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ABSTRACT

Research and development efforts at the Florida State University Computer Assisted Instruction (CAI) Center have centered on four main areas: (1) computer systems development, (2) research, (3) instructional product development, and (4) instructional validation and service. Progress on Project THEMIS was made on developing learner strategies, training strategies, validation strategies, and computer systems strategies. Activity continued on the Wakulla County Computer-Related Instructional Technology project. A study was started on the systems factors and potentials of CAI. Work continued on a model for adaptive training via CAI, utilizing regression analysis techniques, and on learner control in automated instruction. CAI played a role in a curriculum revision project at the Center. An institute was held in computer-related multi-media instruction for administrators and faculty. A major reorganization of the Florida State University instructional support units had some effect on the CAI Center. Appendices list publications by staff and students at the Center, demonstration reports given, and the titles and status of current projects. (JY)

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CAI CENTER

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TECH REPORT

ANNUAL PROGRESS REPORT

January 1, 1969 through December 31, 1969

PREPARED BY

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INTRODUCTION

A yearly report can be approached in two manners. First, one can analyze and describe the mission and functions of the Florida State University Computer-Assisted Instruction group or, on the other hand, one can report on the projects that reflect the implementations and operations for attaining these goals. We decided to combine both approaches in preparing the 1969 annual report.

The report is divided into four major sections. Section I, (Mission) characterizes our overall activities by presenting four major functional domains being pursued by the Florida State University Computer-Assisted Instruction Center. Section II (Research Programs) describes our major research projects that reflect the research interests shared by ourselves and sponsoring agencies. They are as follows: A. Department of Defense, Office of Naval Research, Project THEMIS; B. Wakulla County Schools, United States Office of Education, Title III, Computer Applications within Public Schools; C. Naval Training Device Center, Computer Applications for Training Systems; D. National Science Foundation, Basic Research in Fostering a Theoretical and Empirical Basis for CAI Applications, and E. Development of a CAI Evaluation Paradigm. Section III (Training) reflects the considerable effort that has been put forth in the development of a graduate training program in computer-based "Educational Technology."

Section IV briefly describes the organization of the Florida State University's Division of Research and Services (DIRS), of which the CAI Center is an administrative component. This section also describes our organization and personnel.

A list of pilot projects and publications is provided in the appendices, to provide the reader with the sources for finding additional information about specific projects.

From its beginning some five years ago, the Florida State University CAI Center has focused primarily on research and development activities. Aside from the limited instructional service activities described in the DIRS section, the mission of the CAI Center is primarily concerned with R and D activities. We turn now to a more detailed description of the mission of the FSU-CAI Center.

I. MISSION OF THE FSU-CAI CENTER

In order to implement an effective approach to relating computers to excellence of instructional practice, four R and D efforts have been pursued at the FSU-CAI Center: (1) computer systems development, (2) research, (3) instructional product development, and (4) instructional validation and service. Within each of these areas the functional mission of the CAI Center will be delineated.

A. Computer Systems Development

Appropriate computer systems underlie any of the current and potential instructional and training uses of computers. A university R and D center desiring to utilize computers in a CAI mode must recognize that the technological basis of computers is continuously changing. Each six months brings a new array of computer components that can, in fact, drastically change the cost-effectiveness as well as the research potential of the possible computer configurations and available software. Our basic approach has consisted of working with small, dedicated CAI computing systems such as the IBM 1500 CAI system, or the DEC PDP/8 TSS system. Building on the existing available time-sharing operating systems, the preponderance of our efforts has gone into extending the research capability of these languages (COURSEWRITER, APL, BASIC, and FOCAL) as well as developing better data analysis procedures for both real time experimentation and statistical analysis. We anticipate continuing our efforts to expand the functional utility of our present 32 terminal system and expand via a new CAI computer system which will be a 64 terminal system.

B. Research

There is a recognized need to pursue research topics within CAI that will hopefully provide the following: (1) identification of those instructional processes and learning behaviors which are most efficiently optimized by computer support, (2) investigation of appropriate instructional strategies that implement optimal learning, (3) investigation of learner strategies as they are revealed within CAI training systems, and (4) investigation of the reliability, effectiveness, and validity of each new computer based instructional activity (e.g., computer-managed instruction).

Since research has been the primary focus of the FSU-CAI Center, the majority of this yearly report is devoted to brief descriptions of studies subsumed under each of these topic areas. It is our intention to continue this research program in that it has contributed substantially both to developments at FSU and, hopefully, to the broader research basis for educational technology throughout the United States.

C. Instructional Product Development

In terms of contributing to the resolution of current instructional problems, the vast majority of contributions have come through prototypic units created by the efforts of individual FSU faculty members who were building upon their competency in regard to computers. The CAI Center has recognized that many of its most significant activities over the past years have been in the area of development of new techniques for relating computers to instruction. For example, we have evolved a "Systems Approach" by which faculty members, graduate students, and supporting staff can work as project sub-teams in the generation of new CAI learning materials. We are presently investigating the developmental techniques for the appropriate

use of computer-managed instruction, especially in regard to diagnostic and prescriptive relationships. Even more importantly, individual faculty members have contributed significantly to the development of simulation and learning games that utilize computers in their execution. Thus, the CAI Center recognizes that the development of appropriate techniques and useful instructional curricular products to be utilized within the ongoing university courses is an essential and highly important activity.

D. Instructional Validation and Service

The FSU-CAI Center has come to recognize that computer instructional activities should be pursued over long periods of time in a service mode. Many of our new and most promising developments for the use of CAI terminated because of their cost or the priority problems found with the allocation of highly limited computer resources. We are optimistic that a better understanding of computer-managed instruction with embedded computer-based testing and remedial CAI applications may overcome many of these cost problems. It is, moreover, important to pursue our growing activities within the ongoing instructional services offered to the departments within our university. This service commitment extends beyond the university in that we have had active relationships with Florida A & M, Tallahassee Junior College, and public schools, such as Wakulla County. Thus, the role of service and continuous validation of the cost-effectiveness of CAI approaches to instructional processes is most important. It is an area within which we have made an even stronger commitment for the coming year.

II. RESEARCH PROGRAMS

A. Project THEMIS*

The Department of Defense awarded a university excellence grant to the FSU-CAI Center on July 1, 1968. The general goal of this grant is to provide facilities for both basic and applied research within the area of computer-assisted instruction. It has brought together ten professional faculty members from a variety of disciplines to work on mutual problems which focus on research and instructional use of computers. The organizing scheme that will be used to report progress on the THEMIS Project will be devoting one section to each of the following areas of investigation: learner strategies, training strategies, validation strategies, and computer systems strategies.

1. Learner Strategies

These basic research studies of learner strategies will be grouped as follows: (a) Information Structuring and Storage, (b) Subjective Organization, (c) Learning and Anxiety, (d) Learning of Graphic Materials, and (e) Inferential and Decision Processes.

*This research is supported by the Department of Defense and is administered and monitored through the Office of Naval Research. The contract number is N00014-68-A-0494.

a. Information Structuring and Storage. The research efforts that are currently being pursued within this area of CAI and learner strategies for information processing focus on intentional or selective forgetting processes. The design of the intentional forgetting tasks involves a situation where a student is instructed to forget information. Four studies completed in this area indicate that those information units presented immediately prior to the intentional forgetting instruction are most often deleted.

Our future efforts within the area of intentional forgetting will focus on the problems of testing for retention of information preceding a forget cue, and the degree to which the intentional forgetting process is related to both short term and long term retention processes.

b. Subjective Organization. The purpose of this investigation is to explore the effects of the organization upon learning rate and recall, and to determine how this behavioral process can be utilized to maximize instruction. The results of our pilot studies concerned with subjective organization suggest that students differ in the extent to which they organize material to be learned and that the student's subjective organization affects learning and retention.

Our research efforts have been concerned with an investigation of individual differences that are related to subjective organization. Response latencies and patterns of information retrieval have been employed to identify those individuals who easily and idiosyncratically organize learning material. The future research activities will be concerned with substantiating the preliminary results and establishing a reliable test that will validly identify the organizational aptitude.

c. Adaptive Processes and Anxiety Research. Our entry into the investigation of adaptive processes has been through an exploration of the effects of trait and state anxiety and how they affect performance in a CAI learning task. Four major studies document the effect of trait and state anxiety on learning. The results of these studies indicated (1) a relationship between trait-state anxiety and CAI performance, (2) a positive confirmation for trait-state anxiety theory in that it predicted the relationships between A-Trait, A-State, and errors, (3) a potential role for memory aids as facilitators of performance, and (4) a relationship between a student's subjective confidence estimates and his level of state anxiety.

This program of research will be extended in the next year in three directions. In the first study, the relationship between anxiety and implicit or overt responding to computer-assisted learning materials using graphics will be evaluated. In the second study, the relationship between anxiety and corrective feedback on achievement will be assessed. The third study will investigate techniques aimed at reducing anxiety and thereby improving performance. The importance of extending research in these directions relates to the need for testing both Drive Theory and Trait-State Anxiety Theory as theoretical explanations for a wide range of learning behaviors. In turn, the theories should suggest techniques to facilitate CAI training.

We also plan to extend this area of research by investigating other CAI based personality scales. Plans are to completely automate the administration, scoring, and interpretation of the Minnesota Multiphasic Personality Inventory (MMPI). The use of a computer to fulfill the functions of a skilled clinical psychologist with regard to the MMPI should begin to

relieve the critical shortage of skilled professionals in the area of personnel assessment. In addition the MMPI will provide assessment on other dimensions of adapting processes, thereby extending the scope of our investigation of adaptive processes.

d. Informational Processing of Graphic and Pictorial Presentations Under CAI. A theoretical framework for understanding the process by which a student processes graphic and pictorial presentations has remained one of the unexplored areas within the behavioral sciences. Given the great potential of the cathode-ray tube terminal for dynamic graphic presentations, it is obviously important to gain a better understanding of the variables that underlie the informational processing capabilities of a student for graphic presentations.

During 1969, the experimental context involved the learning and interpretation of flow charts or diagrammatic representations such as found in PERT (Programmed Evaluation and Review Technique). By conceiving a PERT network as an "information map", the graphic features can represent the varying properties of the conceptual relations by arrows, temporal relationships by time parameters, periodicity by feedback loops, and nested dependencies by multi-pathways. The investigations to date have yielded a number of important findings. First, prior instruction in the concepts and techniques for PERT network analysis did not appear to play a major role in analyzing PERT graphics and relating these to language units. Secondly, the number of bubbles (circles) in the network was not a critical variable within the experiments. Third, the number of concurrent interdependent pathways is a critical variable in determining performance. Our interpretation led us to postulate a simple "subject-predicate" relationship

analysis that could account for the results as well as confirm our conjectures about the close relationship between language analysis and graphic analysis. We plan to extend this study by having students construct sentences representative of path networks; appropriate psycho-linguistic analyses will be performed on these language protocols.

In regard to the role of graphics as conceptual organizers, we have prepared a set of graphic representations of significant concepts such as population changes during our century, or the ecology of transportation systems. We plan to study the power and adequacy of these graphic representations as a student attempts to match the appropriate key concepts with the graphics. As a second step in the proposed research development, we plan to explore the use of the dynamic graphic capability on the CRT terminal to allow the trainee to construct his own graphics. We hypothesize that such graphical creation may provide for better informational synthesis as well as better retention over long durations.

In regard to the relationship between pictorial and graphic presentation, we are presently attempting to develop a touch sensitive pictorial CAI terminal device (see Computer Systems Strategies, p. 21). When it is developed, we will be able to present pictorial material on this device as well as graphic material on an accompanying CRT device. We would propose to allow the student to construct graphic materials on the CRT device as representations of features from the pictorial presentation. Thus, the interactive responding with both sets of material hopefully will allow us to gain some initial insights into the students' interpretations of highly meaningful materials.

e. Complex Inferential and Decision Processes Within CAI: War gaming and tactical simulations are now considered an appropriate part of military training. The learner strategies as manifested in inferential behaviors as well as decision processes within these complex training simulations are still in need of investigation. Thus inferential and decision processes are considered a promising area of investigation which hopefully will contribute to our basic understanding of these war game situations.

The context for this investigation centers around the military history course within our FSU-ROTC program. The students are taught the principles of warfare as they are exemplified by a series of historical case studies. These students are instructed to rate battle commanders as to whether they observed or violated the nine principles of war. These nine principles of war have been recognized by the United States Army and are included in the Army's Field Service Regulations. The student, then, must identify the principles that have been violated and assess the extent to which the evidence supports this inference.

This line of research, hopefully, will permit us to explore the use of CAI to gain a greater understanding of decision processes, especially as these processes are sequentially organized. It is anticipated that our research will provide insight into the construction of better tactical simulations. We have accomplished the following: (1) The development of a CAI curriculum for the application of the nine principles of war, (2) the completion of an experiment which indicated: (a) the low impact of prior knowledge in military history, and (b) the importance of context analysis within decision processes for the application for the nine principles of

war, and (3) the establishment of a liaison with the FSU-ROTC unit for the development of tactical simulations based on CAI techniques.

In our future research efforts, we plan to develop graphics which will be used in conjunction with battlefield case studies within an experimental context. We also plan to utilize miniature information retrieval systems for investigating the information search which precedes decision making.

2. Training Strategies

Our investigations in the area of training strategies are directed toward the concepts and techniques of CAI that can be utilized in training systems. Investigators in the training strategy area typically extrapolate from the prototypes currently existing in CAI. For example, computer-managed instruction can be thought of as a variation from computer-assisted instruction. For the FSU Project THEMIS research activities, we have attempted to investigate CAI within a total training system's concept which include the areas as follows: (a) Computer-Managed Instruction, (b) Learning Approaches to Information Retrieval Systems, (c) Learning Uses of Computer Simulations, and (d) CAI Based Learning Games.

a. Computer-Managed Instruction. Several definitions and examples of computer-managed instruction have appeared in the literature in recent years. These examples have included instructional systems which stress the utilization of behavioral objectives and frequent criterion reference testing. Actual instruction does not take place via a student-computer interaction as in CAI, but rather via some off-line mode, which may or may not be self-instructional. The role of the computer is mainly one of

analyzing test results in comparison with specified objectives and reporting these results to the instructor. Our approach to CMI stresses the utilization of the interactive, real-time evaluation, and branching capability of CAI.

Florida State has completed the implementation and initial formative evaluation of a collegiate level CMI course. System analysis techniques were utilized to develop the objectives for a course titled "Techniques of Programmed Instruction," a graduate level course. This course requires the student to learn both a body of knowledge and a set of skills by actually writing and documenting a short programmed instruction text.

The course received its first formative evaluation during the Fall Quarter, 1969, when sixty students completed the course. The CMI project activities can be summarized as follows: (1) systems analysis techniques have been utilized to convert a conventional graduate course in "Techniques of Programmed Instruction" to a course which was suitable for implementation via computer-managed instruction; (2) management techniques have been devised for using a CAI language for implementing the CMI course; (3) sixty graduate students have completed the first field evaluation study of the effectiveness of the CMI course; (4) extensive data has been collected on student performance in the course as well as on aptitudes and prior knowledge, and (5) time and cost information has been obtained.

Briefly described below are five potential research areas from which hypotheses will be investigated during 1970. The exact selection of research areas and hypotheses will be deferred until more data on the actual operation of the course have been collected and analyzed.

- 1) Diagnosis and Prescription. The computer/student interaction which characterizes the FSU-CMI course offers a unique opportunity to investigate diagnostic and prescriptive techniques. Ideas are only now being developed in terms of valid diagnostic techniques; we seem less certain than before that we have ways of determining what a student "knows" or "can do."
- 2) Multi-media Resources. At the present time, the CMI course incorporates primarily printed instructional materials. While more media-based materials are becoming available and could be added to the pool of resources, the CMI course offers the potential for extensive data collection in student preferences for materials, as well as initial attempts at assigning students to media.
- 3) Sequencing of Instruction. In the initial administration of the CMI course, one group of students was assigned to what was considered the best sequence through the materials while other students chose their own pathways. Data analysis is now underway to detect any systematic differences in the performance of these two groups, or in the characteristics of the students who were most successful with the assigned treatments. This type of research will be continued and alternate hypotheses investigated.
- 4) Role Functions. An almost unexplored area of research remains in terms of the various roles which are required in order for a CMI course to operate successfully. In the initial study of the FSU-CMI course, the students in the course tended to interact with the graduate assistants on conceptual problems, and tended to call on the assigned course instructor when administrative questions arose. While this was a legitimate and reasonable use of resources, there are probably additional services which could be provided via such techniques as small group discussions.
- 5) Cost/Benefit Analysis. While preliminary data have been collected on the first implementation of the CMI course, there needs to be a continuous analysis of the costs and benefits from the utilization of CMI techniques. Exact costs for the development and operational use of the course need to be expressed in generalizable units. Comparisons with other instructional methods will be conducted.

This past Fall Quarter also provided a first opportunity for implementing the CMI activities within the social welfare curriculum. During the early portion of 1969, an extensive test on behavioral science concepts was prepared and administered to students in the FSU Social Welfare Department. Then in September of 1969, 87 beginning social welfare students were

administered a CMI version of this test. If a student failed any given test item with its related instructional objective, a reading assignment was given. The major question concerned the follow-up reading assignments and the change in performance for given students. In the late fall, eighteen students were readministered the test.

The accomplishments of the CMI Social Welfare Project can be summarized as follows: (1) the development of a pool of test items representing the primary objectives from the behavioral sciences appropriate to social welfare students, (2) the development of appropriate CMI objectives and course reading assignments to be assigned if testing results indicate deficiencies, (3) the first empirical assessment of these materials and its approach within an experimental design that compared students who were assigned the CMI task as opposed to those who were not.

Our research plans for 1970 in Social Welfare include analysis of the fall data and preparation and field testing of a sequential testing structure. Also, a comparative experiment will be conducted for a group of students who will receive individualized instruction under CMI techniques.

b. Incorporation of Learning Tasks with a CAI Based Information Retrieval (IR) System. The roles of learning tasks and information retrieval systems have rarely been considered concurrently. Given that the searching for information and its utilization in complex behaviors such as formulating explanations are two learner strategies made possible via CAI, the availability of an information retrieval system for behavioral studies of this training type seems most pertinent. The following paragraphs describe the characteristics under investigation within our training system's research.

First, the behavior of both the student as well as the IR system must be adaptive in nature. The rules and strategies provided by the IR

system must facilitate this adaptive behavior and lead to a second important feature which is the development of intellectual skills on the part of the student to utilize individual structured yet patterned information provided by the IR system. Lastly, it is important to be aware that the IR system must provide information flow and feedback to the student's inquiries in a non-threatening and, hopefully, optimally matching manner.

Two field studies have been completed using the Social Science Generalization (SSG-IR) system. The student utilized the SSG-IR system to formulate questions and generate explanations based on the retrieval generalization. Appropriate case studies were written to provide a sequence of learning tasks. The findings indicate (a) improved and more optimal search behaviors, (b) improved question-explanation behaviors, and (c) positive attitudinal ratings of this learning IR activity. For the future, the task sequence will be extended to include graphic models that both synthesize the generalization and provide new approaches to students' explanation behaviors. Thus we are continuing our research with the SSG-IR system by exploring additional learning tasks that combine the learning skills feature with the IR system's structure.

c. Computer Simulation for Instruction. The investigation of computer simulation has focused on the replacement via CAI techniques of at least two different kinds of laboratory instructional tasks, namely, science laboratory tasks and statistical laboratory exercises. It is the goal of these studies to specify the conditions under which CAI techniques can replace conventional exercises and hopefully improve the cognitive understanding of the student. In some cases, the CAI presentation will be supplemented with cartridge films, graphic material, and actual physical apparatus. The use of the CAI system by the student should help his learning by (a) checking

intermediate performances, (b) providing techniques for problem solution upon request, and (c) making available computational support from the computer.

The flexibility of the CAI system with its potential branching capability, the possibility of generating random numbers for varying the complexity of the exercises, the availability of the data bank stored within the CAI system, and sequential testing techniques make this area of computer simulation of laboratory exercises most promising. The major goal as cited above will be to specify those exercise characteristics which can best be replaced via the CAI approach.

In the area of science laboratory exercises, a pilot study and an experiment have been completed. The experimental results indicate the feasibility of this approach, and equivalent terminal performance levels were found with a natural laboratory situation in comparison with the CAI computer simulation situation. Moreover, the results suggest that those complex concepts to be illustrated by the laboratory exercise are perhaps better emphasized via the CAI approach.

The research plans for 1970 include a revision of the physics laboratory computer simulation exercise to include more remedial branches. The revised simulation will then be empirically evaluated. There are also plans to initiate statistical simulation exercises that will be utilized in the training of graduate students.

d. CAI Based Learning Games. CAI approaches to computer based learning games are still in their infancy. Our interest in creating CAI based learning games focuses upon (a) a new technique for task simulation and instruction for complex decision making, (b) exploring the role of

social simulation with multiple people on line with the CAI system, and (c) monitoring the play of a student in manipulating the payoff matrix in order to systematically induce new and more sophisticated decision strategies.

During the past year a Social Science learning game has been created. The game "Explanation" allows for a multiple player situation in which different intellectual roles are played by the participants. The game provides for the increased generation of insightful questions to case phenomena as well as a more powerful and sophisticated explanation of these questions. Preliminary experimentation indicates that the game does accomplish its overall purpose of increasing the questioning and explaining behaviors of the participants. Limitations in the payoff matrix and the procedural rules have led to two revisions of the game.

Another game being implemented on the computer is called "Instructional Strategy." This game focuses on all of the decisions used in the systems approach to instruction. Via the use of case studies, the players systematically attempt to generate new instructional alternatives, a major conceptual problem in the systems approach. These student alternatives are rated by the criteria embedded in the CAI system and points are assigned.

The last area of concern is the implementation of a political war game called "Power Play." This game is an attempt to extend the war games utilized within the military service to relate to the political aspects of military strategy. The intention of the game is to increase the political and social awareness of the participants as they make political and military strategic decisions with consequent play. The game itself is patterned after the game "Inter-Nation."

During 1970 the games "Explanation" and "Instructional Strategies" will be field tested with appropriate analysis and reporting of the results as follow-up activities. There will also be a continuation of the development of the war game "Power Play."

3. Validation Strategies: Project ENRICH

During the past year, Project THEMIS researchers have investigated the requirements for implementing findings from the more basic research at the FSU-CAI Center. Educational organizations have varying existing instructional systems which have to be considered when one attempts implementation and field validation of the concepts developed from CAI research.

At the present time the primary focus of these validation strategies resides in the field studies with the Naval Reserve unit in Tallahassee. Utilizing the concepts and techniques of computer-managed instruction implemented via CAI, Project ENRICH has provided a first field study with a small group of seaman recruits.

Turning to the objectives for Project ENRICH, the overall goal of these validation strategies is the application of an individually prescribed instructional system which utilizes new educational technology, particularly computer-managed instruction, and which is designed primarily in the context of reserve forces training. After considering the array of Naval Training problems, the area of recruit training was selected. It was decided that the textbook for the Bureau of Naval Personnel Training course, Basic Military Requirements, (NAVPERS 10054-B) would be used for the training program. The design procedures followed by the ENRICH team involved the adaptation of the correspondence course materials for CMI presentation.

After the CMI course development, six seaman recruits were used as subjects for a preliminary evaluation of the materials.

This first field study of the system has raised several management questions which will be explored in the future. The first is the matter of time. There is every indication that through the nine computer lessons and the End-of-Cycle test there can be a marked reduction in instructional time as compared with the conventional training programs. While the data has not yet been adequately analyzed for this first group, the time reductions appear to be as much as one-half, with the performance on advancement in rating tests being equal to or above existing district and national levels.

Sequencing is a second area of major concern. Certain trainees do not complete the CMI training cycle because they must attend boot camp. If these recruits are to attain the performance level required, they will have to be re-cycled. This situation suggests the monitoring of performance via computer-based systems to achieve optimal guidance for the trainees.

The accomplishments of the validation strategies project can be summarized as follows: (1) the creation of a validation plan of investigation that has received the full support of the Naval Reserve Command, (2) a field study with seaman recruits that replicates prior research results in that superior performance levels were achieved with a significant savings in training time, (3) establishment of liaison with the Naval Reserve that will eventuate in a jointly sponsored conference in April, 1970, and (4) identification of required implementation techniques that should eventuate in a specification of new training roles and operational patterns of CMI implemented within a military training system.

During 1970 it is anticipated that the seaman recruit curriculum will be revised and field tested. Also a conference is being planned which will

bring together those elements which have a major interest in the development and implementation of CMI concepts to the Naval Training Systems.

4. Computer Systems Strategies

The computer system was improved and extended during 1969 in these areas: input-output routines, internal sequence sensitive bi-direction sorts, instructional support systems, a touch sensitive CAI terminal, and a M-17 CAI computer. The following is a brief description of these research and development areas.

a. Input-Output Routines. In the FSU Data Analysis and Management System there are large files that need to be regularly manipulated by highly efficient programming which maximizes program execution times. Programs in this system can normally execute no faster than the time it takes to pass data through it; hence, the term "throughput" is derived. Throughput improvements have speeded up internal execution speeds so that the programs have approached I/O boundary conditions while still maximizing efficiency. It is the improvement in this overall computer throughput that has allowed CAI systems to provide significant capacity increases and facilitate greater operating economies.

b. An Internal Sequence Sensitive Bi-Direction Sort. The development of this sort has been completed to take advantage of the fact that CAI data records are not randomly ordered but rather are more often only slightly out of sequence. The bi-directional sort locates the correct sequence position of a currently encountered out-of-sequence record in no more than eight comparisons for any 100 response records. Intermediate data swaps have been eliminated by indirect data examinations via a bi-directionally linked index listing procedure.

The development and availability of the overlapping I/O routines and the bi-directional sort has provided an opportunity to evaluate the extent to which CAI systems should have specific programs that capitalize on the unique features of CAI operations, namely, high I/O requirements and partial ordering of CAI response data.

c. Instructional Support System (ISS). We are currently redesigning the Data Management and CAI System into one complete support and operating system. The major benefits of the ISS integrated system would be as follows: (a) improved CAI efficiency due to complete utilization of the CPU, (b) improved computer operations in that parallel systems will be avoided, (c) simplified training procedures for the computer operator in that all operations would be parameter controlled and not manual, and (d) better assessment of the total CAI operational requirement in that multi-programming can be implemented. Most importantly, we plan to document the operational activities in a CAI training course that could be shared with all future CAI research centers.

d. Touch Sensitive CAI Terminal. In cooperation with the University of Pittsburgh, there are plans to implement and evaluate a touch sensitive terminal device. Being a low cost unit, this terminal feature will allow us to investigate potential training applications in the graphics area. The implementation of a low cost, pictorial terminal device is consistent with our major THEMIS goal of full exploration of CAI training applications.

e. M-17 CAI Computer Development. During the past year, the DOD Office of Surplus Automatic Data Processing Equipment provided two M-17 surplus computers for the FSU-CAI Center. Ultimately there are plans to install one of these M-17 computers in the Tallahassee Naval Reserve Center. A power supply has been designed and implemented for the M-17 computer.

Future developments call for the following: (a) interfacing of an inexpensive teletype CAI terminal, (b) development of a CAI operating systems program, (c) development of a CAI authoring and debugging program, and (d) implementation of the Project ENRICH learning materials on the M-17.

B. The Wakulla County Computer-Related Instructional
Technology Project*

As of July 1, 1968, a joint project was undertaken by the Wakulla County, Florida, Board of Instruction, and the FSU-CAI Center. The FSU-CAI Center's Annual Progress Report: January, 1968-December, 1968, Report Number 7, pp. 35-49 describes the activities of the project inclusive of December, 1968. This section of the annual report will highlight the activities of The Wakulla Project that took place during the interval from January, 1969 to December, 1969.

During the period from January, 1969 to March, 1969, teleprocessing communication lines were completed between FSU and Wakulla County (approximately 20 miles). The number of terminals was increased to eight by adding a DEC 680 switching system to the FSU 1500 CAI system. This system adds the telecommunication capabilities by collecting and sending data to local or remotely located teletype terminals under control of a PDP-8 computer. This provided for full CAI operation in reading and mathematics which permitted each student to have three CAI instruction sessions weekly. An extensive preparation of oral language lesson materials was accomplished

*A limited supply of "End of Budget Project Report" July, 1969, is available through the FSU-CAI Center. This project is supported by the Office of Education through the Title III Program.

and the oral language program became a part of the student's daily non-CAI activities.

During the spring of 1969, the feasibility of paired-instruction was pursued; that is, pairs of students were given daily instruction in mathematics and reading. The paired technique proved to be an effective method of increasing terminal time without detriment to student performance. Also during the spring, the project evaluation program was completed. Despite the fact that the total CAI aspects of the project were not in full operation until February, 1969, results clearly indicate that students who participated in the CAI and oral reading program showed positive gains in both reading and mathematics. This result is most encouraging, but should be considered preliminary at this stage.

The fall activities (1969) have focused on a broader evaluational effort. A control group was selected from a predominantly rural Negro school in a nearby county and has been administered the same battery of tests that was administered to the Wakulla students. Both groups were tested in September, 1969. The battery consisted of (1) The Slosson Intelligence Scale, (2) The Slosson Reading Scale, and (3) The Wide Range Arithmetic Scale. Of course, the main fall activities have been concerned with the actual implementation and daily use of the CAI reading and mathematics materials, and the oral language materials. These materials are being used by approximately 150 elementary students and approximately 125 junior high students. The major goal of the 1969-70 activities is to assess the overall effectiveness of the instructional materials when applied to a rural student population.

C. Cooperative Studies with the Naval
Training Device Center

1. Development of a Model for Adaptive Training
Via Computer-Assisted Instruction Utilizing
Regression Analysis Techniques*

Many investigators (Dick, 1965; Hansen, 1966; Gentile, 1967; Zinn, 1967) report that one of the major advantages of using a computer for instruction stems from its capability to adapt the instruction based on the individuals most recent performance as well as his past history. Therefore, it can be hypothesized that a computer, because of its unique monitoring capabilities, would be an ideal manager of a dynamic adaptive instructional system. However, there is a need for studies that would shed light on the question of the methodology to be employed, and further, whether there is a need for sophisticated electronic devices to accommodate dynamic instructional decision models.

The intent of this study was to investigate the research factors underlying the construction of a dynamic decision model for ongoing learning situations presented via computer-assisted instruction (CAI).

The decision variables of probability of correct responding, latency of the response, and the learner's confidence regarding the response were investigated within a linear regression adaptive decision model. The first phase of the investigation consisted of looking at the predictive relationship of these three variables as assessed on (a) individual learning concepts, (b) criterion frames testing the concept, and (c) within course unit quizzes.

*Based on an abstract taken from preliminary manuscript submitted to the Naval Training Device Center, Orlando, Florida. The contract number is NAVTRADEVCECEN N61339-68-C-0071.

The data for the three variables for the above three response types were placed in a stepwise linear regression model to assess the predictive values on the final examination for the two hour course on concepts of Boolean algebra. Based on the results of the regression analysis with the final examination as the dependent measure, the most relevant predictor variables were incorporated in a discrete value decision model which directs a trainee to appropriate remedial material.

In the second phase of the study, validation results indicated that this linear regression adaptive decision model was effective in identifying students in need of remedial instruction. However, due to a number of developmental problems, the group of trainees under the adaptive decision model did not prove significantly better than a comparable group. This study illuminates the basic methodology to be developed for a linear regression adaptive decision model to be used within CAI. The study represents an initial developmental effort in this area. Using insights gained from this investigation, future research endeavors are planned in the coming year that will expand on this initial effort.

2. Learner Control in Automated Instruction*

An adaptive and sophisticated component in any automated instructional system is the student or trainee. However, many designers of instructional systems seem to operate on the assumption that the trainee is a placid, receptive component, incapable of being actively engaged in the decision making process concerning the type of instruction he will receive.

*This research was supported by the Naval Training Device Center, Orlando, Florida, under NAVTRADEVEN Contract No. N61339-68-C-0071.

This research effort was directed toward investigating the following questions regarding learner control: (1) given control of media presentation (CRT, typewriter, audio), what device will the trainee select? (2) given control of the information level (terse, medium, redundant) what level will the trainee select? (3) given control of the sequence of topic presentation, will the trainee determined sequence differ from the designer's sequence of presentation?, and (4) what individual characteristics interact with media, information level, and sequence of presentation?

The content used to explore the learner control variables can be described as "patterns of curriculum organization" which is normally taught to advanced FSU education students. This instructional content was modified so that the subjects could control (1) the media (CRT, typed print, and audio), (2) redundancy (terse, medium, and redundant), and (3) sequence of presentation (two patterns). The three presentation devices were: (1) computer-controlled CRT, (2) computer-controlled typewriter, and (3) human-controlled tape recorder. These modifications result in nine distinct versions of the instructional program.

After development of the instructional program, subjects were obtained from the introductory psychology course (a naive group) and from an educational administration course (an experienced group). The experimental design employed two distinct treatments which permitted an examination of the effects of the media variable, redundancy variable, and sequence of presentation variable.

The preliminary analysis of the data indicates that students quickly learn to optimize the matching of media and redundancy. For example, redundant materials were selected to be presented by tape recorder which is a much faster information carrier in comparison to a typewriter. Conversely

when terse materials (high information load) were being presented the students consistently chose a typewriter presentation. In regard to the sequence of presentation variable, the psychology subjects skipped more materials and took fewer reviews than did the subjects from the educational administration course. This would seem to indicate that for learner control to be more effective than a fixed control presentation, the subjects should have sufficient prior knowledge and motivation to make wise decisions.

D. A Research Study of the Systems Factors and Potentials of Computer-Assisted Instruction: Present and Future*

In September, 1969, the FSU-CAI Center was awarded a research grant from the National Science Foundation. The investigations being conducted under this grant can be classified as a basic research endeavor that will contribute to the future CAI system design. The strategy for executing the basic research is to develop a student-computer interaction model by experimentally manipulating the structure of the learning materials, systems response times, and individual differences as they relate to learning and retention. These investigations can be grouped into two primary areas: (1) the study of the content and time parameters involved in the student-computer interaction, and (2) an empirical investigation into the researcher's needs and requirements for effective research methodology when utilizing a CAI system. What follows is a description of the activities which point up the highlights of the "student-computer interaction investigation," and evaluation of the researcher's needs.

*This research is supported by the National Science Foundation Contract GJ-623.

Beginning in the fall of 1969, CAI instructional materials concerned with the general topic of set theory were prepared. The set theory units were adapted for the student-computer interaction study from a larger Boolean algebra course as described in detail in the FSU Technical Report Number 5 (Love, 1969). The materials are composed of twenty-three lessons; the first fourteen are a combination of definitions and algorithms, the last nine lessons are proofs of set theory theorems. The CAI instructional materials will be presented during five sessions, each requiring approximately one hour of terminal time.

The major independent variable involved in the investigation of student-computer interaction is the length of the delay of feedback or systems response time. A literature survey has been completed on the delay of feedback variable and four conditions of delay have been identified and incorporated into the set theory CAI program. The feedback will occur after delays of 24 hours, at the end of each day's session, after 15 seconds and immediately. The specific purpose of this study is to investigate the differential effects on retention for males and females on the four feedback delay intervals with respect to the three structural types within the set theory material: definitions, algorithms, and proofs.

The major dependent variable for this study will be two retention tests taken one week and two weeks following the last day of original instruction. The data collection procedures are scheduled for completion in May, 1970.

The second primary area of investigation under the National Science Foundation grant is concerned with the needs of the prime user of the CAI systems, who is the researcher/evaluator. It is he who both creates the

learning environment for the student and makes demands upon the system to assist him in analyzing his results. While, on the one hand, the researcher/evaluator may be a conceptualizer of experimental materials and data analysis routines, he is at the same time totally dependent on the students, the data which they generate, the operational staff and the programs of analysis which they produce.

The early literature in computer-assisted instruction held great promise for the researcher in terms of the ease with which he could prepare and run an experiment and analyze his data. One could almost assume that the researcher would merely enter his instructional materials into the system and that somehow he would magically be presented with results of his study neatly printed out and ready for publication. This certainly has not proven to be the case. Rather than try to determine the locus for the blame for the lack of data from CAI, it would seem more profitable to obtain more information about how researchers use the present CAI systems, and determine how the researchers would like the future CAI systems to be designed.

There are, in fact, many varieties of researchers who find themselves wanting to use the CAI system as a research tool. In utilizing the CAI system, the researcher must be concerned with three primary steps: (1) the preparation of the experimental materials, (2) the monitoring of the experiment itself, and (3) the supervision of the post-experimental data analysis. Each of these steps is crucial to the successful completion of the experimental research, and therefore, each must be carefully designed and executed. It is the purpose of this research to examine the role of the researcher at each one of the steps in the preparation and analysis of

a CAI research study. It is hypothesized that the derivation of this data will provide other researchers with a more enlightened view of CAI research and a more realistic expectation of the competencies which he himself must have. A direct outcome of this investigation will be a document which will outline recommended training procedures for future CAI researchers.

Currently within the FSU-CAI Center frequency counts are being recorded on the types of the various analysis requests, and the types of response data needed. These frequency counts will be invaluable in terms of establishing priorities for programming needs of future CAI installations. A second source of information is the collection of subjective reports. These subjective reports are being requested from each researcher after he has received data from the FSU-CAI Data Management System. These reports will reveal the usefulness of the data to the researcher, and will request suggestions about ways in which the data management programs can be enhanced or extended.

E. The Role of CAI in Curriculum Revision

The Intermediate Science Curriculum Study (ISCS)* (Dr. Ernest Burkman, Director and Dr. David D. Redfield, Associate Director) at Florida State University is engaged in developing a science curriculum for grades 7-9. This curriculum has undergone extensive field testing and repeated revisions at each grade level. Computer-Assisted Instruction (CAI) has played an important and unique role in the formative evaluation of the ISCS program. For three

*Performed under USOE Contract OE 2-6-061762-1745 from June 1966 to September 1969 and supported by the National Science Foundation Grant GW 4235 from February 1969 to September 1969.

years now, seventh, eighth or ninth grade students have received ISCS instruction via IBM 1500 student terminals in the Florida State University Computer-Assisted Instruction Center. The primary purpose of this presentation of ISCS materials via CAI has been to provide the curriculum revisors with information and student performance data to aid them in their revision of the materials. The ISCS use of CAI as a curriculum evaluation technique has revealed two critical characteristics of the CAI data which make it of unique value to the curriculum revisor. First, much more detailed frame-by-frame evaluation is made possible via CAI than is possible on the basis of field trial data. Much of the detailed information made routinely available by CAI could be obtained only with great difficulty if attempts were made to recall text and other student records from the field. Other data such as item latency and sequence through the material could not be obtained from any source other than CAI without a considerably greater outlay of time and effort.

The second critical feature of the CAI data is that information can be provided to the curriculum revisor with a much shorter lag time between student encounter of the material and delivery of the data to the curriculum revisors. Given the constraints of the material development schedule, this lag time is often crucial.

In this year's program three ninth grade units of ISCS material have been presented via CAI to two ninth grade classes from the Florida State University Laboratory School. In addition to the curriculum revision data normally provided by CAI, in this year's program one experimental variation has been introduced in each of two units of the instruction. In the first unit of the ISCS materials, entitled "Investigating Variations,"

the experimental version which was introduced involved the student use of the excursion remedial and enrichment materials. In one class the students were given the freedom to complete excursion material at appropriate times if they desired to do so or to skip the excursion material. In the other class students were required to complete the excursion material when it was first mentioned to them. This will provide one of the first objective evaluations of the effectiveness of ISCS excursion material.

In the second unit, consisting of instruction on meteorology, the variation introduced consisted of providing periodic reinforcement frames. Due to the open-ended nature of the ninth grade materials, reinforcement could become a critical factor in student performance. The third unit, geology, is somewhat unique in the ISCS program in that students are provided with an array of resource materials and are then allowed to freely select those resources which they wish to use for help with answers to questions. CAI will provide the sole source of information on the detailed sequence in which students choose to use the various blocks of instruction. In the third unit CAI will constitute the sole source of information concerning one important dimension of student performance in the ISCS material.

Based on the three year ISCS-CAI Center cooperative effort, the following conclusions seem justified: (1) CAI, by virtue of the detailed performance records it provides, constitutes an innovative powerful approach to curriculum revision, (2) The fears of student rejection of CAI in long term use do not seem to be justified. Students now in the third year on CAI still appear to be highly motivated. These students, having received approximately four hours of instruction per week, have compiled more hours of CAI than any other known group. Now nearing the end of this prolonged

exposure, the students have given a strong positive reaction to CAI. They have expressed a willingness and a desire to continue in CAI programs, (3) The involvement with ISCS has provided the faculty and staff of the CAI Center with valuable experience in implementing a complete curriculum and providing daily instruction reliably on a long term basis. (4) The involvement with ISCS has provided the faculty and staff of the CAI Center an opportunity to become more aware of the types of information helpful to curriculum developments and has led to the development of capabilities which allow us to be more responsive to these needs.

The ISCS program is now reaching the terminal phases of its materials revision and development effort. No additional ISCS presentation via CAI is anticipated in the immediate future. However, due to the vast amount of fine grain data collected on each student, much data remains unanalyzed even after the analyses which are most useful for curriculum purposes have been performed. The three years in which this project has been in operation have produced a vast amount of such student record data. During the coming year, in cooperation with the ISCS personnel, this data will be analyzed more thoroughly. It is anticipated that, in addition to providing additional insights into ISCS student performance, this thorough analysis of the data will provide reality checks of many of the data management capabilities developed within the CAI Center as well as fostering the development of additional capabilities.

III. GRADUATE TRAINING PROGRAM: INSTITUTE IN COMPUTER-RELATED
MULTI-MEDIA INSTRUCTION FOR ADMINISTRATORS AND FACULTY
IN JUNIOR COLLEGES AND UNIVERSITIES*

The Faculty and Administrators Training Institute conducted by the Computer-Assisted Instruction Center of the Florida State University under the grant from the Higher Education Act of 1965, Title VI-B, for 20 participants was held from September 16, 1968 through June 15, 1969. The overall objective of the Institute was to provide an opportunity for present and prospective college and university level administrators and faculty members to acquire an in-depth understanding of all aspects of computer-based multi-media instruction in collegiate level education. The academic year-long duration plus scope of this Institute again documented the requirement for sufficient formal and informal instruction to accomplish professional development and new competencies. A similar finding resulted from the prior Institute held in 1967-68. The demonstrated competencies and understanding of the learning and systems analysis aspects of computer-based multi-media instruction were developed through a series of theoretical courses offered for graduate credit, individual projects, hands-on experience with various computer systems, and close personal interaction between the students and the faculty members.

*Tech Memo Number 6, July, 1969, describes the Institute activities in greater detail. The Institute is supported by the U. S. Office of Education through Project No. 8/2014.

The program was again guided by six general objectives found to be effective in our previous Institute. These were as follows: (1) to acquaint the participants with the field of computer-assisted instruction, (2) to provide the participants with an understanding of the educational and learning theories that form the basis for the application of computers within instruction, (3) to develop a high degree of proficiency on the part of the participants in the utilization of the FSU Computer-Assisted Instruction systems, (4) to develop knowledge about the newer techniques of data analysis such as sequential analysis, tests of goodness-of-fit for instructional models, and dynamic decision-making, (5) to learn how to administer CAI installations so that the participant would understand the operational factors of cost, time schedule, course development and personnel, and (6) to author a CAI course unit on the FSU-CAI system and to evaluate its efficiency.

All of the participants achieved the Institute's objectives with varying degrees of success according to their particular academic orientation and background, plus their personal goals. In general, the overall goals of the Institute were more than accomplished in that all the students who participated received graduate credit and made excellent grades in this formal course work. More importantly, each participant made a significant contribution to the research and development of this new professional field via the authorship of learning materials and the successful solution of current developmental tasks.

Fortunately, the selection procedure plus the great professional interests in CAI led to a fairly homogeneous group of highly qualified

trainees. This allowed the formal courses plus seminars to be aimed toward this homogeneous grouping so that efficient utilization of professional time was maximized.

Consideration of revisions for the Institute during 1969-70 will re-evaluate the sequence of courses offered so as to maximize their value, integration of other FSU instructional systems faculty (namely, Leslie Briggs, Robert Gagne, Torry Esbensen, and Robert Morgan) into the program, and utilization of new faculty so that a greater number of hours can be spent in individualized student-faculty contact. In addition, an extended introduction to the computer systems hardware and its functional characteristics appears to be required. Thus the Institute for academic year 1969-70 sponsored by USOE will reflect many changes that resulted from evaluation of this year's Institute plus a follow-up evaluation of the members from the 1967-68 Institute.

On September 15, 1969, 20 trainees reported for orientation to the Institute. With the experience obtained through the previous institutes plus the modification of the curriculum it is felt that the 1969-70 year-long institute will improve both efficiency and effectiveness.

IV. DIVISION OF INSTRUCTIONAL RESEARCH AND SERVICE SPONSORED ACTIVITIES

Florida State University reorganized in 1968 its major instructional support units and the Institute of Human Learning into the Division of Instructional Research and Service (DIRS). DIRS houses and administers the major R and D projects plus service instructional components on campus, e.g., Instructional Television, Testing Service, and Media Center, etc. This organization also has a research unit, in which the CAI Center is administratively included. This provides the CAI Center with immediate access to a large pool of multi-media equipment and staff, plus access to identify FSU instructional problems. This setting facilitates both the research and developmental aspects of the CAI Center's program.

A. Instructional Service

In addition to the research function of DIRS, there is a service function which concentrates on offering the best instruction available to FSU students. The CAI Center has contributed to this service function on a limited basis. The main reasons for this limited instructional service are the constraints relating to our CAI computer system and to our externally supported program of research and development. In regard to providing instructional services at FSU, there is a spirit of optimism that with a better understanding of computer-managed instruction (CMI), computer-based testing, and remedial CAI materials, the seemingly insurmountable cost problems in relation to the service function can be overcome within the next two years.

Although the major effort of the CAI Center is concerned with research, a few examples will illustrate the instructional service activities that were provided by the CAI Center during 1969. One example, briefly described in the training strategies section, is a CMI course titled "Techniques of Programmed Instruction." This course provided all the instruction for approximately sixty graduate students majoring in education. Three additional instructional service programs used in 1969 were: Physics-Problem Solving Exercises, Elementary Model Project, and a project dealing with curriculum patterns in education entitled "CURPA." A brief review of these CAI service activities is presented in the following section.

1. Elementary Model Project

The Elementary Education Training Model was concerned with developing a computer-managed record system for monitoring teacher training performances in a highly individualized instructional program. During the Fall of 1969, there was a feasibility investigation that involved interfacing a typewriter terminal into the IBM 1500/DEC PDP/680 switching system plus accompanying data handling procedures. The terminal was located in the Education Building and permitted the students to input their performances into the system so that record files could be continually updated. The revised learning files were utilized for prescribing the student's future instructional assignment and sequence. Essentially the project involves developing a CMI undergraduate course module in elementary education.

2. Physics-Problem Solving

We have offered a multi-media CAI undergraduate physics course for credit on three different occasions during the past two years. One of the

most encouraging results found within the CAI physics course was the practice exercises or problems that were utilized prior to each major examination in the course. The students were highly enthusiastic about the test-review sessions. During 1969, a large number of FSU undergraduates interacted with these problem sets. There are plans to continually utilize the physics test-review problems and to implement and extend the physics problem solving units.

3. Project CURPA

This course involves the topics related to curriculum organization as offered in the FSU Department of Higher Education. To proceed through the CAI materials requires the student to spend approximately 6-10 hours of actual time at the CAI terminal. The CURPA materials are continually available as an adjunct unit of instruction for the Department of Higher Education. During 1969, Higher Education students were instructed via CAI.

During the coming year, the CAI Center plans to continue the above three cited examples plus numerous other pilot activities. These include computer-based approaches to instruction in chemistry, mathematics, library science, and psychology.

B. FSU-CAI CENTER PERSONNEL

Involved in the several programs of the Center are various categories of membership. During the past year, six resident faculty members, seven Project THEMIS faculty, twenty-six graduate students, and fourteen research support personnel have been involved in the research and training programs of the Center.

Center Director

Duncan N. Hansen, Ph.D., 1964, Educational Psychology, Stanford University, Associate Professor of Educational Research and Psychology, FSU.

Resident Research Faculty

Walter Dick, Ph.D., 1965, Psychology, Pennsylvania State University, Research Associate in the CAI Center and Assistant Professor of Educational Research, FSU.

Henry T. Lippert, Ed.D., 1967, Education, University of Illinois, Research Associate in the CAI Center and Assistant Professor of Educational Research, FSU.

Bobby Richard Brown, Ph.D., 1969, Psychology, Pennsylvania State University, Research Associate in the CAI Center and Assistant Professor of Educational Research, FSU.

Harold F. O'Neil, Ph.D., 1969, Psychology, Florida State University, Research Associate in the CAI Center and Instructor in the Department of Psychology, FSU.

Lloyd Lauffer, M.S., 1968, Electrical Engineering, Carnegie-Mellon University, Director of Hardware Development and Instructor in Educational Research, FSU.

Project THEMIS Investigators

All of the above Research Faculty plus the following:

Guenter Schwarz, Ph.D., 1942, Physics, Johns Hopkins University, Professor of Physics and Director for Research in College of Instruction of Science and Mathematics, FSU.

Walter H. Ehlers, DSW, 1962, Social Welfare Administration, Brandeis University, Professor of Social Work, FSU.

Charles H. Adair, Ed. D., 1961, Social Science, Florida State University, Associate Professor of Social Science Education, FSU.

William L. Maloy, Ed.D., 1958, Secondary and Teacher Education, Florida State University, Educational Consultant to Governor Claude R. Kirk, Tallahassee, Florida.

Darryl Bruce, Ph.D., 1966, Psychology, Pennsylvania State University, Assistant Professor of Psychology, FSU.

Gerald Jahoda, D.L.S., 1960, Library Education, Columbia University, Professor in the School of Library Science, FSU.

Richard R. Lee, Ph.D., 1967, Education, Stanford University, Research Associate in the Institute of Human Learning, and Assistant Professor of English Education, FSU.

Graduate Students

Third Year

Paul Gallagher
Nancy Hagerty
Bill Harvey
Arthur King
Gary Lipe
Jim Papay
Lee Rivers

Second Year

Thomas Dunn
Lorraine Gay
Darol Graham
John Hedl
Mike Lawler
Barbara Leherissey
Gail Rayner
Dave Thomas

First Year

Regina Caveny
Ed Durall
Paul Geisert
Wallace Hannum
Ed Harris
Tom James
Barbara Johnson
Ora Kromhout
Merle Morgan
Chuck Sisson
Peter Stoycheff
Bill Whaley

CAI Research Support Staff

Data Systems Director
Bruce H. Freed

Director of Systems Operations
Gene Wester

Programmers

Dewey Kribs
Katherine Jacobsen
George Hogshead

Operators

Dave Danner
Jim Guerry
Ray Frost
Paul McClellan

Coders

Betty J. Wright
Sharon Papay
Dennis Adair
Edna Reynolds

Program Documenter

Beth Lines

C. Organization and Facilities

The Computer-Assisted Instruction Center of Florida State University has received continuing support over the past five years from the

University in the form of both facilities and faculty support. The historical development of the CAI Center reflects this commitment.

The CAI Center was informally established in September, 1964 by Dr. Russell P. Kropp, Director of the Institute of Human Learning. In October, 1964, IBM and the University entered into a research agreement for the cooperative study of CAI. IBM contributed a teaching terminal and connection to their computer equipment. The University staffed the project. The Florida State Department of Education granted the University funds to defray the telephone line charges for connecting the teaching station to the IBM Research Center in New York. A major activity of the project was demonstrating CAI and disseminating information about it. Several hundred educators, including University faculty members, were served in this way. The project terminated on August 31, 1965. The University then installed an IBM 1440 computer system capable of running 24 student terminals. The Florida State Department of Education granted the University funds to underwrite some research costs and the FSU Division of Sponsored Research granted funds to accelerate collegiate level CAI instructional research.

On September 1, 1966, the CAI Center was formally established and was placed in new quarters on the campus. Approximately 3,000 square feet of space in a permanent building was renovated for the project. It contained faculty offices, graduate assistant work spaces, a reception and secretarial area, storage room, a learning laboratory, a computer room, four student stations for CAI instruction, a demonstration station, and a connected viewing area. The Center layout was designed to facilitate operational use of CAI and to be functional for research, course preparation, and field testing.

In August of 1967, the University made an additional significant contribution to the expansion of the CAI Center by providing over 2,500 square feet for expansion of faculty and student office space as well as a greatly enlarged computer room. This activity was necessitated by the delivery of an IBM 1500 CAI Instructional System. The system presently drives 32 cathode ray tube terminals which have both light pen and keyboard response devices.

The FSU-CAI Center has an IBM 1500 system equipped with a dual magnetic tape drive upon which all student responses are uniquely identified and recorded. The staff of the FSU-CAI Center has developed a data management system which compresses, sorts, merges, and summarizes data for theoretic analyses.

In early 1969, a telecommunications capability was added to the FSU 1500 CAI system. This was accomplished by the addition of a DEC 680 Switching System. This device collects and sends data to local or remotely located teletype terminals under control of a PDP/8 computer. This system is interfaced with the IBM 1502 Station Control in such a way that the 1500 system will service remote teletypes in the same way it would a local 1518 typewriter. Eight teletype terminals are currently supported via the 680 system.

APPENDIX A

Publications

The following publications by the FSU-CAI Center staff and students have appeared or have been accepted for publication in the period January 1, 1969 to December 31, 1969. The center will try to supply the articles to interested and qualified researchers.

JOURNAL ARTICLES PUBLISHED

- "An Investigation of Computer-Based Science Testing," Duncan N. Hansen, Computer-Assisted Instruction, Academic Press, Inc., 1969.
- "Computers in Education at Florida State University," Duncan N. Hansen, Walter Dick and Henry Lippert, Educational Technology, Vol. IX, No. 4, April, 1969.
- "Acoustic Similarity Effects on Long-Term Memory for Paired Associates," Daryl Bruce and Joseph Crowley, Journal of Verbal Learning and Verbal Behavior, 1969, 8, 430-433.
- "The College Board Physics Achievement Test," Raymond E. Thompson and Guenter Schwarz, The Physics Teacher, 7, 143-148, 1969.
- "Effects of State Anxiety and Task Difficulty on Computer-Assisted Learning," Harold F. O'Neil, Jr., Charles D. Spielberger, and Duncan N. Hansen, Journal of Educational Psychology, Vol. 60, No. 5, 343-350, 1969.

JOURNAL ARTICLES ACCEPTED FOR PUBLICATION

- "Acoustic Similarity Effects on Retrieval from Secondary Memory," Daryl Bruce and Joseph Crowley, Journal of Verbal Learning and Verbal Behavior, 1970.
- "The Effects of Idiosyncratic Verbal Feedback on Computer-Assisted Learning," Kenneth Majer, Duncan Hansen and Walter Dick, NSPI Journal.

- "Public School Activities and Related Sources of Information Concerning Computer-Assisted Instruction," Walter Dick, Ray Latta, and LeRoy Rivers, Educational Technology.
- "Comparative Effects of Ability and Presentation Mode in Computer-Assisted Instruction and Programmed Instruction," Walter Dick, and Raymond Latta, AV Communication Review, November, 1969.
- "Computer-Assisted Instruction: Major Activities and Sources of Information," Walter Dick, Raymond Latta, and LeRoy Rivers, British Columbia Teacher.
- "Computer-Assisted Instruction: A Glimpse of CAI Today," Walter Dick, Raymond Latta, and LeRoy Rivers, British Columbia Teacher.
- "Computer-Assisted Instruction: Interest in Canada Increasing," Walter Dick, Raymond Latta, and LeRoy Rivers, British Columbia Teacher.
- "An Investigation of the Feasibility of Computer-Assisted Academic Advisement in a Junior College Setting," Walter Dick and Harry Smith, Personnel and Guidance Journal.
- "Impact of CAI on Classroom Teachers," Duncan N. Hansen and William Harvey, Educational Technology, February, 1970.
- "College Students' Attitudes Toward Computer-Assisted Instruction," Duncan Hansen, Arthur Mathis, and Timothy Smith, Journal of Educational Psychology, (In press).

TECHNICAL REPORTS PUBLISHED

- "A Study of Computer-Assisted Multi-Media Instruction Augmented by Recitation Sessions," Kenneth Majer, Tech Report 1, Florida State University, Tallahassee, 1969.
- "Educational Applications of Instructional Computer Systems," Duncan Hansen and Kenneth Majer, Tech Report 2, Florida State University, Tallahassee, 1969.
- "Research and Implementation of Collegiate Instruction of Physics via Computer-Assisted Instruction," Duncan N. Hansen, Walter Dick, and Henry T. Lippert, Tech Report 3, Florida State University, Tallahassee, 1968.
- "A Systematic Investigation of Three Facets of Programmed Instruction: Tutorial Assistance of Study, Explanation of Incorrect Answers and the Spacing of High Difficulty Frames," John Hedl, Tech Report 4, Florida State University, Tallahassee, 1969.

- "Individual Versus Paired Learning of an Abstract Algebra Presented by Computer-Assisted Instruction," William Love, Tech Report 5, Florida State University, Tallahassee, 1969.
- "Effects of Stress on State Anxiety and Performance in Computer-Assisted Learning," Harold F. O'Neil, Tech Report 6, Florida State University, Tallahassee, in press.
- "The Effects of Anxiety on Computer-Assisted Learning," Charles D. Spielberger, Tech Report 7, Florida State University, Tallahassee, in press.

TECHNICAL MEMOS PUBLISHED

- "Implementation of CAI at Florida State University," Walter Dick, Tech Memo 1, Florida State University, Tallahassee, May, 1969.
- "Current Issues in CAI," Duncan N. Hansen, Tech Memo 2, Florida State University, Tallahassee, June, 1969.
- "Computer Applications in School Psychology," Duncan N. Hansen, Tech Memo 3, Florida State University, Tallahassee, June, 1969.
- "CAI in Social Work," Walter Ehlers, Tech Memo 4, Florida State University, Tallahassee, June, 1969.
- "Comparative Effects of Ability and Presentation Mode in Computer-Assisted Instruction and Programmed Instruction," Walter Dick and Raymond Latta, Tech Memo 5, Florida State University, Tallahassee, July, 1969.
- "Institute in Computer-Related Multi-Media Instruction for Administrators and Faculty in Junior Colleges and Universities," Duncan N. Hansen, Walter Dick, and Henry T. Lippert, Tech Memo 6, Florida State University, Tallahassee, July, 1969.
- "A Guide to Running a Study in the CAI Center," Duncan Hansen, Betty Wright, and George Hogshead, Tech Memo 7, Florida State University, Tallahassee, September, 1969.
- "The Data World of CAI," Duncan Hansen and Walter Dick, Tech Memo 8, Florida State University, Tallahassee, September, 1969.
- "An Overview of CAI for Adult Educator," Walter Dick, Tech Memo 9, Florida State University, Tallahassee, October, 1969.
- "Impact of CAI on Classroom Teachers," Duncan Hansen and William Harvey, Tech Memo 10, Florida State University, Tallahassee, October, 1969.
- "Development Processes in CAI Problems, Techniques and Implications," Duncan N. Hansen, Tech Memo 11, Florida State University, Tallahassee, October, 1969.

- "An Investigation into the Differential Effectiveness for Males and Females, of Three CAI Treatments on Delayed Retention of Mathematical Concepts," Lorraine R. Gay, Tech Memo 12, Florida State University, Tallahassee, November, 1969.
- "The Behavior of Teachers Involved in Two Simulated Inquiry Environments: A Social Simulation Game and a CAI Based Information Retrieval System," Charles Adair, Duncan Hansen, Gail Rayner, and Adesh Agarwal, Tech Memo 13, Florida State University, Tallahassee, in press.
- "The Effects of Pre-task State Anxiety on Performance and Subjective Confidence," R. Michael Lawler, Tech Memo 14, Florida State University, Tallahassee, in press.
- "Effects of Memory Support on Anxiety and Performance in Computer-Assisted Learning," Barbara Leherissey, Tech Memo 15, Florida State University, Tallahassee, in press.
- "Multi-media Simulation of Laboratory Experiments in a Basic Physics Lesson on Magnetism," Darol Graham, Tech Memo 16, Florida State University, Tallahassee, in press.
- "Current Research Development in Computer-Assisted Instruction," Duncan Hansen, Tech Memo 17, Florida State University, Tallahassee, in press.

APPENDIX B

Demonstration Report

| Florida State University | Number Demos | Number Participating |
|--|-----------------|-------------------------|
| Physical Education Dr. Peter Everett | 1 | 6 |
| Educational Administration Dr. Nell Kannwischer | 2 | 25 |
| Administration and Supervision Dr. Mildred Swearingen | 1 | 14 |
| Educational Administration Dr. Marion Black (class participation) | 2 | 12 |
| Art Education Dr. Mary Mooty | 2 | 14 |
| Higher Education Dr. Raymond Schultz | 2 | 15 |
| Math Education Seminar in Calculus | 2 | 20 |
| Speech Education Dr. Deems Brooks | 3 | 30 |
| Educational Research Dr. Bobby Brown | 1 | 9 |
| Science Education Dr. Paul Westmeyer | 3 | 30 |
| Other Demonstrations | | |
| Tallahassee Junior College College Students from South America | 3 | 30 |
| University of Georgia, College of Education | 3 | 15 |

| | | |
|--|---|----|
| University of Antioquia, Dean of Education Columbia, South America | 1 | 2 |
| National Science Foundation Participants | 2 | 24 |
| Advisory Committee for Social Welfare in Computer Managed Instruction Project | 1 | 5 |
| Leon County Public Schools | 4 | 45 |
| Space Age Technical Institute | 2 | 20 |
| Pensacola Junior College Faculty | 2 | 15 |

Other visitors to the FSU-CAI Center, but not included in the preceding list, include the following:

Dr. Guenter Klotz, Stuttgart, Germany, Journal of Educational Research

Northeast Georgia Instructional Services Unit, Cleveland, Georgia

E. J. Diuzet, Head of Audiovisual Department, Sintra Co., Annieres, France

ASCONTE Air University, Maxwell Air Force Base, Alabama

United States Atomic Energy Commission, Washington, D. C.

Argonne National Laboratory, Argonne, Illinois

United States Office of Education, Washington, D. C.

Dean, Graduate Studies and Research, Georgia, Tech

The Johns Hopkins University

University of Lund, Sweden

University of Uppsala, Sweden

University of Gothenburg, Sweden

Swedish Broadcasting Corporation

Senior High Schools, Sweden

U. S. Army Missile and Munitions Center and School, Redstone Arsenal, Alabama

University of Florida, Gainesville, Florida

University of Dayton, Dayton, Ohio

University of Paris, Paris, France

Board of Education of Hyogo, Japan

Florida Department of Education, Adult Education

Lowry Air Force Base, Colorado

Department of Elementary and Adult Education, Ministry of Education,
Bangkok, Thailand

School of Education, Stanford University, California

APPENDIX C

Project Status Report

| PROJECT NUMBER | TITLE | PHASE |
|----------------|--|-------|
| 0027 | Social Science Information Retrieval (it) | V |
| 0033 | A Rural County Computer Related Instructional Technology Project (read) | V |
| 0040 | ROTC History, THEMIS Investigation in Complex Mental Processes (rotch) | V |
| 0041 | The Mediated Transfer of Words (edr2) | V |
| 0042 | Finding Roots of Polynomial Equations (algw2) | V |
| 0043 | Behavioral Science Test (best) | V |
| 0044 | Preventative Maintenance Systems (pms) | V |
| 0045 | The Effect of Prior Knowledge of PERT on the Detection of Grammatical Properties in these Graphic Networks (tdunn) | V |
| 0046 | Computer-Assisted Instruction in Dynamics; Rotation of a Rigid Body in Three Dimensions (egsdy) | V |
| 0047 | Learner Control in Automated Instruction (brown, brow2) | V |
| 0048 | Individual Versus Paired Learning on an Abstract Algebra Presented by Computer-Assisted Instruction (pic) | V |
| 0049 | Effects of Memory Support on Anxiety and Performance in Computer-Assisted Learning (psy4) | V |
| 0050 | Effects of Negative Feedback and State Anxiety on Subjective Confidence Assessments (psy5) | V |

| | | |
|------|---|-----|
| 0051 | An Investigation into the Effects of Differential Example Treatments on Delayed Retention of Meaningful Material (gayri) | V |
| 0052 | Data Collection Upon Which to Base the Computer-Managed Instruction Model for Florida State University Elementary Education Teacher Training School (teach) | V |
| 0053 | Testing of Enablers in Elementary Model Field Study (quiz) | V |
| 0054 | Relationship of State Anxiety and Response Modes on Performance in Computer-Assisted Learning (ekg) | IV |
| 0055 | Computer-Assisted Instruction and Computer Problem Solving for Summer Institute (wills) | III |
| 0056 | Development of a Dynamic Decision Model for CAI Utilizing Regression Analysis Techniques (nr2, nr3, nrpic) | V |
| 0057 | Investigation of Personality Variables, Consideration of Latency and Educational Applications with the Minnesota Multiphasic Personality Inventory (fmmpi) | III |
| 0058 | An Investigation into the Effects of Retention on Differential Feedback Delay Intervals (nsf) | III |
| 0059 | A Feasibility Study Implementation and Optimization of a Computer-Managed Instruction System in Graduate Education (scury) | V |
| 0060 | Seamen Military Requirements Curriculum (smrc) | IV |
| 0061 | Effect of Sex and Stress on State Anxiety and Performance in Computer-Assisted Learning (psy6) | V |

Phase Description

- I Planning and Design
- II Coding
- III Loading and Debugging
- IV Checkout and Revision
- V Experimentation and Analysis