan. Nine participants or participant teams were selected from the military community. Twenty-five potential participants were selected from the civilian community (business and education) in the expectation that about half would participate. It was hoped that there would be an approximate balance of participants from the military and civilian communities in the final participant pool. This balance was achieved (see Table 1). Most of the potential participants were contacted by telephone by one of the authors. A letter confirming telephone responses and/or soliciting participation in the study was sent to potential participants on August 30, 1974 (Appendix II.A). Enclosed with this letter were a working paper describing the study and a questionnaire requesting biographical information (Appendix II.A). A list of potential participants being contacted was also sent in this mailing. Different cover letters and participant lists were sent to potential civilian or military participants. Responses trickled in, and a few participants nominated other individuals either in substitution for or in addition to themselves. Letters were sent the week of September 31, 1974, acknowledging receipt of biographical questionnaires (which confirmed the participant's intention to participate in the study) or requesting completed questionnaires from a few participants who responded by letter only.

A list of the actual participants with notations regarding questionnaire rounds in which they participated is contained in Table 1. A total of 25 experts agreed to participate. Two never responded further. The balance is distributed into 20 participant-teams, as noted in Table 1. Brief biographical summaries of active participants are contained in Appendix I.A. In addition, a note concerning solicitation of military participants is contained in Appendix I.B.

TABLE 1

Active Participant Response Record

PARTICIPANT	STATUS	ROUNDS ONE	TWO	THREE	FOUR**
Dr. Ernest Anastasio		X			
Dr. Alfred Bork		X	X		
Dr. Peter Dean		X	X	X	X
Mr. Richard Ditzik			X	X	X
Dr. Robert Fitzhugh and Dr. Robert Glaser	@	X		X	
Dr. John Ford	*	X	X	X	X
Mr. Frank Giunti	*		X		
Dr. Keith Hall		X	X	X	X
Dr. Albert Hickey		X	X		
CPT Larry Hinkle	*	X		X	X
Mr. Donald Kimberlin	*	X	X	X	X
Dr. David Merrill		X	X	X	X
Dr. Leon Nawrocki	*	X	X	X	
Dr. Marty Rockway	*	X	X	X	
Dr. Worth Scanland	*	X			
Dr. Bruce Sherwood		X	X	X	
Dr. Joseph Ward	*	X	X	X	
MAJ D. A. Weihe, CPT D. Glessner, and TSGT L. Miller	*@	X	X		
Dr. Jon Wexler			X	X	X
Dr. Karl Zinn		X	X	X	X
		---	---	---	---
		17	16	14	9

STATUS KEY:

*Military
@Participated as a "team".

**All participants were telephoned in Round Four.

Questionnaire Rounds

Each round of questionnaires was designed by the authors. The questionnaire for each round of query after the first round was based upon the responses to the previous round. Participants were sent an introduction to each round and a summary of responses to the previous round for each round after the first.

Questionnaires and summaries are contained in Appendix III.

Round One. The questionnaire for round one was designed to probe the general attitudes or "stance" of each participant regarding CAI/CMI, to discover projected military uses of CAI/CMI, and to direct query and feedback during future rounds. Each question provided two or more alternatives and asked for the respondent's preferred stance as well as stances he would be willing to accept for purposes of consensus. While consensus (i.e., a preponderance of preferences for one alternative) was achieved on some points, the exercise was primarily useful in identifying and clarifying potential issues which could be raised in Round two.

Along with the questionnaire, a set of scenarios was provided to orient participants by suggesting future CAI/CMI environments in the military (Appendix II.B). The authors expected that participants with no military experience would use the scenarios as a surrogate for such experience, and that participants with military experience would suggest revisions of the scenarios. Since no comments about the scenarios were received from the participants, the scenarios were not referred to again in the course of the study. As shown in Table 1, 17 responses were received in round one.

Round Two. The questionnaire for round two was developed after receiving the majority of responses (16) from round one. Round two was used as a bridge between the first round (probing participants' stances) and the third round (concentrating on specific terminal features). Participants were asked to respond to three types of questions:

(1) Anticipated payoff of investment in terminal development;

(2) Identification of terminal features to be explored in round three; and

(3) Continued probing of round one issues, such as design of terminals for users with a wide range of motivation and intelligence levels.

The questions were open-ended and succeeded in eliciting substantial written responses. It was possible to sense informally which issues were felt to be significant and to feed this back to participants in both the summary and in the round three questions.

In round two participants were encouraged to respond by an offer of a small stipend. Civilian participants who responded did receive the stipend. Unfortunately, it was later realized that participants employed by the military could not be paid from project funds; so, a letter informing them of this problem was sent to those participants (Appendix II.C). Nevertheless, 7 of the 9 military participants responded to round two, and 9 of the 11 civilian participants responded.

Round Three. Following the previously established procedures, the round three questionnaire was designed and sent to participants along with a summary of round two results and a list of active participants. The questions were structured so as to get degree of commitment information regarding particular policies and features. The lack of qualifying remarks in the responses suggests that the questions were appropriate and the respondents felt they were ready to vote.

The analysis of the third round questionnaire responses constitutes the results section of this report. A total of 14 responses were received in round three.

Round Four. In a final mailing this report in draft form was sent to participants with the request that they communicate any comments and/or dissenting opinions to the authors. Participants were also contacted by telephone. Dr. Merrill said that he thought the emphasis on course development rather than terminal development was consistent with his feelings. Dr. Wexler stated that he expected that the final round would have resulted in a more precise specification of desirable terminal features, with relative weights. Mr. Ditzik said he felt the study should be replicated with a wider selection of participants. Six other participants responded with no further comments.

Results

The major conclusion of the study is that research money should be invested in pedagogical software or coursewriting rather than in the development of new military terminals. It is shown that the terminal needs of both civilians and military should be combined, that investing in new terminal development receives low priority, that features of terminals felt necessary will most likely be available from commercial vendors, that no resolution of the stand-alone/time-sharing problem can be reached, and that software features felt most necessary are interactive ones for tailoring instruction to the course-related needs of individual students.

1. It is in the best interests of advancing the CAI/CMI terminal state-of-the-art to combine civilian and military needs as opposed to focusing on just military or just civilian needs. When asked this question, ten respondents favored combining military and civilian needs, zero favored keeping the needs distinct, two chose the category "other", and two did not respond. The two "other" responses both indicated that there are some unique military requirements and instructional situations requiring special terminals, but that generally military and civilian needs can be combined. Almost every participant at some point during the study observed that special terminals are needed in special situations. Sometimes ruggedness and/or portability are essential. Other times simple input not involving typing and/or verbalizing is important.

2. In terms of their potential payoffs for advancing CAI/CMI state of the art (assuming a 1980-1985 time frame), investments in either innovative pedagogical software or innovative coursewriting rank higher than investments in terminal technology. When asked to rank four possible investment strategies from 1 (greatest potential for advancing the state-of-the-art) to 4 (least potential), terminal hardware received an average rating of 3. Both an investment in software and an investment in coursewriting received an average rating of about 2. The fourth alternative -- an investment in large-scale use of existing systems -- averaged out about equal to terminal hardware. Exact tabulations are included in Appendix III.F.

It should not be assumed from this ranking that an investment in terminal hardware is not considered important. In the second round at least eight participants felt that an investment in terminal development would have a significant payoff. Many of the reasons given in support of such an investment argued that the CAI/CMI marketplace was not large enough to attract special attention from vendors and that business-oriented terminals would not meet instructional needs. This concern for the size of the marketplace may explain why it is in the best interests of civilians and military to combine their markets.

3. The features felt to be most necessary in all CAI/CMI terminals are likely to be available from mainstream terminal vendors. When members were asked to rate 24 possible terminal features in terms of their necessity using the following rating scheme

++ definitely yes
+ would be nice
0 neutral
- probably not
-- definitely not

seven features received an average rating between ++ and +. [See Appendix III.F, question 4(1) for details.] The two most definitely needed features (alphanumeric typed input and a single action to invoke frequently used functions) are available on most existing terminals. Only limited graphics features are definitely needed (an ability to touch or point to screen locations and an ability to generate simple straight line figures). Symbol set requirements may not currently be available in many terminals, but will not be too difficult to incorporate (programmable symbol sets and a variety of predefined symbol sets). The final definite need is for signals for controlling external equipment, which is also not too difficult to incorporate.

On the other hand, the only features with "neutral" or below ratings are precisely those that might prove difficult to implement (spoken word input, shading and texture in display, and generation of large numbers of symbols in displays).

The remaining features fall generally in the neutral to "it would be nice" range. At the lower end of the range are color displays, memory, exact reproductions of screen images, computer-composed speech, and lights under keys. At the upper range are signals received from plug-ins, alphanumeric printouts, line drawing input, display of complex line drawings, high- and low-resolution stored visuals, moving visuals, prerecorded audio output, and processing capability.

It is the considered opinion of the investigators that by the time a terminal could move from development to large scale production, commercial vendors will be marketing terminals that meet all but perhaps the least necessary of these features.

4. No recommendation can be made about whether terminals should be stand-alone CAI/CMI systems or rather communication devices connected to time-sharing systems. In both the first round and in the third round, participants were asked about whether or not terminals should be stand-alone systems. In the first round 9 ranked stand-alone over time-shared with 5 ranking the options the other way. In the third round 3 felt stand-alone capability was definitely needed, 6 felt it would be nice, 4 were neutral, and 1 was slightly opposed. While both responses show a preference for stand-alone systems, the trend is not strong enough to be called consensus. A glance at the comments in Appendix III.D will reveal why some participants feel very strongly in favor of stand-alone systems. Perhaps the best solution is to rely upon the commercial marketplace, which is likely to provide a variety of solutions to the stand-alone problem.

5. Turning to pedagogical software, the features felt most necessary in CAI/CMI software are course-related, student-tailored and interactively oriented. When asked to rate fourteen possible software features in terms of their necessity using the following rating scheme,

++ definitely yes
+ would be nice
0 neutral
- probably not
-- definitely not

four features received an average rating between ++ and +. [See Appendix III.F, question 7(1) for details.] The most definitely needed was software permitting instructional sequences tailored to the abilities and/or weaknesses of individual students. Next came problems and examples responsive to interests of particular students, hints that reduce problem difficulty, and summaries of student progress.

Immediately following these features with average ratings of + or close to + are course-related "intelligent" features that (1) contrast concept/strategy information with information about potential students, detect difficulties, and advise the instructor; (2) discover patterns of course-related behavior and advise the instructor; (3) derive course-related strategies from examples provided by the instructor; (4) respond meaningfully to course-related problem-solving strategies; (5) respond meaningfully to course-related questions or statements by students; and (6) accumulate course-related concepts and vocabulary from examples provided by the instructor.

Finally with ratings between + and neutral are features that respond to (1) course-independent problem-solving strategies; (2) pauses; (3) dialogue cues; and (4) course-independent questions.

While it was not the major intention of the study to probe into specific software or courseware areas needing attention, it was felt from the results of round two that exploratory probing might prove fruitful. Unlike the list of terminal features, which was assembled from round two recommendations, the software list was assembled purely by the investigators. No claim is made that the best or most relevant features were included. Most likely a better analysis could be done at some future time. However, when asked for additional software features, only five of the fourteen respondents mentioned anything. Two mentioned that they had worked so long on the problem that it was hard to summarize their opinions. Two others mentioned the problem of exporting courseware for use on other systems. For more comments regarding authoring and adaptable software, see the responses to question 3 of round two in Appendix III.D.

In conclusion, it would seem that the major focus for funding should center upon software and/or courseware and not upon terminal hardware. Perhaps people in the computer-based instruction field are recognizing that hardware cannot solve the problem of good instruction. Rockway summarizes:

> "The basic problem of so called teaching software is that most of the 'material' encountered makes no attempt to understand the student's knowledge except as reflected by simple answers to multiple choice questions. The material does not carry out the dialogue of an expert tutor because most authors do not understand how this is done or because it cannot be supported by the computer available to the author. ... We could probably

profit both from development of the technology and technique of carrying out verbal and manual dialogue. The case for an expensive electronics presentation system for fixed material is very difficult to make."

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Appendix I: Participants

Appendix II: Materials Sent to Participants

Appendix III: Questionnaires and Summaries

Appendix I.A

BIOGRAPHICAL SUMMARIES OF PARTICIPANTS

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Director of Educational Technology Research and Associate Director of the Office of Data Analysis Research at ETS.

He has taught graduate studies in statistics and the use of computers in research at Princeton University and the New School for Social Research. His research interests are in areas of instructional technology, computing methodology and the methodology of modern data analysis.

DR. ALFRED M.BORK
Department of Physics
University of California
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We have developed at Irvine, a large group of student-computer dialogs for physics use, including the underlying macro-based software. Most of the material uses graphics, with the Tektronix 4013 or our primary terminal. These materials are in heavy use in our beginning classes, and are beginning to see some use on other campuses of the University of California.

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BSE (EE), University of Michigan; M.S. Cybernetic Systems, California State University, San Jose. Presently representing Control Data Corporation (Terminal System Division) efforts in developing an education terminal for future CBE systems. Primary interest in computer-base instructional communication systems.

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Computer scientist interested in system design and educational use of computers.

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Assoc. Director, Advanced Instructional Systems, Navy Personnel Research and Development Center, San Diego. Ten years experience at Navy Personnel and Training Research Lab., San Diego; SDC, 1958-64; RAND 1956-58. Academic experience: Temple University and University of Delaware. Education: Ed.D. Teachers College, Columbia University 1954. Research interests: Instructional research and technology development including CAI/CMI and simulation.

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Mr. Frank E. Giunti has been serving as the Technical Director, Computerized Training Systems Project, Product Manager's Office, since its establishment in August 1972. Prior to this period of time he served as the

Chief, CAI Division, US Army Signal Center and School (October 1970 to August 1972) and initially as an instructional programmer, CAI classroom supervisor, and CAI project planner (August 1966 to October 1970).

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BS in business administration, State University of New York; MBA, University of Alabama; 8 years active duty with the Air Force. Teach management at San Antonio College. AFMPC representative on study of Automatic Processing Requirements of the 80's (SADPR-85) and the Base Communications Mission Analysis (BCMA); developed and implemented research method to analyze base level functional requirements.

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Psychologist interested in instructional research and development.

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Graduate study in instructional systems and technology and educational psychology - Indiana University. Research interestes in adaptive, interactive instructional systems. Management responsibilities for 4 CAI systems - 1 fixed site and 3 mobile systems.

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Ft. Gordon, GA 30905
(404)791-3193 or 7297

Mr. Donald A. Kimberlin served as an instructional programmer, course development team chief, and classroom supervisor in the CAI Division from 1968 to 1972. From 1972 to the present, Mr. Kimberlin has served as an Educational Specialist and Chief of Course Development for the CTS Project. He is now the Chief of the Course Development and Applications Division, Project ABACUS.

DR. DAVID MERRILL
Department of Education
Brigham Young University
Provo, UT 84601
(801)224-2350

My Ph.D. was obtained from the University of Illinois under Larry Stolurow, my dissertation being one of the first studies on SOCRATES. I have published in the area of instructional design. I was leader of the team which did courseware design for the TICCIT system. This design was based largely on the theoretical work which I had done on instructional design. I am currently on sabbatical leave from B.Y.U. and serving as Vice-President of Courseware, Inc. which is currently involved in two major projects training military personnel to develop CAI materials.

TSGT L. A. MILLER
AFMPC/DPMYC
Randolph Air Force Base, TX 78148
(512)652-2414

Entered the Air Force in 1955; participated in the tests the Air Force was conducting prior to release of CAI Air Force wide in 1972; has directed training programs and managed CAI/CMI systems.

DR. LEON H. NAWROCKI
Computer Instruction Research Program
U.S. Army Research Institute
Commonwealth Building
1300 Wilson Blvd.
Arlington, VA 22209
(202)694-3954

Dr. Nawrocki received his Ph.D. from the Ohio State University in 1969 and has since been employed by the Army Research Institute. From 1969 to 1972 he was assigned to Command Systems unit and conducted research on information displays. From 1972 to present he has been senior psychologist in the Educational Technology unit. Organizational membership includes APA (Divs. 1 & 21), HFS, ADCIS and AERA.

DR. MARTY R. ROCKWAY
Technical Training division
Air Force Human Resources Laboratory
Lowry Air Force Base, CO 80230
(303)394-4385

Marty R. Rockway is a native of Chicago, Illinois. After completion of undergraduate work in the physical and engineering sciences he received a Ph.D. in psychology and statistics from Northwestern University in 1953. In 1963-64 he was a Princeton Fellow at the Woodrow Wilson School of Princeton University where he majored in the areas of public administration and national security affairs. During 1967-69 he was a Littauer Fellow engaged in a joint program in management science and science and public policy at Harvard and M.I.T.

During the past twenty years Dr. Rockway has held a number of R and D posts within the Air Force Systems Command, including the position of Chief Engineer for Human Factors at the Aeronautical Systems Division and his current position as Technical Director, Technical Training Division, Air Force Human Resources Laboratory.

DR. WORTH SCANLAND
Chief of Naval Education and Training
Code N-330
Naval Air Station Pensacola, Fla. 32508
(904)452-3466

Attended the Naval Academy followed by 30 years active duty as a Naval officer, mostly submarines, followed by graduate, studies at FSU, with a M.S. in educational research and a Ph.D. in Instructional Technology, followed by a couple of years as director of research with the Florida Youth Services Authority (juvenile delinquency), followed by current duties with the Naval Education and Training Command staff.

DR. BRUCE SHERWOOD
Room 252
Engineering Research Lab
University of Illinois
Urbana-Champaign, IL 61801
(217)333-6210

B.S. Engineering Science, Purdue Univ.-1960
Fulbright to Padova, Italy
Ph.D. Physics, University of Chicago - 1967

Taught and did experimental particle physics research at Caltech 1966-1969. At University of Illinois (Urbana) since 1969 - now Assistant Director of the Computer based Education Research Laboratory (PLATO) and Associate Professor of Physics. Worked on design and implementation of TUTOR language. Developed PLATO version of introductory classical mechanics course. Author of the text The TUTOR Language.

DR. JOSEPH S. WARD
U. S. Army Research Institute
Commonwealth Building - Room 2045
1300 Wilson Blvd.
Arlington, VA 22209
(202)694-1397

Dr. Ward has worked in the design, development, management, and evaluation of CAI/CMI systems in Army training programs. His primary interests in this study are in instructional systems development research involving CAI/CMI as one delivery mode of instruction.

MAJ D. A. WEIHE
AFMPC/DPMYC
Randolph Air Force Base, TX 78148
(512)652-2414

I have a degree in secondary education from the University of Wichita (now Wichita State University) and 16 years experience in Air Force personnel management. I also have 27 hours of graduate study leading to an MS in systems management from St. Mary's University, San Antonio, Texas.

DR. JON WEXLER
(During study)
Department of Computer Science
State University of New York at Buffalo
4226 Ridge Lea Rd.
Amherst, NY 14226
(Currently at Tempe, AZ)
(602)967-3248

Research/teaching interests are in the area of artificial intelligence and the application of its representations and processes to computer-based teaching systems to generate portions of the material needed for intelligent (interesting) student-computer dialogue. Involved in the (slow) development of a generative teaching system for multiple programming languages; current work focuses on the generation of equivalent target language programs from a visually-oriented abstract language.

DR. KARL L. ZINN
Research Scientist
University of Michigan
Center for Research on Learning and Teaching
109 E. Madison Street
Ann Arbor, MI 48104
(313)763-4410 or 0158

Karl L. Zinn, Research Scientist at the Center for Research on Learning and Teaching, and Associate Director of the MERIT Computer Network at the University of Michigan, is engaged in development of innovative uses of computers in education, giving special attention to computer languages and supportive systems. He has worked with dozens of curriculum authors in a variety of subject areas who have prepared learning exercises using ten different authoring languages as well as a number of general-purpose programming languages.

Appendix I.B
MILITARY PARTICIPANT SELECTION

MEMORANDUM FOR THE RECORD

From: Monty C. Stanford

Date: October 28, 1974

Subject: Obtaining Military Participants in the CAI Study

Military participants were obtained for the CAI terminal study in the same manner as civilian participants. That is, the same kind of letter requesting participation in the study was sent to military participants as was sent to civilian participants. Names of military participants were obtained from recommendations and by contacting key agencies in the various armed services.

One reason for using this method was to attempt to ensure that a participant from one of the armed services was not participating merely because he or she had been assigned by his or her superior to participate. I still feel that such "volunteer" participation is good and is a desirable aspect of this and future studies.

However, several military personnel expressed some hesitancy to participate in the study. They seemed to be unsure as to whether or not such participation would be sanctioned, approved, or required by higher command. And, in one case, the potential participant we contacted desired to participate in the study, but, after receiving our initial materials, the person's superiors denied permission to participate in the study.

Recommendation:

It is, therefore, recommended that in future studies of this type participation be requested from military personnel on a volunteer basis in the same manner as was done in this study. But, it is also recommended that the highest command level possible be contacted and approval for participation in the study be obtained before requests are made to individual military personnel.

Appendix II.A.1.a
COVER LETTER TO CIVILIAN PARTICIPANTS

August 29, 1974

[Name of participant] [Address of participant]

Dear [Title and last name]:

The Information Sciences Institute and the Annenberg School of Communications at the University of Southern California are conducting a study for the Advanced Research Projects Agency in order to learn from experts what features should be included in pace-setting CAI terminals five to ten years from now and why. The intention of the study is to discover if there are new devices and/or strategies for making CAI user interfaces more effective.

Would you be willing to participate on a panel of experts from October 1974 until January 1975? We expect to conduct four rounds of query and feedback regarding possible features and reasons for the features. Enclosed is a working paper detailing the goals of the study and procedures we plan to follow, a questionnaire that will help us all better understand each other, and a list of the other people who are being contacted. Please let us know as soon as possible whether or not you can participate and who else we ought to contact.

Sincerely yours,

/s/Monty Stanford

for/ Bill Mann, ISI
Rick Carlson, ASC
Tom Martin, ASC
Monty Stanford, ASC

Enclosures

Appendix II.A.1.b
COVER LETTER TO MILITARY PARTICIPANTS

[Name of participant]
[Address of participant]

Dear [Title and last name]:

In reference to our recent telephone conversation, I am enclosing materials on the Computer Assisted Instruction Terminal Study being conducted by the Information Sciences Institute and the Annenberg School of Communications at the University of Southern California for the Advanced Research Projects Agency. We hope to learn from experts what features should be included in pace-setting CAI terminals five to ten years from now and why. The intention of the study is to discover if there are new devices and/or strategies for making CAI user interfaces more effective.

Through the course of the study, we expect to conduct four rounds of query and feedback regarding possible features and reasons for the features. Enclosed is a working paper detailing the goals of the study and procedures we plan to follow, a questionnaire that will help us all better understand each other, and a list of the other people in the military community who are being contacted. We have also enclosed brief vitas of the ASC study members, so that you will have some idea of who we are.

In addition to participants from the military community, we are contacting potential participants from academic and business organizations who are CAI users or researchers. Brief biographical statements on all participants will be sent to you with the first round of questionnaire materials.

We look forward to your participation in this study. Please let us hear from you as soon as possible.

Sincerely yours,

/s/Monty Stanford

for/ Bill Mann, ISI
Rick Carlson, ASC
Tom Martin, ASC
Monty Stanford, ASC

Enclosures

Appendix II.A.2

WORKING PAPER

The ARPA Contract

There are a number of tasks included in the contract between the Information Sciences Institute and ARPA's Human Resources Research Office, only one of which is the querying of experts. Some of the other projects that will be completed during the first year include 1) putting PLATO terminals on the ARPA network, 2) surveying the literature for CAI user interface descriptions, 3) tracking technological developments that might significantly advance CAI terminal state-of-the-art, 4) transforming the recommendation of the panel of experts into specifications for a terminal that can be sent out to contractors. The major long range study is directed toward discovering and modeling human discourse processes that can later be incorporated into interactive computer systems.

Goals for the Querying of Experts Task

Available terminals frequently limit what authors, designers, and researchers can do with CAI or CMI systems. In order to have equipment on hand five years from now that meets needs then, we must find out what designers, teachers, and researchers plan to be doing and what they will need in a terminal. While we must produce an end product that can be turned into specifications, we will not limit ourselves to terminals. If it is more important that certain types of software be developed, or that new types of learning laboratories be established, we want to find that out. We are particularly interested in what terminal features that are not normally needed are needed for carrying out user

interaction research. We suspect many of you have good ideas about data capturing techniques, monitoring devices, and plug-in features you feel you need but which cannot be justified in mass-produced terminals. However, if discussion becomes too blue sky, we plan to move back toward operational environments. We are expected to make recommendations regarding stand-alone versus networked systems, but will fight hard to keep this from becoming the sole topic of discussion.

It is very important that we not come up with a list of features without filling in the reasoning behind the features. We want to know what payoffs you see in the features you recommend. While it may not be possible to justify features in a strict cost/benefit sense, curiosity alone is probably not enough. We hope you use the justification process as an opportunity for influencing each other.

One final note: ARPA is interested in helping to make military education more efficient and effective. While the recommendations we come up with are likely to have wide applicability, they must take into consideration the type of student, teacher, and learning environment encountered in the military. We plan to provide background material to those of you who are unfamiliar with Armed Services education.

Procedures We Plan to Follow

In many respects we are planning to have the study be like a Delphi study. There will be a series of rounds, feedback will be used to bring participants towards consensus, names will not be mentioned, and most of the interaction will be through the mail. However, we are not interested in finding out when you think some development will take

place, but rather what you want to have done. In the early stages we plan to be frankly nonstatistical. We are more interested in letting you inform each other about your positions than in forcing you to react to ours. In order to help you we plan to provide you with background scenarios, sample position statements, and checklists of things about which others might want to know your opinions. In the first few rounds we are really looking for statements that will bolster the final selection of features.

The final rounds are intended to be much more concrete and feature-oriented. You will be asked to rate how important you feel various features to be, and to agree with or attempt to reword supporting reasons. We expect that some of you will feel the need to talk things over with us or with each other. We plan to be available via the telephone, can make a limited number of site visits (provided there are clear and compelling reasons), hope to use teleconferencing via the ARPA network and/or the PLATO network, and may need to hold a one-day workshop in order to reach consensus. We welcome suggestions from you regarding how to improve upon the querying procedure.

The final procedural issue is one for which we have no good answer--how to come up with a single set of recommendations. A number of participants are bound to feel there is a need for a number of different types of terminals. Other participants will feel that features cannot be talked about in isolation. We may be forced to come up with a family of terminals each responding to a different environment, or a family ranging from cheap to expensive. Features are likely to cluster into groups, with some groups less essential than others, and some groups mutually exclusive. The match between features and reasons for features is not likely to be one-to-one. However, we will do our best to

keep participants working toward a loosely ranked list of justified features for a single terminal.

If you have any further questions, call Rick Carlson, Tom Martin or Monty Stanford at (213) 746-6273. We want you to feel that the study is for your benefit more than for ours, and hope that you will let us know how it can be made more responsive to your needs. We think the procedure will work and that the potential payoffs are great enough to make it a worthwhile endeavor for everyone involved.

Appendix II.A.3

BIOGRAPHICAL QUESTIONNAIRE

In order to give all of us who are participating in this study some idea of the composition of the participant group, we would appreciate your completing and returning to us this biographical questionnaire.

If you have, in addition, a one-page vita or references to papers or articles that you feel reflect your current thinking on the topic of this study, it might be helpful for you to include these also.

1. Your experience relative to computer assisted or computer managed instruction:

   1.1 In general it would be helpful to know what experience you have had working with CAI/CMI systems that you feel is relevant to the topic of this study. But first, there are some specific items of information that we would like to obtain from all participants. For these items, would you please check the appropriate items below. For each item, circle CAI, CMI, or both.

   ( ) I have taken courses using CAI/CMI systems.
   ( ) I have authored CAI/CMI coursework.
   ( ) I have designed and/or programmed CAI/CMI programs.
   ( ) I have managed a CAI/CMI system.
   ( ) I have designed terminal hardware.
   ( ) I have other relevant experience, including:

   1.2 Now, could you describe your working experience that you feel is relevant to the topic of this study?

2. Your experience relevant to military training:

2.1 Again, since the ultimate goal of this study is to provide recommendations for CAI systems in the military training environment, it would be helpful to know what kind of familiarity you have with that environment.

( ) I have been a student in a military service training course.
( ) I have taught in a military service training program.
( ) I have authored military training materials.
( ) I have directed a training or education program at the local command level or higher.
( ) I have worked on the staff of a military service training command (or at DOD level).
( ) I have other experience with military training, including:

2.2 Now, could you describe your working experience with military training that you feel is relevant to the topic of this study?

3. Your availabiiity and access to computer networks:

3.1 Are there any times during the conduct of this study when you will <u>not</u> be available?

3.2 If you have access to the PLATO network or to the Advanced Research Projects Agency (ARPA) network, it might be most convenient to communicate with you via one of the networks. Do you have access to either or both of these networks?

( ) PLATO
( ) ARPA

3.3 If you have access to either or both of these networks, would prefer to participate in the study via one or the other?

4. Your suggestions and comments on this study:

4.1 What benefits do you anticipate or would you like to derive from participating in this study?

4.2 Do you have any comments on the design and procedures for this study and/or do you have any suggestions for the study?

5. In the first round of this study we will provide all participants with brief (say, five lines) biographical summaries of all participants. What would you like to say in yours?

Appendix II.B.1

INTRODUCTION TO ROUND ONE

As you know from reading the working paper (distributed at the beginning of the study), the end product of the querying process must be translatable into specifications for future CAI/CMI terminals. In this round we are hoping to find out what some of your general attitudes are, how you see CAI/CMI fitting into the military environment, and in what areas we can direct discussion during future rounds. Enclosed you will find a set of nine scenarios and a questionnaire. The scenarios are intended to orient participants by suggesting (not delimiting) how CAI/CMI terminals might be used in 1980-1985. They hopefully will act as a surrogate for military CAI/CMI terminal projected usage data. The questionnaire contains eight general attitude questions and fifteen usage environment questions. We do not view the questionnaire as a validated instrument for gathering reliable data. Rather we view it as a sounding board for stimulating and focusing discussion. Notice the wide empty margins next to questions. We want to know what the questions mean to you and how you would follow up on them in succeeding rounds. If you have no attitudes about an issue, do not feel compelled to place an "x" next to one of the alternatives. If your attitude has stipulations, tell us what those stipulations are.

Some participants have asked why we are diverging from the Delphi methodology and whether or not we view our methodology as reliable. From a social scientific view, the querying process we are employing cannot be called reliable -- the sample size is too small, we are querying experts rather than end users, the participants were not chosen at

random from an homogeneous population, and the questions have not been thoroughly pre-tested. Nevertheless, we believe that it is better to ask your opinions than to pretend we already know all we need to. Querying panels of experts is a common practice when establishing standards for hard and soft technologies. If we all keep in mind the limitations of the methodology and the vastly differing backgrounds we come from, perhaps we can educate each other.

Delphi studies have come under criticism recently in a report by Harold Sackman of the Rand Corporation (Delphi Assessment: Expert Opinion, Forecasting, and Group Process, H. Sackman, The Rand Corporation R-1283-PR, April 1974, 117 pp.). We are attempting to obviate some of his objections to Delphi. He objects to the estimating of future dates, which we are not attempting to do. He argues that the anonymity of participants leads to a lack of responsibility -- we plan to summarize where possible, but not to guarantee anonymity. He objects to lack of supportive reasoning behind predictions, so we plan to ferret out the reasoning of each participant regarding the more significant questions. While we are hoping for consensus, we do not plan to punish outliers, and instead plan to bring their arguments to the attention of all so that the most persuasive reasoning can prevail.

Feel free to challenge us on the methodology. If you think the profiles are a waste of time, tell us. If you think they could be revised to really get at the essence of military instruction, revise them or make up your own. If you think questions are unclear, ambiguous, or too "lumpy", please suggest revisions. The second round will cover terminal input/output features, but the third round will return to the topics covered in round one. It will be as exciting as the responses you are about to send us can make it.

Appendix II.B.2

SCENARIOS

ONE:

Seaman Jones checks into his local CAIFAC (Computer Assisted Instruction Facility) for a lesson on the Mark IV, Mod 2, Radar Repeater. Jones is a striker for ET3 (i.e. he is trying to make the rating of Electronics Technician Third Class) and he is preparing for the ET3 Rating Exam.

After showing his pass to the guard to ensure that he has the required security clearance, Jones goes to the nearest available terminal and logs into the ET3 course. He selects lesson 21 from the menu. The introduction to the lesson informs him that he will need a mockup of the radar repeater for this lesson. Jones goes to the instructional equipment area, finds the mockup on a rolling cart, and takes it back to the terminal. Jones then proceeds with the lesson.

TWO:

Journalist Second Class (JO2) Bill Brown is studying for the advanced rating exam, the JO1/JOC exam. He has logged onto the CAI system aboard the USS CONSTELLATION (CVA-64), an aircraft carrier currently on station in the Western Pacific.

JO2 Brown is currently reviewing newspaper editing procedures and has been presented with a diagnostic test on photo layout. This test presents him with a story title and a number of photographs. Brown's job is to indicate the way he would crop (cut and trim) the photos, the captions or cutlines he would write for each photo, and how he would arrange the photos and copy blocks (captions or cutlines) on a standard sized newspaper page.

Brown will be using both the light-pen to indicate cropping and layout and the keyboard for entering caption text. This lesson is the sixteenth in the preparatory course for the JO1/JOC Exam and Brown has also completed the JO3/JO2 course (35 lessons) as well as a special short course on photojournalism (10 lessons).

THREE:

The Education Services Officer at Clark AFB, Philippines, is reviewing the training records of the men at his command. From this review he must determine what advancement examinations to requisition from Training Command Headquarters. This review is relatively simple, since most of the courses have been CAI and records have been automatically maintained. The ESO can obtain a printout of these records in a variety of formats by using an author level program which he learned in a CAI course.

After reviewing the records, the ESO can also have notices for all the men automatically prepared informing them that their rating exam has been ordered. In any case the CAI system will automatically record a notice for each student informing him that his records have been reviewed, which records were reviewed, when, and by whom.

FOUR:

Lieutenant Williams is updating a CAI course on Japan for personnel who are being transferred to Japan. In this course the student is introduced to the history, culture, and customs of the Japanese. The student is also given information specifically relevant to the conduct of American armed forces personnel in Japan. This information ranges from status of forces agreement information to sensitive topics such as nuclear power and weapons.

Several thousand personnel ranging from recruits just out of basic training to field grade officers (up to Colonel) take this course or particular lessons from it each year and, it is available at all commands and installations throughout the world. Some of the information changes frequently and the course has to be updated semi-annually. Once Lieutenant Williams finishes updating the course materials in the courseware at the origination point, all future students receive the updated version of the course.

FIVE:

Airman Farrel has just reported, along with the other new men in his squadron, to the Base Firefighting School. After checking into the school, the men are sent to the CAI Terminal Room. A sergeant there gives the men a half-hour lecture with platform demonstration on the use of the CAI terminal. The men then go to individual carrells where they begin the first of three half-hour lessons on firefighting. They will receive lesson two day after tomorrow and lesson three two days after that. Few if any of the men have ever seen a CAI terminal, so the sergeant and several of his assistants wander about the room providing individual assistance.

SIX:

Technical Sergeant Maxwell Denver had just begun the third phase of his training on the ARC 23 Mod 6 Mark XV SSB FSK Teletype. He had been working on the ARC 23 frequency standard and is now about to start the trouble shooting procedures for the emitter follower in the first stage of the demodulator.

He begins by taking the pretest module, and being assigned a PC board mockup which he plugs into his test stand. (Two modules earlier he learned the peculiarities of the extenders and their test points, and he is using the appropriate extender now.)

Denver will be told as he probes the circuit under test the appropriateness of the points he selects for viewing on his simulated oscilloscope. If he becomes lost in the hunt for the malfunction, he will be prompted and perhaps receive a short review of the basic principles he is using in solving the problem.

SEVEN:

Staff Sergeant James Kildaire is taking a special CAI course on emergency diagnostics as part of his paramedical training. He is proceeding through lesson 14 of the 30 lesson course. In this lesson he is given a list of symptoms for a patient in a combat situation which is also described. Sergeant Kildaire may ask for additional information about the patient which he would normally be able to obtain under the given conditions. Sergeant Kildaire must then enter his diagnosis of the patient's condition using standard medical terminology and suggest emergency treatment procedures.

In previous lessons he has then received advice from a medical officer with whom he was in radio contact. In this lesson, however, he is on his own. The CAI program accepts the Sergeant's treatment procedures and then informs the Sergeant of the effects on the patient. The Sergeant then recommends further treatment or calls in a medevac team. This dialogue is continued until the patient is evacuated or expires.

EIGHT:

Staff Sergeant Friendly is preparing a lesson on personnel record keeping in regard to PERSCOM FORM 362-A (REV 1/9/75). The individual serviceman's record of training is kept on this form which includes entries pertaining to military training courses, USAFI courses, and courses completed in civilian schools as part of the serviceman's career enhancement program.

Sergeant Friendly wants to use Computer Assisted Instruction so that he can present a variety of examples that illustrate the basic categories of entries to be made on this form. In CAI he can occasionally check to see if the student has grasped the basic category. If the student has, the CAI can advance him to another category; if not,the student can be given remediation until he understands the category.

At the same time, Sergeant Friendly wants to give the student practice in actually making the entries on the form. The sergeant cannot decide how best to do this.

NINE:

LCDR Moore, the navigator aboard the Polaris submarine USS GEORGE WASHINGTON, has just been relieved as Officer of the Deck on the second dog watch. After stopping by the galley for a fresh cup of coffee, LCDR Moore goes to the Communications Room. A

special stand-alone CAI terminal is kept in the Comm spaces for top secret work, since the Comm spaces are among the most higly secured areas of the submarine. The terminal is one of the new stand-alone types developed for use aboard Polaris submarines which must maintain tight two-way communication silence during patrols.

LCDR Moore checks out a CAI pack from the duty Classified Materials Control Officer and takes the pack to the terminal. Moore plugs the pack in and keys in his personal student combination on the terminal to log in and activate the courseware.

This is the twelfth in a series of thirty lessons on combat command. In this lesson LCDR Moore has command of the submarine during a simulated hunter-killer operation. He will encounter an enemy submarine of the same type and engage the enemy in combat. In his first such simulated engagement, LCDR Moore lost his submarine in the first five minutes of battle. But he has improved through the tutoring of the CAI system and got a rating of 750 out of 1000 on his last engagement.

Appendix II.C.1
SPECIAL LETTER TO MILITARY PARTICIPANTS

[Name of participant]
[Address of participant]

Dear [Title and last name]:

It has been brought to our attention by the University's Office of Contracts and Grants that we are restricted from reimbursing government personnel for services out of funds from our government contract. Consequently, we will not be able to send you twenty-five dollars for responding to the second round of the CAI/CMI study. If you have already responded to the second round, thank you. In the event you have not, we hope that you will respond promptly in any case.

Sincerely,

/s/Monty C. Stanford

for/ Bill Mann, ISI

Rick Carlson, ASC

Tom Martin, ASC

Monty Stanford, ASC

Appendix III.A

ROUND ONE QUESTIONNAIRE

You, the experts, have general attitudes that will be contributing to your specific responses throughout the study. We need to find out what those attitudes are so we can find a common ground if one exists, or at least can better understand your responses. The following trade-off questions attempt to tap those attitudes. Place an "x" next to the alternative that best characterizes your opinion and check marks next to the other alternatives you would be willing to accept for purposes of consensus. If there are other trade-off questions we should have asked, feel free to suggest them. Write us explanations if you think it might help. Remember that the context is military CAI/CMI.

1. The user interface should be

   a) _____ easy to use (even if this means limiting system capability)

   b) _____ powerful (even if this makes it hard to use)

2. The terminal should be

   a) _____ usable for a wide range of tasks (text-editing, programming, etc.)

   b) _____ intended specifically for CAI/CMI

3. The system should

   a) _____ adjust to the user (even if this is expensive computerwise)

   b) _____ have the user adjust to it (even if this is expensive humanwise)

4. The user interface should be primarily

   a) _____ built into the hardware

   b) _____ located in the software

5. The system should be

   a) _____ innovative (even if it sometimes doesn't work)

   b) _____ reliable (even at the expense of discouraging innovation)

6. The terminal/computer resource(s) should be

   a) _____ stand-alone

   b) _____ time-shared

7. The design philosophy should be oriented toward

a) _____ maximizing benefits (even where costs are high)

b) _____ minimizing costs (even where benefits are slight)

The next fifteen questions deal with ranges of users, tasks, and learning environments. Once again place an "x" next to the alternative that best characterizes your opinion and a check mark next to alternatives you will accept for purposes of consensus. We have asked you to try to explain what you think each question is getting at and how you would like subsequent rounds to probe in greater depth. Feel free to write on the backs of pages or to enclose additional pages.

8. The terminal should be locatable

   a) _____ in the user's preferred environment
      (even if help is not readily available)

   b) _____ only where help is readily available
      (even if this is not the user's preferred
      environment)

9. Military personnel vary greatly in their intellectual abilities. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

   a) _____ the total range of user intellectual competencies

   b) _____ the more intelligent users

   c) _____ users of average intelligence

10. Military personnel vary greatly in their motivation to learn. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

   a) _____ the total range of user motivations

   b) _____ the more motivated users

c) _____ users of average motivation

11. User interfaces are needed for many aspects of CAI/CMI activity. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of system activities

b) _____ primarily courseware development

c) _____ primarily research into CAI/CMI usage

d) _____ primarily student learning

12. Computerized systems vary greatly in the portion of the teaching load that they carry. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of CAI/CMI

b) _____ primarily CAI (Where they carry most of the load)

c) _____ primarily CMI (Where they carry only part of the load)

13. Military training courses vary greatly in the time it takes for students to complete them. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of course durations

b) _____ those requiring a week or more

c) _____ those requiring less than a week

14. Military training tasks vary greatly in the degree to which they have security clearance requirements. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

    a) _____ the total range of security clearances

    b) _____ where the material is unclassified

    c) _____ where the material is classified below secret

15. Military training tasks vary greatly in the need for spontaneous, free-form student responses. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

    a) _____ the total range of user responses

    b) _____ those where spontaneous, free-form responses are important

    c) _____ those where spontaneous, free-form responses are not important

16. Military training tasks vary greatly in the need for non-canned, student-tailored courseware. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

    a) _____ the total range of student-tailored courseware

    b) _____ those where non-canned, student-tailored courseware is important

c) _____ those where non-canned, student-tailored courseware is not important

17. Military training tasks vary greatly in the need for realistic visuals (color, three-dimensions, shading, movement). Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of visuals

b) _____ where realistic visuals are important

c) _____ where realistic visuals are not important

18. Military training environments vary greatly in the accessability of an instructor. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of instructor accessibility

b) _____ where instructors are not readily available

c) _____ where instructors are readily available

19. Military training environments vary greatly in the accessability of a power supply. Five to ten yers from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of power accessability

b) _____ where the power supply must be contained in the terminal

c) _____ where the power supply is available outside the terminal

20. Military training environments vary greatly in the accessability of communication bandwidth (via lines or broadcast frequencies). Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of bandwidth accessability

b) _____ where no outside communication is possible

c) _____ where narrow-band (voice-grade telephone) communication is possible

d) _____ where broad-band (cable-television) communication is possible

21. Military training environments vary greatly in the need for lightweight equipment. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of terminal weights

b) _____ where the terminal weighs less than thirty pounds

c) _____ where the terminal weighs thirty pounds or more

22. Military training environments vary greatly in the duration

of an average learning session. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of learning session durations

b) _____ where the learning session lasts less than an hour

c) _____ where the learning session lasts an hour or more

23. Miiitary training environments vary greatly in the grouping of students. Five to ten years from now (1980-1985), the greatest payoff will come from user interfaces intended for

a) _____ the total range of student groupings

b) _____ where students are in close proximity

c) _____ where students are not in close proximity

Appendix III.B

SUMMARY OF ROUND ONE

So far sixteen of the twenty-five questionnaires have been returned. Eight of the twenty-three questions reflect consensus, i.e., a single alternative receiving a preponderance of the x's and checks. These are represented below with the favored alternative first, the second-most favored alternative last, and the response tally in the middle. A vote of (10+1 vs 0+2) means that the favored alternative received ten x's and one check while the second-most favored alternative received two checks. The eight points of consensus are:

1a; easy to use (10+1 vs 1+1) powerful

3a; adjust to user (11+2 vs 1+0) user adjust

5b; reliable (9+4 vs 2+0) innovative

7a; maximize benefits (8+1 vs 3+1) minimize costs

8a; in user's preferred environment (11+1 vs 3+1)
where help is available

11d; primarily student learning (12+0 vs 3+4)
range of research, coursewriting, and learning

13a; range of course durations (10+0 vs 3+0)
duration less than a week

18b; where instructors are not readily available
(10+1 vs 3+7) range of instructor availability

For eight of the questions, opinions were split between a choice of the total range of something and a single one of the alternatives. Theses are represented below with the range first, the single alternative last, and the response tally in the middle.

9; user intellectual competency range (11+2 vs 4+4)
average intelligence

10; user motivation range (7+2 vs 4+5) average
motivation

14; security clearance range (7+2 vs 5+1) unclassified

15; spontaneous, free-form response range (8+5 vs 6+1)
is unimportant

16; non-canned, student-tailored courseware range
(8+4 vs 8+2) is important

17; realistic visuals range (7+4 vs 4+3) is important

19; location of power supply range (5+2 vs 7+0)
outside terminal

22; length of learning session range (7+2 vs 7+1) less
than an hour

For seven of the questions, no pattern of responses emerged. The tallies and comments for separate items follow.

General comments and contributor:

"I continue to be totally mystified by this project. The kind of information that seems to interest you is worthless for planning purposes Maybe your second round (terminal I/O features) will be more meaningful, but i rather expect questions such as "which is more important, local editing or graphics?" Not that I don't think that reasonable questions could be constructed--I just think you are trying something that is literally impossible, in the same sense as violating the second law of thermodynamics." (Sherwood)

"I'd prefer that we not use the word terminal, particularly as it could mean a stand-alone system--why not display?" (Bork)

"The function of the scenarios is not clear" (Wexler)

The following entries will deal individually with each first round question and the responses:

****Question One: The user interface should be a) easy to use(even if this means limiting system capability)--10"x", 1 check--- b) powerful (even if this makes it hard to use) 1"x", 1 check---

COMMENTS: Neither (a or b)- the interface must be so powerful that it is easy to use.(Sherwood) "If not easy to use, then at least each activity should be self-evident in context. The terminal must not interfer with learning."

"These alternatives are not incompatible. (Dean) Current software developments permit both types of user interface to be supported by a single system. False dichotomy. (Ford)

"but more power can be "uncovered"when needed." (Zinn)

****Question two: The terminal should be
a) usable for a wide range of tasks (text-editing, programming, etc.) 8"x", 0 checks--
b) intended specifically for CAI/CMI. 5"x", 2 checks--

COMMENTS: "The cost benefits of volume production are well known. Terminals should not be exclusive military devices." (Dean)

****Question three: The system should
a) adjust to the user(even if this is expensive computer wise) 11"x" , 2 checks--- b) have the user adjust to it (even if this is expensive humanwise) 1"x", 0 checks---

COMMENT: All systems are adjusted to users and users must adjust

themselves to all systems. The question should be one of determining tradeoffs for specific situations. (Ford)

****Question four: The user interface should be primarily
a) built into the hardware 5"x", 1 check--- b) located in the software 5"x", 2 check---
COMMENTS: "Both about equally-else an imbalanced design" (Sherwood)

"Question really is one of engineering design. I suspect that technology will force the answer. (Dean)

"This requires a technical background I don't care where it is located as long as it works." (Hall)

"a-When economics are sure to be realized b-Where flexibility should be maintained" (Zinn)

****Question five: The system should be
a) innovative (even if it sometimes doesn't work) 2"x", 0 checks--- b) reliable (even at the expense of discouraging innovation) 9"x", 4 checks---
COMMENTS: "These and similar questions are meaningless. Any real-life implementation must strike a balance, and it is not possible even to give an inclination in one direction or another." (Sherwood)

"Innovative during development phases , but reliable when it is put into operations with students." (Hall)

"Quite important (reliability) in operational setting. usually is first question asked by military, justifiable or not." (Nawrocki)

"Both- I don't see these as either/or questions. This is like asking if you like apples or oranges." (Bork)

****Question six: The terminal/computer resource(s) should be
a) stand alone 7"x", 3 checks-- b) time-shared 6"x", 3 checks
COMMENTS: a-Where logistics demand it, b-for maximum cost effectiveness where possible(Dean) "for CAI/CMI activities-time shared among CAI/CMI users, but not with administrative functions." (Hall)

"former easier to implement given current military structure and preferences, though latter may be preferable to reduce inter/intra service redundancy." (Nawrocki)

"Most of the time, (stand alone) but with possible access to a large computer occasionally for computation or large data base." (answered reluctantly perhaps, but I am thinking of 10 years from now.) (nawrocki)

"A blanket recommendation is not possible." (Ford)

****Question seven: The design philosophy should be oriented toward
a) maximizing benefits(even where costs are high) 8"x", 1 check-- b) minimizing costs (even where benefits are slight) 3"x" , 1 check--
any real-life implementation must strike

"latter better until benefits can be determined accurately."

"Some suitable mix." (Bork)

"The intent will always be to maximize certain benefits and to minimize certain costs. Again, requires situation specific tradeoffs. (Ford)

****Question eight: The terminal should be locatable
a) in the user's preferred environment(even if help is not readily available) 11"x", 1 check--- b) only where help is readily available (even if this is not the user's preferred environment) 3"x", 1 check
COMMENTS: "except for initial aid, the device and the programs can be made to work well with no "help"." (Bork)

****Question nine Military personnel vary greatly in their intellectual abilities. Five to ten years from now, the greatest payoff will come from user interface intended for:
a)the total range of user intellectual competencies--11"x", 2 checks-- b)the more intelligent users--0"x", 1 check c)users of average intelligence--4"x", 4 checks
COMMENTS: "This is basically a question of vocation vs decision skills. Both are necessary for maximum benefit, but early emphasis will be on vocation." (Nawrocki) "Computer materials can and should be adaptable to a wide audience." (Bork)

"I take payoff to mean a favorable comparison of total 'costs' between using skilled human teachers(if available) vs. placing major emphasis on CAI/CMI in the following kind of situation: it is necessary to train a single person to a specific level of familiarity or expertise in a subject or on an instrument and this is to be done within a prescribed amount of (real) time. (not in the flavor of your scenario). The time and proficiency constraints are to be jointly satisfied". (Wexler)

"most desirable features of terminals seem to serve both b and c." (Zinn)

****Question ten: Military personnel vary greatly in their motivation to learn. Five to ten years from now, the greatest payoff will come from interfaces intended for:

a)the total range of user motivations-7"x", 2 checks b)the more motivated users-2"x", 0 checks c)users of average motivation--4"x", 5 checks

COMMENTS: "Instruction s/b written to motivate the user." (Weike-Glasser-Miller)

"Motivation may be an irrelevant question in military environments." (Nawrocki)

"The highly motivated individual can learn in a wide variety of ways--real learning problems come from those not so motivated." (Bork)

"The less well motivated." (Anastasio)

****Question eleven: User interfaces are needed for many aspects of CAI/CMI activity. ...The greatest payoff will come from user interfaces intended for:

a)the total range of system activities-3"x",4checks b)primarily courseware development-0"x",2checks c)primarily research into CAI/CMI usages 1"x", 1 check d)primarily student learning--12"x",0checks

COMMENTS: "tricky question to answer. Interpreted this in terms of ultimate goal, though student learning will not be significant without others." (Nawrocki)

"small number of terminals of special design(if necessary) could serve b and c---(Zinn)

****Question twelve: Computerized systems vary greatly in the portion of the teaching load that they carry. ...the greatest payoff will come from user interfaces intended for:

a)the total range of CAI/CMI-8"x",3 checks b)primarily CAI(Where they carry most of the load) 4"x", 2 checks c)primarily CMI(Where they carry only part of the load) 4"x",2 checks

COMMENTS: "I don't like this, but it seems to be the case. CAI likely to be relatively limited to material requiring simulation/gaming, but still hard to say with any certainty." (Nawrocki)

"I regard this as a partially artificial distinction, reflecting our current relatively primitive abilities." (Bork)

****Question Thirteen: Military training courses vary greatly in the time it takes for students to complete them. ...the greatest payoff will come from user interfaces intended for:

a)the total range of course durations 10"x", 0 checks b)those requiring a week or more-0"x", 1 check c)those requiring less than a week--3"x", 0 checks

COMMENTS: "for modules of courses requiring 20 hours or less of study-our research indicates that 20 hours is maximum for study length."(Dean) "What is magical about a week?"(Bork)

"user interfaces should respond to rather than determine the aspects I have not marked, e.g. if training of short duration is better tailored to trainee then terminal should be portable, etc. (no responses given) (Zinn)

****Question fourteen: Military training tasks vary greatly in the degree to which they have security clearance requirements...the greatest payoff will come from user interfaces intended for

a)the total range of security clearances 7"x", 2 check b)where the material is unclassified 5"x", 1 check c)where the material is classified below secret--0 "x",2 checks

COMMENTS: "b-Classified material would be a management problem." (Weike-Glasser-Miller)

"Mostly because much equipment and info referred to will be classified to some extent."(response a"x") (Nawrocki)

"Why is it an issue? Is the worry that that the system might not be secure?"(Bork)

"If classified material should be handled in automated system, then terminal can designed accordingly to assure security(no response indicated) (Zinn)

****Question fifteen: Military training tasks vary greatly in the need for spontaneous free-form student responses. ...the greatest payoff will come from user interfaces intended for: a)the total range of user responses-8"x" 5 checks b)those where spontaneous, free-form responses are important-2"x", 2 checks c)those where spontaneous, free-form responses are not important--5"x", 1 check

COMMENTS: "Education should adapt to student, not vice versa." (Bork)

"Author of training material should not be constrained, but only advised of costs or other considerations which might favor less spontaneous response." (Zinn)

****Question sixteen: Military training tasks vary greatly in the need for non-canned , student tailored courseware. ...the greatest payoff will come from user interfaces intended for:

a)the total range of student tailored courseware--8 "x",4 checks b)those where non-canned, student tailored courseware is important-8"x",2 check c)those where non-canned, student-tailored courseware is not important-0"x"0checks

COMMENTS: "I'm not certain I understand this. any good student-computer dialog should provide different experiences for different students." (Bork)

"Clarify 'non-canned' or replace."(Zinn)

****Question seventeen: Military training tasks vary greatly in the need for realistic visuals(color, three-dimensions, shading, movement). ...the greatest payoff will come from user interfaces intended for

a)the total range of visuals-7"x", 4 checks b)where realistic visuals are important 4 "x", 3checks c)where realistic visuals are not important 2 "x", 0checks

COMMENTS: "Who know where they are important yet my personal bias is that sophisticated interactive graphics directly on a terminal are a luxury with low general utility. Peripheral visuals are cheaper generally as effective." (Nawrocki)

"but perhaps experimental work here will show that not all of these are equally valuable." (Bork)

"sometimes line drawings(and animated drawings are more important than photos." (Zinn)

****Question eighteen: Military training environments vary greatly in the accessability of an instructor. ...the greatest payoff will come from user interfaces intended for:

a)the total range of instructor accessibility 3"x", 7 checks b)where instructors are not readily available--10"x", 1 check c)where instructors are readily available 3"x", 0 checks

COMMENTS: "note--Previous answer on this subject was based on the knowledge the present CAI systems require some mgt. Ideally future CAI systems will require far less management." (Weike-Glasser-Miller)

"Opinion; probably use of remote terminals will come into its own." (Nawrocki)

"c--computers may play lesser role."(Zinn)

****Question nineteen: Military training environments vary greatly in the accessability of a power supply, ...the greatest payoff will come from user interfaces intended for:

a)the total range of power accessability 5"x", 2 check b)where the power supply must be contained in the terminal--1"x", 1 check c)where the power supply is available outside the terminal-7"x", 0 checks

COMMENTS: "doubt this will be feasible in time period required-if so very high utility"(response c="x" b=check)--more than likely will emphasize option c with gradual use of option b.(as supplement not alternative)." (Nawrocki)

"in a true scale power will still make considerable demands." (Bork)

"training decision(no response indicated) (Zinn)

****Question twenty: Military training environments vary greatly in the accessability of communication bandwidths (via lines or broadcast frequencies). ...the greatest payoff will come from user interfaces intended for:

a)the total range of bandwidth accessability 6"x", 3 checks b)where no outside communication is possible 1"x", 2 checks c)where narrow-band(voice-grade telephone) communication is possible 2"x",4 checks d)where broad-band (cable-television) communication is possible-3"x",3 checks

COMMENTS: "this problem does not arise with stand alone systems, one of the reasons that such systems will be important in the future." (Bork)

"c-d "if economical, then interaction with instructors via cable may be preferable to computers." (Zinn)

****Question twenty-one: Military training environments vary greatly in the need for lightweight equipment. ...the greatest payoff will come from user interfaces intended for:

a)the total range of terminal weights 6"x", 2 checks b)where the terminal weights less than than thirty pounds--5"x", 4 checks c)where the terminal weighs thirty pounds or more--1"x", 2 checks

COMMENTS: "hard to imagine a terminal of any capacity weighing more than 30 lbs, ten years from now." (Dean)

"obviously a technological question. Weight important, but terminal effectiveness more important." (Nawrocki)

"not the most critical issue." (Bork)

"Portability is not yet an issue" (Anastasio)

****Question twenty-two: Military training environments vary greatly in the duration of an average learning session. ...the greatest payoff will come from user interfaces intended for:

a)the total range of learning session duration 7"x", 2 checks b)where the learning session lasts less than an hour-7"x", 1 checks c)where the learning session lasts an hour or more-1"x",0 checks

COMMENTS: "much more than an hour will bore or at least tire the student." (Weike-Glasser-Miller)

"1-2 hours max." (Dean) "clearly varies with content of course, need, etc. Not a particularly useful question."(Nawrocki)

"Training decision " (Zinn)

****Question twenty-three: Military training environments vary greatly in the grouping of students, ...the greatest payoff will come from user interfaces intended for:

a)the total range of student groupings 6"x", 1 check b)where students are in close proximity 4"x", 3 checks c)where students are not in close proximity -- 3"x", 2 checks

COMMENTS: "students should interact with terminals alone! should discuss course material with other students offline!"(Dean)

"strictly opinion, current thinking and planning tends to emphasize option b."(Nawrocki)

"small groups of 2-3 offer great advantages advantages for many types of work-student learn much from interacting with each other."(Bork)

Appendix III.C
ROUND TWO QUESTIONNAIRE

Hi, enclosed are the results of round one of the 1980- 1985 military CAI/CMI study and the questions for the second round. The response rate was over sixty percent (16 out of 25) and it took a long time for responses to trickle in. This time we plan to reward you (25 dollars) for responding promptly. (If you have not yet returned round one, you may want to do so now.)

Last time we told you that round two would get down to features. Instead we decided to use this round as a bridge between the first round and the features round. The questions fall into three groups-- Whether or not an investment in terminal development is likely to lead to the greatest payoff, preparations for round three feature identification questions and further probing of round one issues. We will get results to you as soon as responses have been collected and analyzed, and we strongly encourage you to be verbose in your responses. Remember that this is more a discussion to help you influence us than a reliable sampling of some homogeneous population.

1. Do you think that an investment in the development of new terminals for CAI/CMI will have a significant payoff? What are some of the reasons underlying your opinion?

2. Do you think that five to ten years from now the mainstream terminal vendors will be responsive to the needs of the military CAI/CMI users (assuming no concerted push by the military)? What terminal-related needs are likely to go unmet without a concerted push? What features do you think will be available by then?

3. It can be argued that factors unrelated to terminals are responsible for holding back the advancement of CAI/CMI. In what areas (other than terminal development) do you think that an R&D investment would more significantly advance the 1980-1985 state of the art in CAI/CMI? Why?

It is likely that the design specifications for CAI/CMI terminals resulting from this project will fall into a hierarchy. At the top level are components that can be incorporated at the time of procurement. At the bottom level are components that can be incorporated (plugged-in) by the end user. Components can be input devices, displays, storage media, or processors. In the next round we intend to find out your priorities regarding which components should be at which levels. Right now we need to find out a little about the top through bottom levels.

4. What components do you feel could be standard across all terminals? How strongly do you feel about each?

5. What components do you feel should be optional in which situations so that they can be added on by the end user. How strongly do you feel about each?

6. In anticipation of the next round, what specific components do you want us to ask about? Is there any other advice you want to give us?

As indicated in the summary of the first round, eight questions had responses balanced between a total range of something and a particular option. Two of the questions related to users of average intelligence and average motivation. We would like

to ask those questions again, reworded slightly, to be sure we are reading you correctly. Elaborate upon your answers if it will help.

7. While it is true that the total range of user intellectual capabilities must be considered when designing CAI/CMI user interfaces, do you agree that priority should be given to interfaces intended for users of average or below average intelligence? Why?

8. While it is true that the total range of user motivational levels must be considered when designing CAI/CMI user interfaces, do you agree that priority should be given to interfaces intended for users of average or below average motivation? Why?

9. What bottlenecks make it difficult for users of average or below average intelligence to use CAI/CMI today?

10. What bottlenecks make it difficult for users of average or below average motivation to use CAI/CMI today?

11. In operational terms, what does an "easy to use" terminal look like? (e.g., limited choice in options, lack of an alphanumeric keyboard, hardware to lock out features that aren't applicable).

As indicated in the summary of the first round, a number of the questions elicited consensus. The user interface should be reliable, be easy to use, adjust to the user, be in his preferred environment, and not be dependent upon readily available instructors. We need to draw out the implications that flow from these priorities and be certain we are reading you correctly. The questions will tackle acquisition of user interface skill and support backing up use of the interface. Elaborate upon your answers if it will help.

12. How much, when, and primarily from whom should the beginning user learn about the interface? (e.g.,live instructors, other users, remote consultants, software, written guides)

13. How much, when and primarily from whom should the experienced user learn about additional aspects of the interface?

14. What sorts of things should the system be able to take care of so that the user does not have to learn about them (e.g.,bad telephone connection, spelling errors, error recovery...)

15. When things are not functioning properly and the system cannot assist the user, who and what are the primary sources of support that the user can fall back on?

16. There was consensus that the greatest payoff will come from an emphasis upon student learning (rather than the total range of research, course writing, and learning). Are we at a stage where enough is known about course writing and learning so that reliable and effective courseware can be developed?

17. During the first round, a lot of questions about this versus that priority were asked. A number of you felt this was unfair, unnecessary, or could not be done. In this round we have continued extracting your priorities, preferences, and opinions about areas where payoffs are most likely. By now you probably have a personal set of the most central priorities when thinking about the 1980-85 military CAI/CMI user interface. What are they?

APPENDIX III.D
ROUND TWO SUMMARY

1. Do you think an investment in the development of new terminals for CAI/CMI will have a significant payoff? What are some of the reasons underlying your opinion?

COMMENT: Most respondents feel that an investment in terminal development will have a significant payoff (Bork, Ditzik, Giunti, Hall, Kimberlin, Rockway, Sherwood, Zinn). Reasoning varied, but the following comments are generally representative:

> Yes, but not just terminals -- also stand-alone systems with intelligence. Existing terminals have been designed primarily for the business market, so are not ideal for education. (Bork)

> Yes, if done right. First, in order to have a significant payoff the terminal must be general enough for university, public school, industrial, and military instruction. However, the entire CAI/CMI system must be applied in such a way not to discourage or threaten the instruction by its use. That is the system must be adjunct to the normal instruction not a mainline instructional system. Plus, the terminal itself must be designed from ground up incorporating established human factor requirements. (Ditzik)

> Yes, I do think an investment in the development of new terminals for CAI/CMI could have significant payoff. The major reason for this assumption is that there are many, particularly CAI type, applications for terminals with varying degrees of complexity. These could be designed to match the requirements of the particular learning tasks involved and the instructional strategies being implemented. For example, the current PLATO IV plasma panel is over-designed (and too expensive) for many of the applications for which it is being used. Much of the material being delivered is in a programmed instructional format with a multiple-choice type response. It would be much more economical to use a simple responder augmented by off-line adjunct materials. I accept the need for a family of terminals with each class being designed to meet a particular set of instructional requirements. Just how many classes should be considered and what their functional characteristics would be is a matter for a more detailed analysis. (Rockway)

COMMENT: Some respondents disagreed (Dean, Ford, Merrill, Ward), reasoning as follows:

> No, I believe that commercial vendors will develop competitive terminals in response to market forces. With possible exception of Plato, which is still unavailable, as far as image and audio are concerned no significant terminal has been developed except by industry. (Dean)

> I think existing terminals can do far more than they are being required to do. In my view courseware design is far more crucial than design of a particular delivery system. (Merrill)

COMMENT: And two respondents were "lukewarm" about terminal development:

> Strikes me that the available terminals (current) are more than sufficient for CMI already and that the only additional technology with potential utility might be audio input/output communication. For CAI, major "need" would seem to be low cost sophisticated graphics terminal (3-D, color, etc.).. Also recognition of voice or written input might be worthwhile. The preceding, plus increased portability would seem to have highest payoff potential based on user "complaints" and to a lesser extent, current data on learning processes and man-machine communication. (Nawrocki)

> The PLATO group did tinker and did come up with an interesting terminal configuration (although they have yet to meet their original cost projections). You ask if similar developments are likely to occur in the near future (1980-5). In thinking about the phrase "significant payoff" I find my response to be a lukewarm "maybe." (Wexler)

2. Do you think that five to ten years from now the mainstream terminal vendors will be responsive to the needs of the military CAI/CMI users (assuming no concerted push by the military)? What terminal-related needs are likely to go unmet without a concerted push? What features do you think will be available by then?

Among the reasons mentioned were:

COMMENT: Most respondents feel vendors will not be responsive (7 NO, 1 YES, 3 NO(?), 3 YES(?). Military and civilian CAI/CMI needs are essentially similar (Bork, Ditzik, Ford). Neither market is large enough to influence vendors, who respond more to business applications of terminals (Bork, Hall, Zinn).

> Equipment manufacturers will not be responsive to the needs of military CAI/CMI users unless a concerted push is made. Their approach in the past has been to give educators the very best station that the bankers and airlines need for their applications and let the educators adjust their instructional materials to fit the existing hardware. The military has very specialized training requirements which must be met by a specially designed terminal, e.g., the display of electronic diagrams, symbols, mathematic equations, special symbols for physics, and chemistry. Terminals must be capable of displaying any material which can be printed on a page, display photographic materials under systems control, and play audio material under systems control. These needs are likely to go unmet because banks and airlines don't need them. Unless a concerted push is made it is likely that only the display of upper and lower case characters will be available with perhaps some very rudimentary microfiche retrieval procedures because bankers need that to check current balances before accepting personal checks. (Hall)

COMMENT: Furthermore, military CAI/CMI terminal needs are not well defined or expressed (Nawrocki, Ward). However, some respondents feel that a concerted push from the military could influence vendors (Bork, Ditzik, Rockway).

> Vendors will be responsive if there is an economic payoff. The military should continue to sponsor R and D to lower costs and must make volume purchases. Obviously, agreements and standardizations regarding military terminals could result in larger volume buys. (Rockway)

3. It can be argued that factors unrelated to terminals are responsible for holding back the advancement of CAI/CMI. In what areas (other than terminal development) do you think that an R and D investment would more significantly advance the 1980-1985 state of the art in CAI/CMI? Why?

COMMENT: Almost all respondents stressed need for performance demonstration of CAI/CMI and need for emphasis on the total learning environment. Many respondents noted that work on utilizing potential of CAI/CMI, especially interactive programs, and research on learning/instruction techniques are more important than R and D of terminals. Typical responses follow:

This was addressed in the Educom conference of several years ago, and discussed in the report of that conference. The single major factor, in my opinion, is the scarcity of good highly interactive learning programs, rewritten many times on the basis of extensive student use. Partially this is just a lack of experience -- we have much to learn about how to write very effective student -- computer dialogue, and this learning must involve not only research but considerable experience. Most of the current authors are still in a "textbook" mode, not exploiting the full capability of the media. Much additional work, too, is needed with authoring systems which ease the task of preparation of materials. (Bork)

My advice is "save your money" rather than R and D. I would like to see production experiments built around state of the art gear conducted. (Dean)

One of the biggest hurdles in advancing CAI/CMI is providing authoring procedures which are simplified yet powerful enough to allow very sophisticated instructional strategies to be employed by content specialists who are not high-powered programming specialists. A specialized authoring facility could be developed to generate input data which could then be compiled into the operating language of any operational CAI/CMI system. This would enhance the transportability of curriculum from one system to another. (Hall)

Courseware design, strategy, content analysis. In my view:Delivery system (terminal) modification makes the least difference to learning while modifications in strategy and content structure can make major differences. Far too much attention to the "cosmetics" of instruction. Far too little effort on the substance of instruction. (Merrill)

The broader application of CAI/CMI in the immediate future is largely dependent on successful (that it cost-effective) demonstrations. The longer

term success of the area would appear to depend on improvements in instructional technology as well as reductions in the cost of CAI/CMI hardware. On the instructional technology side, one of the major requirements is the improvement in instructional strategies to capitalize on the flexibility of computerized delivery systems. Another is to develop authoring aids to reduce the time and cost of course design and instructional materials development. However, even if no improvements were made in the current state-of-the-art of instructional technology, simply lowering the cost of CAI/CMI systems to make them competitive with conventional techniques would do as much as anything to expand applications. (Rockway)

R and D funding might better be directed towards the development of "intelligent" teaching systems for both students and teachers.

From the point of view of a student working in a conventional CAI/CMI environment there simply is not the richness or flexibility that arises in a live human teaching environment. The type of adaptation exhibited by a teacher who notices the pattern of a student's responses and utterances, and then proceeds to make appropriate alterations in a curriculum sequence is only clumsily replicated. This lack of response options obviously arises from the difficulty (impossibility) of foreseeing or pursuing all the threads emanating from a standard curriculum strand. Perhaps one way to improve the situation is to provide the course author/teacher with an "intelligent teacher's aid."

The situation might be imagined where a teacher preparing a course can turn to a nearby aid and remark that "this material involves concepts C1, C2....and has features F1, F2,..... and is in the following general relationships with what has and will be covered R1, R2,.... The aid might also ask questions when something unusual appeared such as: did you really mean to associate those concepts? Are not these features incompatible? Is not this combination of relationships curious? etc. Then let the teacher leave and let the teaching aid assume the responsibility of interacting with a student when difficulties arise in accordance with the directives and associations supplied by the teacher. Thus the aid should make strategic (and "intelligent") use of the (possibly loose) information provided by the teacher. It may simplify course preparation and expand the range of treatable situations. (The above description is awkward and needs refining but hopefully indicates the trend of my thoughts.) (Wexler)

Some other possibilities, but probably wouldn't do any more than very significant developments in terminals, since the interface with the user affects all components: Instructional science, particularly to make better use of the dynamic nature of the computer-based training system, including attention to the development of learning, self-testing and other skills in the learner.

Prescriptions for effective training materials, in order that the first draft can come closer to the final product (cost savings, primarily)

Incorporation of training into performance systems, including use of simulations for practice (what degree of abstraction, fidelity, tutoring, etc,?) and monitors of performance in actual operating systems. (Zinn)

4. What components do you feel could be standard across all terminals? How strongly do you feel about each?

COMMENT : Numbers of responses follow each feature.
CRT Display -- 2
Graphic Display -- 4
Still Images -- 5
Hardcopy Output -- 2
Interface to Equipment -- 2
Keyboard -- 7
Pointing Input -- 5
Stored Audio Output -- 4

The standard basic terminal should provide the following features: Display of any material capable of being presented on a standard textbook page which includes use defined graphics and special characters, keyboard input, light pen or touch sensitive input, random access photographic image retrieval and display, and random access audio retrieval and display. I would not tolerate any deviation on having these facilities available at each station. Making them a requirement on all stations has two advantages: (1) it encourages authors to develop more sophisticated and richer instructional materials because the facilities are there. (2) Because they are available at each station they are less expensive than if they were produced in smaller quantities. (Hall)

I don't favor plug-in media -- things tend to be written primarily for minimal system, so most programs would not use such plug-in facilities. Simple graphic input should be standard (like that in TEK 4010s) (Bork)

5. What components do you feel should be optional in which situations so that they can be added on by the end user. How strongly do you feel about each?

COMMENT: Numbers of responses follow each feature.

Still Images -- 2
Hardcopy Output -- 3
Stored Audio Output -- 2
Interface to Equipment -- 6
Videotape -- 3
Large Area Screens -- 3
Pointing Input -- 5
Audio Input -- 5
Special Keyboards -- 2
Computing Power -- 2

6. In anticipation of the next round, what specific components do you want us to ask about? Is there any other advice you want to give us?

COMMENT: Most comments were similar to Hall's.

> I would hope that the next round of questions would include each of the components that I mentioned as being requirements for each station to find out to what extent my opinions are held generally throughout the survey group. (Hall)

> Those I've already mentioned. Avoid "terminal" see if the word "military" makes any difference. (Bork)

Ask for specific types of terminal usage anticipated, extent of usage and groups using terminals asking about terminal components is wrong. You want to determine usage requirements for training, counseling, management, etc., and then develop a system which will meet those requirements. (Ford)

Ask about all. Perhaps you should ask for cost estimates in 1980-5 for individual components -- which might reflect their plausibility along with estimates on what will constitute a reasonable terminal cost at that time (in 1975 dollars?) (Wexler)

7. While it is true that the total range of user intellectual capabilities must be considered when designing CAI/CMI user interfaces, do you agree that priority should be given to interfaces intended for users of average or below average intelligence? Why?

COMMENT: Consensus was achieved (10 Yes, 3 No, 1 Other). Most comments were similar to Wexler's:

Yes, they will probably constitute the largest satisfiable group. I don't expect a great increase in the level of sophistication of interactive dialogues and I expect brighter students to realize that an alternative information source (e.g., a well-written book on the subject) may be a more efficient use of their time (although I expect them to be able to tolerate CAI/CMI). Thus the average or below average group may accept more readily the quality of instruction they receive. (Wexler)

Great consideration should be given to designing interface devices which are adapted to humans rather than forcing humans to adapt to the devices. Devices which are designed for individuals with below average intelligence can readily be used by individuals of normal intelligence but the reverse is not necessarily true. By designing for lower intelligence individuals the terminals will be available to a larger audience. This is especially important in the military where a broad spectrum of individual differences must be accommodated. (Hall)

No. Terminal should be flexible enough to be generally useful. The cliche (with a little data to support it) is that bright students learn no matter what the instructional treatment, but that average and below average students need special attention. However, this more a problem of courseware development and implementation priorities than of terminal design. (Ford.)

8. While it is true that the total range of user motivational levels must be considered when designing CAI/CMI user interfaces, do you agree that priority should be given to interfaces intended for users of average or below average motivation? Why?

COMMENT: Consensus was not achieved (6 Yes, 4 No, 3 Other). Representative responses follow:

Yes, the high motivation trainees will acquire information and skills by other means than through CAI and CMI. That is, computer assistance of this kind is less important for highly motivated trainees. Some skills practice which is particularly aided by computing (e.g., highly realistic simulations) may be important to all trainees, and particularly the motivated ones who may be expected to do especially well on the job. (Zinn)

Motivation is a bag of worms. Stay out of it in considering design of CAI/CMI user interfaces. Nobody knows what will work with a particular student under specified conditions at any particular time. (Ward)

No. See question 7. Motivation is not a simple trait -- different students are motivated by different treatments. Those students who are motivated by CAI/CMI should probably be given priority for using it. (Ford)

9. What bottlenecks make it difficult for users of average or below average intelligence to use CAI/CMI today?

COMMENT: Reliance on alphanumeric rather than graphics terminals and consequent emphasis on reading comprehension (Dean, Giunti, Kimberlin, Sherwood, Nawrocki). Poor courseware (Ditzik, Merrill, Sherwood). Poor learning environments (Bork, Hall, Rockway, Wexler, Zinn), e.g.,

The bottlenecks reside in our ignorance about what things are difficult and what things are easy for users of average or below average intelligence. (Ford)

Hardware and software unreliability, difficulty of use, and poor human engineering. (Rockway)

Keyboard arrangements not obvious to novice user of keyboards. Identification of function keys confusing to novice user. Terminals which lack effective pointing capability (light pen, cursor, etc.) Output devices (and displays) with limited character sets. Inconvenient editing facility for altering text before input (as answer or request) Frustration of slow displays and limited line length (and number of lines on screen) (Zinn)

10. What bottlenecks make it difficult for users of average or below average motivation to use CAI/CMI today?

COMMENT: Most respondents referred to response for question 9, or made similar comments. However, the concept of rewards for CAI/CMI experiences surfaced here:

Bottlenecks for average and below average motivated students are: A. Their lack of experience and training in a self-paced environment where the burden

is placed on them to teach themselves rather than to rely on a teacher to tell them what they should know. B. Their inability to relate current success to future tasks. C. The aloneness a student can feel in a self-paced class situation. D. The demotivating environment a military student might find outside the classroom. E. The possibility of an unwelcome assignment after the course is completed. (Kimberlin)

11. In operational terms, what does an "easy to use" terminal look like? (e.g., limited choice in options, lack of an alphanumeric keyboard, hardware to lock out features that aren't applicable).

No long arrays of mysterious buttons with cryptic labels. No visible controls which the user should not use. Off-on switch clearly visible. (Bork)

Not sure that this is a terminal question except that clutter should be avoided and operational features should be obvious to the user -- i.e., see a good office copier -- it is obvious how to use it. (Dean)

12. How much, when, and primarily from whom should the beginning user learn about the interface? (e.g., live instructors, other users, remote consultants, software, written guides.)

COMMENT: Primarily on-line, from the system itself (Ford, Hall, Kimberlin, Merrill, Nawrocki).

Best would be right from system itself (self-instruction) via terminal. All other options O.K., but only for special problems.(Nawrocki)

COMMENT: Primarily instructors, more experienced students, or off-line media (Bork, Giunti, Ward, Zinn)

I don't favor widespread use of instructors for this particular task. (Bork)

At the initial exposure, live instructors should provide as much instruction on interfaces as is required to make each student comfortable. (Giunti)

Live instructors or other users, primarily because this is the method they are familiar with. (Ward)

COMMENT: Both on-line and off-line instruction (Dean, Ditzik, Rockway, Sherwood, Wexler).

Absolute basics should be presented by a human, and additional instruction should be given by the device. (Sherwood)

Printed guides plus CAI at the terminal should satisfy most learning requirements. A human proctor or instructor should be available for consultation, either in person or via communication link. (Rockway)

13. How much, when and primarily from whom should the experienced user learn about additional aspects of the interface?

COMMENT: Most respondents indicated on-line helps, consultants, and/or off-line documentation.

From on-line and off-line documentation, and by on-line and off-line communication with experienced users. (Sherwood)

Manuals, perhaps video or slide-tape presentation, primarily. Often help (or a suggestion) may come from another user. For complex tasks, human aid (experienced colleague or a live instructor) is important. (Zinn)

14. What sorts of things should the system be able to take care of so that the user does not have to learn about them (e.g., bad telephone connection, spelling errors, error recovery.)

COMMENT: Respondents seemed to take the word "system" in this question to heart. For example,

The system should include all the resources (even human) to take care of the problems identified. (Rockway)

COMMENT: While most respondents seemed in basic agreement with Dr. Rockway, Dr. Wexler added some details:

The system should handle hardware errors and should indicate (e.g., by turning on a red light) that it is trying to do something. The light is turned off/to green when the difficulty is resolved. A prolonged red might lead a user to try the CONNECT - SIGN-ON - RESTART sequence. Softer errors remain in the user's baliwick (e.g., spelling, referencing an unknown file, etc), although the system should try to make plausible guesses about the user's intent and indicate its hypothesis prior to carrying out the action. (Wexler)

15. When things are not functioning properly and the system cannot assist the user, who and what are the primary sources of support that the user can fall back on?

COMMENT: Most respondents said support staff, as in the following comments:

A fall back program should consist of a prepared package of study guides and references that relate to each lesson or portion of the lesson that is on the computer. This may be considered redundant, but the same package along with the off-line material will be a self-paced course program that may serve after a student has left the school, or serve in those areas where a terminal is not available. The "who" may be several different people, depending upon the situation. In a unit, it may be a supervisor, peer, or in the worse case, the man may have to "dig" himself out. In a formal training environment, it will be the class instructor. (Kimberlin)

The system should have a manual backup in the form of instructor support and some conventional media to handle automated system failures. (Rockway)

When the terminal environment becomes a malfunctioning environment ("Your terminal is working, why isn't mine?") the normal sources of support would be:

1. A telephone call to the center (unanswered?)
2. Nearby users (unavailable?)
3. A written terminal guide. (Wexler)

This seems a training decision, not a hardware design consideration. But..... When the system fails it should recover as much as possible automatically, perhaps prompting the student for information needed to restart. When the system can't handle this but is still live, it should offer the trainee information which may be helpful for him to initiate recovery. When all else fails, a written guide of "What to do if....." should be handy to the terminal; in many cases it can get a user going again with minimum delay and embarrassment. Then human aid should be at hand when all else fails! (Zinn)

16. There was consensus that the greatest payoff will come from an emphasis upon student learning (Rather that the total range of research, course writing, and learning). Are we at a stage where enough is known about course writing and learning so that reliable and effective courseware can be developed?

COMMENT: No consensus was reached (8 Yes, 6 No). Representative responses follow:

No, much more study must be done in the areas of what is good material for CAI lesson, what are best strategies, what is best for different types of students, what authoring techniques in teams are most efficient and productive. This area has no firm data - everyone seems to do their own pet thing and ignore all other's efforts. (Giunti)

There is still a great deal that we need to know about course writing and learning so that reliable and effective course work can be developed. Perhaps one strategy of accomplishing this is to develop course material and then examine it carefully to see what features of it have contributed to the learning. Repertories of alternative procedures and techniques need to be developed and examined in view of learning difficulties encountered by students so that course material can be improved. (Hall)

If the other consultants think we are they are very naive as to what is known about instruction. I feel we have a tremendous amount left to learn We have just started to learn how to design courses, most are very weak. We have many more questions than answers. If someone thinks we know it all, I invite them to write for a list of questions I'd like answered. (Merrill)

Ha! Depends who you talk to! If we knew what was "effective" and for whom and under what conditions, could probably develop a major in "Educational Engineering"! Despite all the handbooks and texts, courseware development remains heavily intuitive. Dialogue systems where student selects instructional style and material (Socratic) will impact heavily on solving this problem. (Nawrocki)

I think so, although it is unlikely that good courseware can be proven to be good by actual measurement -- there are too many variables. (Sherwood)

Yes - especially in the sophisticated instructional development models used by the military. See Army Regulation 350-100-1 (1968 version) - Systems Engineering and Training for example. (Ward)

No, not in general, although some on-going projects may take exception. It is very well to specify a set of terminal behaviors in a course and then try to carefully structure the course to achieve them. However I seem to remain unimpressed with the quality of objectives or rather the "interpretations" that have been made of them. On the other hand, by a suitable redefinition of competency level, much existing courseware could certainly be deemed "reliable and effective." (Wexler)

17. During the first round, a lot of questions about this versus that priority were asked. A number of you felt this was unfair, unnecessary, or could not be done. In this round we have continued extracting your priorities, preferences, and opinions about areas where payoffs are most likely. By now you probably have a personal set of the most central priorities when thinking about the 1980-85 military CAI/CMI user interface. What are they?

COMMENT: Although most responses to this question repeated responses to previous questions, Giunti and Kimberlin emphasized transportability as a central priority:

I would also like to see a central point for preparation of common lesson material so that all Army CAI/CMI schools would teach or use identical programs for instruction. This would of course require a certain amount of commonality or transportability between systems. (Giunti)

Central priorities revolve around transportability of lesson material. I don't believe that CAI/CMI will really be able to grow into an accepted media unless we are able to reduce the cost. One way of course is to spread the cost over many students and this means distribution. Therefore, such items as language and terminal standardization will provide an early step down the road to transportability. (Kimberlin)

Appendix III.E
ROUND THREE QUESTIONNAIRE

Your
Name_____

Date_____

Please return to:

T. Martin or M. Stanford

Annenberg School of Communications

University of Southern California

Los Angeles, Ca. 90007

GENERAL QUESTIONS

A number of you remarked in your round two responses that you felt terminal-related problems were not the area where a concerted push by the military would result in the greatest payoff.

1. Considering the 1980-85 timeframe, how would you rank the following investment strategies in terms of their potential (1 = greatest potential, 4 = least potential) for advancing CAI/CMI state of the art?

invest in:

_____innovative CAI/CMI terminal technology
_____innovative CAI/CMI pedagogical software technology (see the pedagogical software needs table below)
_____innovative CAI/CMI coursewriting
_____large scale use of existing hardware, software, and courseware

A number of you indicated in your round two responses that you felt more could be gained by not distinguishing between civilian and military CAI/CMI terminal needs. Let's see if we can get consensus one way or another.

2. Do you think that it is in the best interests of advancing the CAI/CMI terminal state-of-the-art to combine civilian and military needs as opposed to focusing on just military or just civilian needs.

COMBINE _____ KEEP DISTINCT _____ OTHER _____

3. In what respects do you feel that 1980-85 military CAI/CMI terminals should differ from civilian ones? (You might want to refer to the table of terminal-related functional needs below.)

TERMINAL-RELATED QUESTIONS

4. In the responses to the second round, many features were mentioned as relevant to CAI/CMI. While it is natural to talk in terms of features, our terminal experts would much rather we pin you down on the functional needs underlying various types of features, leaving final feature specifications to them. Consequently, we have developed a list of functional needs. They are listed down the left side of the following table. For each functional need, we would like three pieces of information from you:

(1) do you think all CAI/CMI terminals should provide for the need?

++ definitely yes
+ would be nice
0 neutral
- probably not
-- definitely not
(put one of these five codes in each row of the ALL TERMINALS column.)

(2) assuming that not all terminals provide for the need, what special situations justify the putting together of special terminals? (put situation-justification explanations in relevant rows of the EXCEPTION column.)

(3) how would you restate the functional need in terms that get closer to what you perceive the real need to be? (put rewordings in each row of the REWORDED NEED column.)

Keep track of additional need categories that occur to you since questions 5 and 6 will ask for them.

TRANSIENT VISUAL OUTPUT

a. A variety of predefined symbol sets (3 or more) can be intermixed during display.

b. Special symbol sets are programmable when needed.

c. Simple straight line figures (involving few lines) can be generated.

d. Complex line figures (involving many lines) can be generated.

e. Complex figures (involving shading and texture) can be generated.

f. Displays may be generated in color.

g. Displays may be generated that contain as many as four thousand readable symbols.

h. Stored visuals (with resolution equal to that of a television screen) can be displayed.

i. Stored visuals (with resolution high enough for reading a picture of a college textbook page) can be displayed.

j. Moving visuals can be displayed at flicker-free speeds.

HARDCOPY VISUAL OUTPUT

k. Exact reproductions of screen images can be produced.

l. Alphanumeric text, using a single type font, can be printed.

TRANSIENT AUDIO OUTPUT

m. Computer-composed speech can be generated and transmitted to the user.

n. Pre-recorded audio output (equal in quality to AM music) can be transmitted to the user.

OTHER OUTPUT

o. Signals are available for controlling external equipment.

p. Lights under some keys on the keyboard can be turned on or off.

INPUT

q. Strings of alphanumeric characters can be typed in by the user.

r. Frequently invoked functions can be specified unambiguously by carrying out a single action.

s. Locations on the screen can be specified by touching or pointing.

t. Lines can be drawn on a two-dimensional surface.

u. A clearly spoken word chosen from a limited vocabulary (about 20 words at any one time) can be recognized about 90% of the time.

v. Signals that are equivalent to terminal-entered input can be received from devices plugged into the terminal.

OTHER TERMINAL FEATURES

w. The stand-alone terminal has sufficient processing capability to manage instruction 70% of the time

x. Digital and analog memory are available within the terminal.

5. Now that you have seen the twenty-four functions, what additional needs come to mind for which you strongly feel features should be standard across all terminals?

6. What additional features do you feel should be developed for special situations? Again we would appreciate situation-justification explanations.

PEDAGOGICAL SOFTWARE QUESTIONS

7. In the responses to the second round, many of you mentioned that there was a need for a more adaptive, intelligent interplay between student and courseware or teacher and coursewriter. Since there are so many things you might have had in mind, and since it appeared so frequently, we felt it was necessary to probe the area in greater depth. A list of software functional needs has been developed similar to the terminal functional needs list. This time we are asking for four pieces of information about each need:

(1) assuming that by 1980-85 it is possible, do you think all CAI/CMI systems should provide for the need?

++ definitely yes
+ would be nice
0 neutral
- probably not
-- definitely not
(put one of these five codes in each row of the ALL SYSTEMS column.)

(2) assuming that by 1980-85 it is possible, but that not all systems provide for the need, what special situations justify the putting together of special software? (put situation - justification explanations in relevant rows of the EXCEPTION column.)

(3) how would you restate the functional need in terms that get closer to what you perceive the real need (or needs) to be? (put rewordings in each row of the REWORDED NEED column.)

(4) how great a payoff do you anticipate from an investment now in software that will respond to the need by 1980-85?

++ very high payoff anticipated
+ high payoff
0 moderate payoff
- low payoff
-- no payoff anticipated

STUDENT-RELATED SOFTWARE

The system can synthesize:

a. Instructional sequences that are tailored to the abilities and/or weaknesses of individual students.

b. Problems and examples that respond to the interests of particular students.

c. Hints that reduce the difficulty of problems.

d. Summaries of a student's progress throughout the course.

The system can follow and respond meaningfully to:

e. Course-related problem-solving strategies (even though novel) employed by students.

f. Course-independent (but pedagogically relevant) problem-solving strategies employed by students.

g. Pauses due to a student's inability to decide what to do next.

h. Course-related questions or statements typed in by students

i. Course-independent (but pedagogically relevant) questions typed in by students.

j. Dialog cues (i.e., topic shifts, impatience, bewilderment, wandering attention).

TEACHER-RELATED SOFTWARE

The system can:

k. Derive course-related strategies from examples provided by the instructor.

l. Accumulate course-related concepts (with associated vocabulary) from examples provided by the instructor.

m. Contrast concept/strategy information with information about potential students, detect difficulties, and advise the instructor of the difficulties.

n. Discover patterns of course-related behavior and advise the instructor during the course.

8. Now that you have seen the fourteen software functions, what additional needs come to mind for which you strongly feel features should be standard across all systems?

9. What additional software features do you feel should be developed for special situations? Again we would appreciate situation - justification explanations.

Appendix III.F
ROUND THREE SUMMARY

1. Considering the 1980-85 time frame, how would you rank the following investment strategies in terms of their potential (1 = greatest potential, 4 = least potential) for advancing CAI/CMI state of the art?

Invest in:

111111222xx34	Innovative CAI/CMI pedagogical software technology
1111122223334	Innovative CAI/CMI coursewriting
1122x33444444	Innovative CAI/CMI terminal technology
22x3333344444	Large scale use of existing hardware software, and courseware

(x stands for an averaged rating of 2.5)

2. Do you think that it is in the best interests of advancing the CAI/CMI terminal state-of-the-art to combine civilian and military needs as opposed to focusing on just military or just civilian needs.

Combine --10-- Keep Distinct --0-- Other --2-- No Response --2--

(The two "other" responses indicated that needs could be combined except that in some situations special terminals would be needed. The comments have therefore been incorporated into the responses to question three.)

3. In what respects do you feel that 1980-85 military CAI/CMI terminals should differ from civilian ones?

No differences	4
No response	3
Rugged construction to enable use in hostile environments	5
Greater emphasis on nonverbal communication (ie. audio, video, graphics, non-keyboard input)	3
Greater need for stand-alone systems	1

4(1). Do you think all CAI/CMI terminals should provide for the following functional needs?

++ definitely yes (shown below as ☆)
+ would be nice
0 neutral
- probably not
-- definitely not (shown below as =)
no response (shown below as o)

[The sections below were reordered in an informal order of positiveness of response, for the participants' ease of reading, as shown.]

☆☆☆☆☆☆☆☆☆☆☆☆☆☆++	q. Strings of alphanumeric characters can be typed by the user.
☆☆☆☆☆☆☆☆☆☆☆☆☆++0	r. Frequently invoked functions can be specified unambiguously by carrying out a single action.
☆☆☆☆☆☆☆☆☆☆☆☆+++=	b. Special symbol sets are programmable when needed.
☆☆☆☆☆☆☆☆☆☆☆+++00=	a. A variety of predefined symbol sets (3 or more) can be intermixed during display.
☆☆☆☆☆☆☆☆☆☆☆+++o0=	c. Simple straight line figures (involving few lines) can be generated.
☆☆☆☆☆☆☆☆☆☆++++00-	o. Signals are available for controlling external equipment.
☆☆☆☆☆☆☆☆☆☆++++00-	s. Locations on the screen can be specified by touching or pointing.
☆☆☆☆☆☆++++++0--	v. Signals that are equivalent to terminal-enteredinput can be received from devices plugged into the terminal.

☆☆☆☆☆☆++++00=-	h. Stored visuals (with resolution equal to that of a television screen) can be displayed.
☆☆☆☆☆☆+++0--=	l. Alphanumeric text, using a single type font, can be printed.
☆☆☆++++++++00=	t. Lines can be drawn on a two-dimensional surface.
☆☆☆☆☆☆++++0--=	d. Complex line figures (involving many lines) can be generated.
☆☆☆☆☆++++++00-=	i. Stored visuals (with resolution high enough for reading a picture of a college textbook) can be displayed.
☆☆☆++++++0000-	w. The stand-alone terminal has sufficient processing capability to manage instruction 70% of the time.
☆☆☆☆++++++0--=	n. Pre-recorded audio output (equal in quality to AM music) can be transmitted to the user.
☆☆++++++++++0-=	j. Moving visuals can be displayed at flicker-free speeds.

☆☆++++++++000==	f. Displays can be generated in color.
☆+++++++o000--	m. Computer-composed speech can be generated and transmitted to the user.
☆☆☆+++o000----	p. Lights under some keys on the keyboard can be turned on or off.
☆++++++00000--	x. Digital and analog memory are available within the terminal.
☆☆☆++++++o0--==	k. Exact reproductions of screen images can be produced.

☆++++00000-===	e. Complex figures (involving shading and texture) can be generated.
+++++++00--===	u. A clearly spoken word chosen from a limited vocabulary (about 20 words at any one time) can be recognized about 90% of the time.
+++++0000--===	g. Displays can be generated that contain as many as four thousand readable symbols.

4(2,3) Questions regarding special situations justifying special terminals and restated functional needs.

Seven of the 14 respondents made no comments.
Of the remaining seven, two or more people made the same comment only three times.

Whether or not terminals or software systems should provide the features is an empirical question based on the feature's demonstrated instructional effectiveness (or lack thereof).
WARD, NAWROCKI

Primary need is for digital, not analog memory.
DEAN, DITZIK

Exact reproductions of screen images can be produced on demand at a single station within the terminal area to serve all users - but not on every terminal.
HALL, DITZIK, KIMBERLIN

5 and 6 -- Questions regarding additional needs and features.

Seven of the 14 respondents made no comments.
Of the remaining seven, in no case did two or more people suggest the same feature.

7(1). Do you think all CAI/CMI systems should provide for the following needs?

++ definitely yes (shown below as ☆)
+ would be nice
0 neutral
- probably not
-- definitely not (shown below as =)
no response (shown below as o)

[The sections below were reordered in an informal order of positiveness of response, for the participants' ease of reading, as shown.]

☆☆☆☆☆☆☆☆☆☆☆☆++oo a. Instructional sequences that are tailored to the abilities and/or weaknesses of individual students.

☆☆☆☆☆☆☆++++++oo b. Problems and examples that respond

to the interests of particular students.

*****+++++++++0 c. Hints that reduce the difficulties of problems.

********+++++0= d. Summaries of a student's progress throughout the course.

*****+++++++o0- m. Contrast concept/strategy information with information about potential students, detect difficulties, and advise the instructor of the difficulties.

*****+++++++o0- n. Discover patterns of course-related behavior and advise the instructor during the course.

*****++++++o00- e. Responsive to course-related problem-solving strategies (even though novel) employed by students.

*****++++++o00- k. Derive course-related strategies from examples provided by the instructor.

*****++++++00-- h. Respond to course-related questions or statements typed in by students.

*****+++++o000- l. Accumulate course-related concepts (with associated vocabulary) from examples provided by the instructor.

******+oo000000 g. Respond to pauses due to a student's inability to decide what to do next.

******+o0000- f. Respond to course-independent (but pedagogically relevant) problem-solving strategies employed by students.

********o0000= j. Respond to dialog cues (eg. topic shifts, impatience, bewilderment wandering attention).

*****o00000-= i. Respond to course-independent (but pedagogically relevant) questions typed in by students.

7(2 and 3) Questions regarding special systems justifying special software and restated functional needs.

Nine of the 14 made no comments.
None of the remaining 5 made equivalent comments.

7(4) Question regarding payoff ratings for software development.

Ratings in this column were for the most part identical to 7(1) ratings and so are not repeated here.

8 and 9 Questions regarding additional needs and additional software features.

Nine of the 14 made no comments.

Two of the remaining 5 mentioned that portability across systems is also highly desirable.

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