AUDIOGRAPHIC-BASED INSTRUCTIONAL DELIVERY: AN EXPERIMENT IN GEORGIA EDUCATION

A Report on the Findings of a Feasibility Study

To Determine the Capabilities of Audiographic Technology

For Supporting Quality Education in Georgia Schools

Project 36–605

A. P. Jensen, Project Director

Sponsored by

THE OFFICE OF THE GOVERNOR OF THE STATE OF GEORGIA

Jimmy Carter, Governor

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Jack P. Nix, Superintendent

1973

SCHOOL OF INFORMATION AND COMPUTER SCIENCE
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PREFACE

This report announces the findings of a unique educational experiment
conducted during calendar year 1972 and part of 1973 in the State of Georgia.
The experiment was designed by the School of Information and Computer Science
of the Georgia Institute of Technology; guided by the Georgia State Depart-
ment of Education; and made possible by the generous support of Georgia
Governor Jimmy Carter. The "laboratories" in which the experiment was con-
ducted were the Georgia Schools themselves, and the experimenters were ten
practicing, professional school teachers who used their classrooms to
introduce to Georgia education an important new kind of instructional de-
livery system: the Audiographic Learning Facility (ALF).

Audiographic learning technology, developed at the School of Informa-
tion and Computer Science of the Georgia Institute of Technology, provides for
the storage and replay of blackboard, narrative/line graphics lectures and
instructional materials. An extremely important feature of this novel develop-
ment in educational technology is its economy - a low cost both in equipment
and in the preparation and storage of learning materials. In its more advanced
form, as implemented in the Audiographic Learning Facility of the School of
Information and Computer Science, the system provides for random access re-
trieval of audiographic lessons via telephone, under the control of instructors
or students. Applications of audiographic technology therefore hold the pro-
mise of upgrading the quality of instruction of students through presentations
of high-quality learning materials, prepared by and recorded by outstanding
teachers, in classrooms manned by less experienced or qualified teachers; of

supplementing curricula of inadequately staffed schools; of aiding in teacher-training; of implementing individualized self-instruction of motivated students; and of providing for a more flexible delivery of instruction.

The primary goal of the experiment described in the report has thus been to make an initial assessment of the utility and effectiveness of this new instructional technology in public education. The report shows that the main results of the experiment have indeed been positive, and that the widely acknowledged potential of audiographic technology for delivering cost-effective and learning-effective supplemental instruction fully warrants its further development for use in Georgia schools.

It should perhaps be emphasized that the work reported in this document was not a demonstration, but rather an experiment. In a successful demonstration, there is little room for risk-taking, and no room at all for failure. In experiments, the situation is quite different, for risk is the very essence of good experimentation. And so, risks have been taken and even welcomed, in pursuit of the fundamental goal, which was to learn as much as possible about the uses, and the limitations, of a major development in the technology of educational delivery. The risks which were taken included the assignment of first-production, essentially prototype equipment to locations dispersed over a wide geographic area; the decision to test the equipment simultaneously in a variety of quite diverse educational environments; and the policy of encouraging each of the teachers participating in the experiment to develop and use audiographic learning materials in whatever manner suited his or her own individual teaching style.

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The consequence of taking these risks have been various, and have included: some failure; considerable success; and an invaluable increase in experience with and understanding of audiographic learning technology - a technology which offers the prospect of considerably enriching educational opportunities without commensurate increases in educational costs.

But further discussion of these observations must now be deferred for reconsideration at appropriate places in the report itself, in order to get to the main business of this preface, which consists of the task of formally acknowledging some of the many persons who contributed to the achievement which this project represents.

First and foremost, our gratitude goes to Governor Jimmy Carter and Superintendent Jack P. Nix, whose joint commitment to educational innovation provided the financial resources, administrative leadership, and moral support without which the project would not have been possible.

Then, for their welcome and wise advice, special thanks goes to Dr. Will Atwood and Dr. Gene Bottoms of the State Department of Education.

Finally, our deep and sincere appreciation is extended to the following superintendents, principals, administrators, and teachers throughout Georgia, who were unstinting in their efforts to make this project a valuable experience:

Appling County School System: Mr. J. M. Vaughn, Superintendent; Mr. Robert E. Fenn, Principal, Appling County High School; Ms. Lawanna Johnson and Ms. Pat Stoner, Teachers.

Bremen City School System: Mr. Buford Arnold, Superintendent; Mr. John Baker, Principal; Ms. Jane Bradley and Ms. Grace Ragsdale, Teachers.

Coosa Valley Vocational Technical School: Mr. J. D. Powell, Director; Ms. Pat Garrett and Mr. G. H. Wallace, Jr., Teachers.

Walker County School System: Mr. Noel Epperson, Superintendent; Ms. Ellen Marie Moore, Principal, Fairyland School; Mr. Phil Shelton, Teacher, Fairyland School; Mr. Robert Westcott, Teacher, Rossville High School; Ms. Gertrude Embree, Director, Instructional Services.

Waycross City School System: Dr. S. C. Adamson, Superintendent; Mr. Lyndol Cain, Principal, Central Avenue School; Ms. Jill Paul and Mr. John Pike, Teachers, Mr. O. D. Paul and Mr. Charles J. West, Coordinators.

After a year's experience gained from this experiment we can say that the concept of ALF is sound, and its potential firmly established. What now remains is the task of extensive field-testing, modification, and re-testing - a task which is essential for the successful general application of any major system, and which, if performed properly, will ensure that audio-graphic technology is used in a manner consistent with, and supportive of, the very best in Georgia education.

A. P. Jensen,
Project Director

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INTRODUCTION: THE AUDIOGRAPHIC LEARNING FACILITY (ALF)

Audiographic technology facilitates the electronic storage of learning materials in two forms, visual and audio. The visual consists of motion line-graphics (handwriting, drawing, etc.) synchronized with narrative audio presentations. A Victor Electrowiter transmitter is used to generate frequency modulated signals representing handwritten line graphics. These multiplexed FM signals are recorded on one channel of a stereo magnetic tape in synchronization with a second channel of the same stereo magnetic tape.

The mechanism for delivering audiographic materials has two essentially different, but complementary, levels: one utilizing decentralized storage at individual user locations, the other utilizing storage managed at one central location (usually under control of a small computer).

At the first level of use, students receive instruction by means of stereo cassette recordings made and played on portable audiographic units, each of which includes a modified cassette recorder player unit and associated special electronics equipment which generates FM signals to a speaker from one channel and to a Victor Electrowriter receiver on the other channel.

At the other level of use, a computer-controlled center can be called, and Touchtone (copyright Bell Telephone Co.) signals representing data and describing selected lesson segments can be transmitted. The student receives the audiographic media requested via telephone lines. The student is in complete control. He can start, stop, repeat, skip, etc., as he sees fit by transmitting Touchtone data. The computer control center monitors his requests and records his activities for analysis and evaluation of media and

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student habits. Since Touchtone signals are FM in nature, they too can be recorded by the author of the media to effect computer control and to close a feedback loop permitting branching strategies and effecting pseudodialog between instructor and student. (A later version of this system will permit live recording via phone lines, thus facilitating such interactive dialog.)*

The first level of use is the one which has been explored by the efforts described in this report, and which is depicted in Figures 1 and 2. The second level will be explored in state government under funding by the National Science Foundation.**

Figure 1 shows a teacher recording a lesson for subsequent classroom use. Shown on her desk is a microphone, for entry of the audio portion of the lesson, and a standard Electrowriter transmitter, for entry of the graphics portion. Using the transmitter's writing stylus (similar in appearance to an ordinary ballpoint pen), the teacher may enter formulas, diagrams, drawings, or any other "chalkboard-type" materials. When she has finished with the page she is working on and desires more writing space, the teacher may in effect "erase the board" by signaling for a page change. The used surface will then roll out of the transmitter, and new paper will be fed from a roller in the front.

The wires extending from the microphone and the transmitter lead to a specially modified recording unit, which makes it possible to capture the audio portion on one channel of the stereo cassette, and the graphics portion on the other. The left track contains frequency modulated signals generated

by the position coordinates of the writing stylus of the transmitter. (The main reason for the modification is to provide for the removal of distortions which would otherwise occur in graphics reproduction as the result of normal wow and flutter characteristics of all tape recorders.) The graphics and audio entries are recorded synchronously and completely, including all page change signals. It is thus possible to replay the lesson exactly as it was recorded. The replaying of a lesson during a formal class session is illustrated in Figure 2, which shows, along with the recording unit, a Victor Electrowriter receiver system. This system consists of a unit for accepting the recorded graphics signals and reproducing graphics materials on an acetate surface, and a projector which is used to enlarge those graphics and project them onto a wall or screen. In addition, a speaker attached to the recorder allows simultaneous reproduction of the recorded narrative (audio) portion of the lesson.

For the sake of completeness, a pictorial representation of a computer-based facility (not employed in the present experiment) is shown in Figure 3. Recording procedures for that kind of use are identical to the procedures used in the experiment described in this report, except that the recordings are made on reel-to-reel tapes rather than on self-contained cassettes. Access to individual lesson units on the tape is controlled by a minicomputer, and transmission of the material to the individual or group learning station is accomplished over ordinary telephone lines.

Because of its conceptual and operational simplicity, the system (in either of its forms) has a potential for cost-effectiveness which is extremely
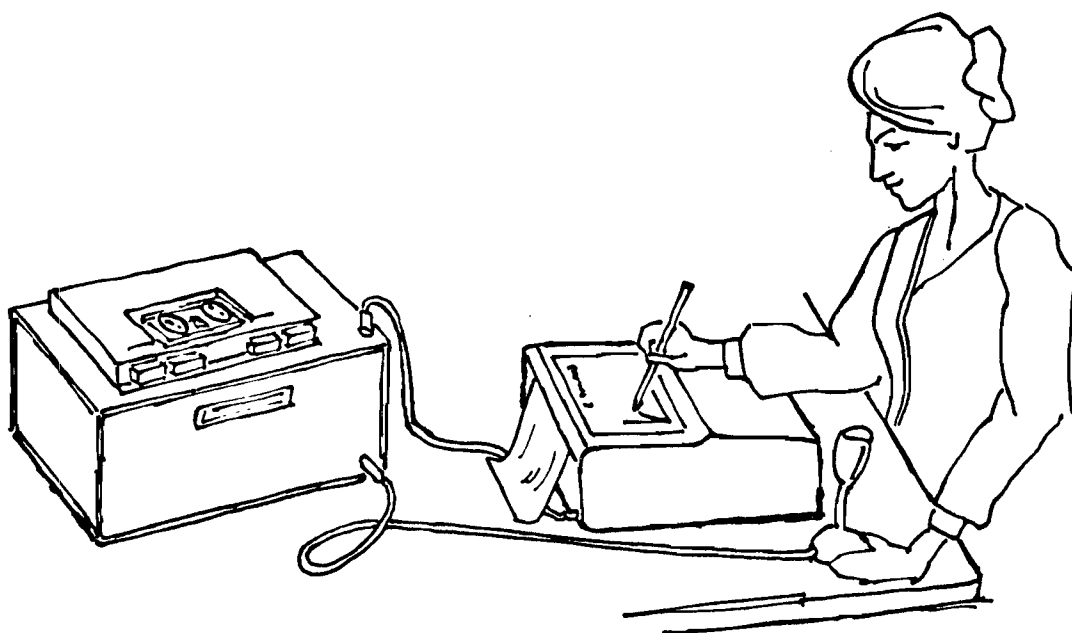
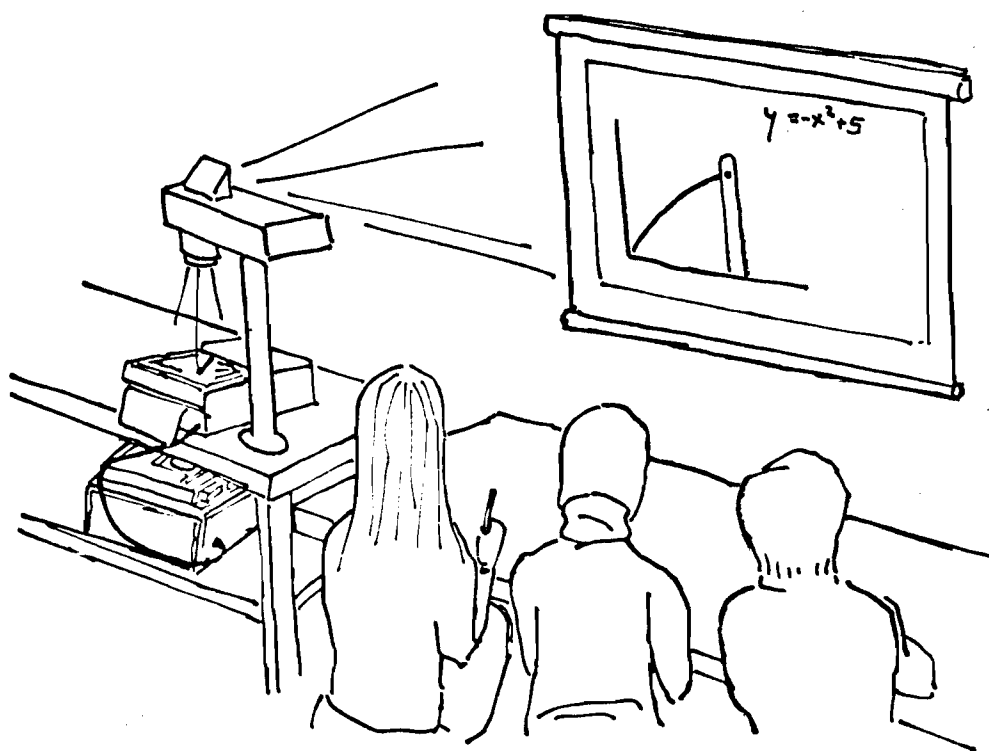FIG. 1. TEACHER MAKING AN AUDIOGRAPHIC RECORDING

FIG. 2. STUDENTS VIEWING AN AUDIOGRAPHIC PRESENTATION

favorable relative to other kinds of educational technology (especially computer-assisted instruction). The operation of the equipment will eventually be no more complicated than the operation of an ordinary tape recorder, and even now an instructor needs no special training to produce learning materials for the system. Therefore, any teacher who is prepared to deliver an effective chalkboard lecture is prepared in all essential respects to deliver an effective lecture via the Audiographic Learning Facility.

When these characteristics of simplicity, economy and flexibility are supplemented by the system's potential for facilitating truly "conversational" learning* and for delivering low-cost, high-quality continuing education the system is clearly seen for what it is: the crucial first phase of a new breakthrough in individualized instruction for the masses.

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* This conversational aspect of the system is discussed further in Vladimir Slamecka, Alton P. Jensen, and Pranas Zunde, "An Audiographic Repository of Knowledge for Conversational Learning," Educational Technology 11:15-20 (Sep. 1971).

Tape Library

Recording by teacher

Minicomputer

Lesson transmitted to individual or group learner station via ordinary telephone line

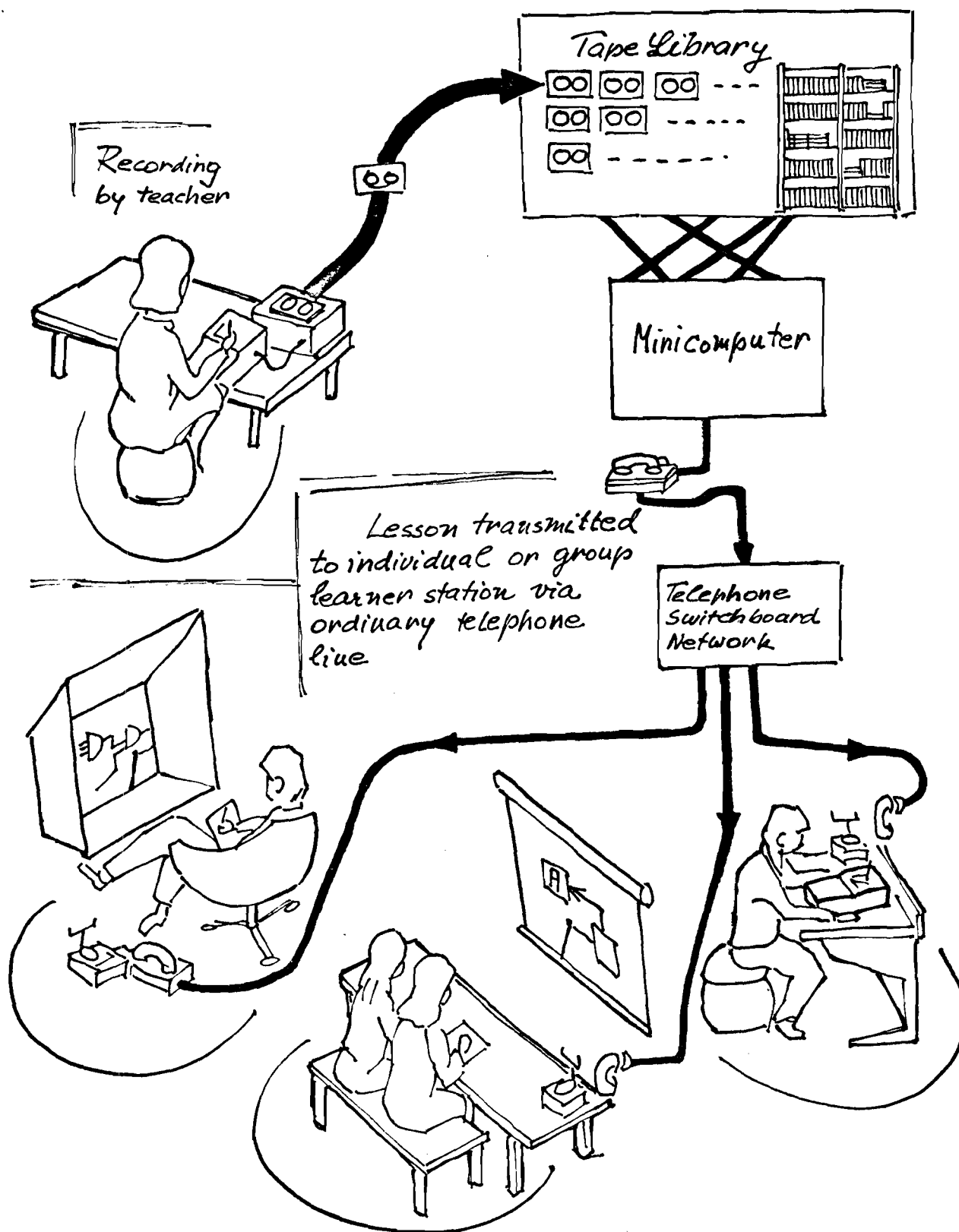Telephone Switchboard Network

FIG. 3. SCHEMATIC OF A COMPUTER-CONTROLLED AUDIOGRAPHIC LEARNING FACILITY

HISTORY OF THE PROJECT

<u>Initial Activities</u>

During the first month of the project, all of the participants were invited to the Georgia Tech campus to receive a basic orientation in the capabilities of the ALF system, and to review and discuss the nature of their involvement in the experiment. It was emphasized in this general meeting that it was not the intention of the experiment to impose a single administrative approach on all participating schools. Rather, it was hoped that from the diversity of environments would emerge a welcome diversity of ideas that would provide a valuable resource for guiding the future development of the ALF system.

The general meeting at Georgia Tech was followed by visits to each of the participating schools by staff members from the School of Information and Computer Science. These visits were used to answer unresolved questions, to review administrative arrangements for implementation of the experiment in local settings, and to discuss the subject areas for which participating teachers would prepare instructional materials in audiographic form.

In all cases, teachers were free to select for themselves what kinds of lessons they wanted to adapt for this experiment. In general, they chose to teach subject areas which they had taught before and in which they therefore felt comfortable and self-confident. The principal exception to this approach was found in the response of the teachers at Coosa Valley Vocational Technical School, who chose instead to use audiographic technology to develop a sequence of instructional materials which had never been taught. For their principal

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subject areas these teachers chose Vocabulary Development for Business Education and Vocabulary Development for Technical and Vocational Specialization. The intent of the lessons prepared for these sequences was to provide new students with an entry vocabulary that would ease them into the new and unfamiliar business and technical jargons of their chosen specialties.

Subject areas chosen by the other schools participating in the experiment were: Algebra I (Bremen H.S.); Albegra II (Appling County H.S. and Waycross Central Avenue H.S.); Bookkeeping I (Bremen H.S.); Energy for the Gifted in Elementary School (Fairyland School); General Math (Waycross Central Avenue H.S.); Grammar (Appling County H.S.); and Marine Biology for the Gifted in High School (Rossville H.S.).

Each teacher planned eventually to prepare enough audiographic learning material to support approximately sixty classroom hours. Of course, this goal represented considerably less than sixty hours of tape, since the amount of recorded material approprate to the support of a particular lesson would vary from subject to subject and lesson to lesson, and in some cases would be quite small. In any event, the percentage of each classroom hour devoted to the use of audiographic technology was left to the discretion of the individual teacher - as were all decisions having to do with conducting the class.

Preparation of Instructional Plans

During the first months of the project the equipment purchased for the experiment was not available for delivery to the schools. This unavoidable delay happened because the contract for the twelve-month period could not be signed until the second half of February 1972, and because subsequent unanticipated

difficulties were incurred in the procurement of hardware and supplies on account of state bidding procedures that had to be followed. However, the teachers participating in the experiment were by no means without important work to do during the period of waiting. Thus, in anticipation of delivery of the equipment, the teachers began the task of developing general plans for the lesson sequences which they would subsequently prepare and record. It was suggested that the teachers develop their plans in accordance with the broad guidelines summarized below:
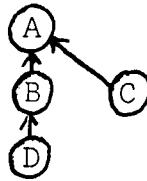
Guidelines for Organizing Instructional Materials for ALF

A principal feature of ALF is that it allows goal-directed learning on the part of the student. That is to say, incorporated into the design of the system is the recognition that different learners approach a given body of knowledge from a variety of different perspectives. Learners have different kinds of and levels of previous education, different interests and different needs. To accomodate these differences, the ALF experiment is attempting to explore techniques for developing and formalizing multiple "strategies" from which a learner can choose one which best satisfies his own information needs.

However, the development of formalized learning strategies will necessitate the creation of a highly structured set of learning materials. Therefore, meticulous organization of the course prior to its entry into the system is an essential prerequisite for the success of the project. The following steps, then, are required:

1) Identify the major learning goal appropriate to the course. For the purposes of this experiment, a "course" will be defined here as a sequence of approximately 60 classroom hours which are devoted to instruction in one "subject" (e.g. Algebra II, Business Math, etc.) that can be taught in a classroom situation during Fall 1972.

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2) Develop behavioral objectives for the course, and prepare two
   tests which would measure a student's mastery both of the material
   presented in the course and of material identified as knowledge
   prequisite to the course.
3) Identify all of the principal concepts which must be mastered
   to achieve the learning goal.
4) Draw a precedence graph which shows the relationship between all
   concepts. The following is an example of a small part of such a
   graph; an arrow indicates an interrelation of two concepts, and
   the direction of an arrow identifies which of the two concepts
   must be understood before the other can be grasped. In the
   example:

   concept D would have to be learned before concept B is mastered;
   concepts B and C are prerequisite for a mastery of concept A.
5) For each concept, plan an appropriate number of ALF "lessons."
   A lesson will be defined as an audiographic lecture presentation of
   5 to 15 minutes in length. (It may be longer, however, if
   necessary). A lesson should be directed to one specific purpose,
   of which the following are some examples: (a) The definition and
   explication of some sub-concept or some set of related defini-
   tions; (b) A discussion of a concept introduced in a previous
   lesson; this further discussion might be devoted to offering a
   variety of examples of the concept to reinforce the concept; (c)
   A discussion of how a previously introduced concept might be
   viewed from a quite different perspective; this discussion
   would presume mastery of the basic notion, and would essentially
   constitute "enrichment" material.
6) Draw a precedence graph between lessons, similar to the one
   which was developed earlier for major concepts. Assign each
   lesson a unique lesson number.

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7) Now consider possible strategies for learning the material; e.g., strategies with such purposes as: (a) providing an overview of the course; (b) providing a review of the course; (c) providing selections of only certain key topics for learners with special reasons for taking the course; (d) providing additional (i.e., redundant) material for slow learners; (e) providing enrichment material for gifted students; and so forth.

8) Begin to document these possible strategies by identifying a sequence of lesson plan numbers associated with each.

At the conclusion of these eight steps, the instructor will be ready to begin the development of detailed material for entry into the system, and will begin to write the lessons, plan the graphics, and record the lessons.

It became apparent by the end of the first quarter that, in general, the teachers participating in the experiment did not feel entirely comfortable with the methodology outlined above. They acknowledged the desirability of preparing behavioral objectives for instructional material, but they were less responsive to the suggestion that, since different learners approach a given body of knowledge from a variety of different perspectives, it was appropriate to "explore techniques for developing and formalizing multiple 'strategies' from which a learner can choose one which best satisfies his own information needs". The reason for this uncertain response to an attempt at individualization seems to be rooted in the fact that the experience of classroom teachers is developed in the context of a search for a common denominator among the students. Thus, a good teacher usually adopts a middle-ground approach: trying to go neither too fast for the slower student nor too slow for the more gifted one. The compromise which this instructional tactic represents is an entirely prudent and justifiable one, given the exigencies of classroom

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teaching and the desirability of being fair to all students. However, the habit of searching for the common denominator is perhaps not the best preparation for developing and formalizing multiple learning strategies. In future experiments, therefore, this task would probably be best assigned to subject specialists, who would develop lesson specifications to guide teachers in the preparation of instructional material to meet specific needs in a well-planned "lesson base."

Planning of Media

During the second quarter, partial equipment deliveries were made to each of the school systems. Although the recording units were still in the production phase, it was thought desirable to deliver transmitters, receivers and projectors so that the participants could become accustomed, through practice, to the use and requirements of equipment-dependent techniques. It was felt that a familiarity with such techniques would be essential for the participants as they proceeded with the major work of this phase, which was the detailed planning of specific lessons for subsequent recording.

In order to guide the participants in the development of specific lessons, guidelines for media development were prepared and distributed. Though attempting to provide firm direction to the participants in their efforts at media development, these guidelines were nonetheless intended to allow participants considerable discretion based on their own experience, and to encourage them to use their professional judgements concerning the most effective use of the Audiographic Learning Facility in the specific

contexts of the educational environments and requirements associated with their various schools.

The material included some discussion of the kind of documentation that would eventually be necessary to manage a large "lesson base" of materials, which would be developed and used by a number of different teachers for a variety of different purposes. And so the guidelines included some discussion of topics such as lesson modularity, learning strategies, lesson catalogs, and system management and control. However, the essence of the guidelines consisted of information concerning tasks more central to the restricted concern of the present experiment. It included information concerning: use of graphics; recording techniques; and lesson documentation. For the sake of completeness, these guidelines are repeated below:

Excerpt from "Guidelines for Media Development"

1) Use of Graphics. Effective use of ALF requires an active graphics presentation, and the lesson should therefore be planned around the graphics. Write the notes or the script for the lesson in the following format.

 *Page change
 *Identify the main topic
 *Begin graphics and accompanying discussion
 *Introduce next item of discussion (e.g., "Now that we have discussed the Legislative and Executive branches of govern-ment, let's next consider the Judiciary.")
 *Page change
 *Begin graphics and accompanying explanation (e.g., "The Judiciary....."")
 etc.

Plan graphics so that the illustrations will be as simple and as large as possible; don't crowd too much visual information on one page. In general, adjust your illustration so that it will be large enough to fill up the whole page - even if it is only one word (e.g., "Polynomials").

Most important of all, don't leave the page blank for long periods of time. Even the simplest graphics are preferable to a blank screen. Develop dynamic graphic illustrations to the extent that the illustrations support and explain your topic of discussion. Use simple graphic devices: ⚥ meets ⚥ . Avoid creating graphics which become ends-in-themselves.

2) Recording Techniques. Recording skill will come only after a few hours of experience. The following suggestions are meant merely to provide some very general guidance for your consideration as you proceed to develop your own styles:

*Speak in a natural voice, as you would speak to a class. To help you retain naturalness, you may find it preferable to speak from notes rather than from a word-for-word script. Practice psycho-cybernetics; picture yourself speaking to your class or a particularly enjoyable and interested student - and communicate.

*Write or print with smooth strokes, keeping the pen in touch with the paper as much as possible. Avoid jerky motions, and try not to write too fast.

*When you are not writing, slowly move the pen to the lower margin of your pad. Put it down completely or hold it still, so that meaningless motions do not distract the student.

*The tip of the stylus on the transmitting unit corresponds to writing point which is not at the tip of the stylus on the receiving unit. Therefore, to point at something, one should aim the pen about three-fourths of an inch below the object intended. (The best way to learn to do this is to record with the projector on, and to watch the projected graphics as you point. After you develop this facility,

record without the receiver, and concentrate on your con-
tent.)

*Don't talk during a page change. Follow the format suggested
previously: i.e., introduce the next item of discussion, then
make a page change, then begin the discussion. (It will be
good practice to disconnect the microphone prior to and dur-
ing your page change to avoid the RONK!ing noise being
recorded.)

3) Documentation of Lessons. After each lesson has been recorded,
enter the following information on a Lesson Documentation Form.

*Topic. Enter brief title of the lesson.

*Level. Characterize the approximate level of difficulty by
entering grade levels of typical students for whom the
lesson was prepared.

*Running Time. Enter running time of lesson (in minutes).

*Description. Describe the lesson with terms or phrases which
will suggest its content and approach.

*Prerequisites. Identify the prerequisites of the lesson not
by referring to other lessons or courses, but by describing
in words what knowledge you assume the student to have.

*Behavioral Objective. Include a statement of the objective of
the lesson to indicate what a student who has taken the lesson
should be able to do.

*Lesson Prepared by. Enter your name and identify your
school.

*Date. Date of preparation.

*Validation. Name of colleague or student who may have re-
viewed the lesson with you; comments you deem important;
results of any tests you have made.

Media Preparation and Documentation

One recording unit was delivered to each participating school system
during the early part of the third quarter, and by the end of the second

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month of the quarter all schools had received full complements of equipment. Participants began the production of cassettes based on the guidelines presented above. In a progress review with Dr. Will Atwood of Georgia Department of Education offices, it was agreed that the adjustments in project management necessitated by equipment delivery delays would not be a serious impediment to the success of the project, but would simply mean that primary evaluation would emerge, not from a series of small, formal experiments but from the professional assessments of participating educators.

For documenting their experience with the use of the facility in classroom and other learning situations, all participants were provided with copies of forms which attempted to elicit, for each use, answers to the following questions:

Purpose. What was the presentation? Was it for a scheduled session? A remedial session? An enhancement session? Etc.

Innovative Uses. Was there any kind of innovative use associated with the presentation? For example, was it used for individualized instruction? Tape manipulation ("instant replay")? Self-quiz? Was the tape stopped for classroom discussion? Etc.

Student Response. Did students respond favorably?

Personal Evaluation. Were you satisfied with the presentation? What modifications would you make if using it again for this purpose? Can this presentation be used again? For what kinds of groups?

Method of Use. How did you use it in class? Before discussion? After discussion? Etc.

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Implementation in the Classroom

During the fourth quarter the materials developed previously were tried out in classroom situations, and documentation forms completed. In addition, teachers experimented with live recording (and live use without recording, via the system's "monitor" feature). Also, other teachers in addition to the formal project participants made use of the equipment. (The results of this use and the comments of students, other faculty, and the teachers themselves -- through diary forms, progress reports, and discussions with Georgia Tech staff - are analyzed in the remainder of this report.)

Use of the equipment continued during an extension of the project into the first half of 1973. In order to gain some further experience with the management of a central audiographic media facility, and to assess the impact which possession of a relatively large number of units might have on a single school, five units were gathered from their previous locations (in the Bremen, Walker County, and Waycross School systems) for reassignment to Coosa Valley Vocational-Technical School and for modification. Two additional units were assigned to the CVVTS.

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EVALUATION OF ALF IN GEORGIA EDUCATION

Objectives of the Evaluation Study

The primary intent of this experimental program has been to make an initial assessment of the utility and effectiveness of audiographic instructional technology, and to plan for a more intensive investigation of its applicability to Georgia's educational needs. To obtain such an assessment, it was appropriate to recruit the diverse talents of a group of educators whose collective experience spans a broad range of subject-area expertise. The diffusion of effort resulting from such a recruitment plan was more than justified by the need to obtain enough experience in each subject area to allow a prudent focusing of subsequent research efforts on the one area which promises the biggest payoff in terms of Georgia's educational priorities.

Thus, the schools chosen for the experiment were selected on the basis of three principal criteria: the desire to participate; a history of innovation in education; and an ability to represent any one important segment of Georgia education. Application of these criteria resulted ultimately in the selection of one elementary school, four high schools, and one post-secondary school. Three of the schools are administered by county school systems; two by city school systems; and one of the schools is an area-wide post-secondary vocational and technical facility. Of the four school systems providing elementary and secondary education, two are in the northern and two in the southern part of the state.

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The broad goal of initial technology assessment contained within it four more specific objectives: (1) the development of experience to guide the production of standard techniques and procedures for the preparation, recording and management of learning materials in audiographic form; (2) the introduction of audiographic instruction in selected schools and the preliminary assessment of its potential for improving the quality of instruction and for receiving the acceptance of teachers and students; (3) the evaluation of technological devices under conditions of extended usage; and (4) the assessment of the associated direct and indirect costs and benefits of audiographic instruction and self-instruction.

A later section of this report will discuss the recommendations which have emerged from the findings sought by these four objectives. For the moment, it will be sufficient merely to consider each objective in enough detail to appreciate the implications of the questions to which it seeks answers.

With respect to the first objective, it is necessary to evaluate the trade-off which exists between the articulation of standard techniques and the insistence on the preeminence of the individual teacher. A teacher fills a dual role: part author, part tutor. As a tutor, the teacher makes use of learning materials designed by others; as an author, he in some sense creates his own material, as he would write his own book. Thus, in his authorship role, the teacher will tend to exercise the prerogatives of authorship, and do things the way he wants to (which may in fact be simply the only way he knows). To the extent that, in a given situation, it is desirable to standardize instruction, to that same extent will it be necessary to have subject-

specialists preempt the authorship function somewhat by supplying the teacher with detailed, content-oriented instructions for the preparation of an audiographic lesson.

The second objective of the evaluation requires interpretation in the context of a specific educational environment, and the answers to the questions it poses may well change from school to school. Like any other technology or like any other teaching tool, audiographic technology will be relatively more or less useful to a teacher depending on his own attitude toward it. Since audiographic technology is in its infancy, the decision to pursue extended developmental research within a particular application area must depend to a large extent on the demonstrated interest of the user and on his ability to utilize the technology effectively. No innovative and experimental system is ever received with equal enthusiasm and resourcefulness by all users. Therefore, the purpose of this study was partially to acquire sufficient knowledge of the participants in the experiment so that an effective reallocation of future efforts could be accomplished in such a way as to consolidate those efforts in the one application area which shows greatest potential for extended development.

The third objective was to test the equipment itself "under conditions of extended usage". The nature of "extended usage" has two dimensions: temporal and spatial. In regard to the first dimension, the objective meant determining how the equipment functioned week after week and month after month; in regard to the second dimension, the objective meant determining how the equipment functioned when installed at a number of widely separated "field locations" not frequently visited by trained technical personnel. Each of the two dimensions of the question yielded a somewhat different answer during the course of the experiment. The equipment has required,

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over time, only the most minor and routine of adjustments, and in that sense has therefore performed superbly. However, because of the diffusion of effort at six different locations besides Atlanta, minor technical problems sometimes translated into major frustrations for teachers with no technical knowledge of the system. This state of affairs is certainly not out of the ordinary for the implementation of an innovative technology, but it reinforces the desirability of consolidating research efforts at one location while system refinement continues.

The fourth objective was simply to assess the associated direct and indirect costs and benefits of audiographic instruction and self-instruction. Of course, only tentative cost/benefit relationships can be derived from a study which did not attempt extensive implementation within any given environment; however, certain broad conclusions are quite possible even from an inquiry restricted to small-scale experimentation in diverse settings.

In summary, it may be said that the goal of the study was to explore the potential of audiographic technology from the points of view of two kinds of economy - dollar economy and learning economy. From the former viewpoint it was desirable to gain some experience concerning both hardware costs, maintenance costs, software costs and usage costs, all of which now appear to be quite modest in terms of educational experimentation and in the context of a large-scale implementation at a single location. From the latter viewpoint it was desirable to gain some experience concerning the system's ability to capture the interest of practicing teachers (contrasted with media experts). For the greatest single resource of an educational system is the experience of its teachers, and no system which (in the name

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of technological advancement) underutilizes that resource can claim to be economical. Rather, an educational technology must be economical both with financial resources and learning resources. In this experiment it has therefore been important to establish that audiographic technology is emphatically "learning effective," in the sense that professional, experienced teachers are able to accept it as an innovation and agree to offer their own expertise as a valuable "system input."

Constraints on the Study

Some of the practical but less important constraints on the study are obvious from the nature of the project itself: its small size, its intentional diffusion of effort over a wide geographical area, and so forth. All such constraints necessarily limited the scope of the investigation. For example, it would obviously be desirable (though cost-prohibitive) to conduct an in-depth logitudinal study of two large student groups - one of which was educated in a comprehensive program of ALF-based instruction, the other of which served as a control group. However, such an evaluation would require nothing short of a massive implementation of the system throughout some given school, and nothing short of several years of evaluation.

On the other hand, none of the practical constraints were as important as one which was self-imposed for what are essentially conceptual, pedagogic and philosophic reasons. This self-imposed constraint was the decision to deliberately integrate the use of audiographic technology with live classroom teaching. The decision is characterized as a constraint of the study because

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it effectively prevented an ultimate determination of whether a student learned "more" from the live classroom discussion or from the lecture presented via an audiographic recording. The reason for such a decision is rooted in the conviction that the best use of the system is as a supplement to personal, live instruction.

Thus, the system has been promoted principally as a vehicle for enriching and extending in-classroom education - not replacing it. Certainly, there are many cases in which there is no practical way of offering live instruction (e.g. to shut-ins, or for remotely located continuing education groups), and in most such cases audiographic technology unquestionably offers an extremely attractive medium of educational transfer. However, where live instruction is available it should most emphatically be used; in such a case, the essential contribution of audiographic technology is to introduce flexibility, variety, individualization, and maximization of teacher resources.

Under this study contraint, the investigation eschews formulation of an hypothesis suggesting that instruction via audiographic technology is more effective than live instruction at its best, and is quite content with the more modest suggestion that audiographic technology offers the educator a useful new medium which he can use to amplify his presence and refine his instruction.

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ALF LEARNING MATERIALS

The motivation for the development of the Audiographic Learning
Facility has been the desire to use technology to effect an efficient and
effective dissemination of instructional materials. Thus, the Audiographic
Learning Facility is essentially an educational "delivery system" which
provides useful new communication links between teachers and learners.
A requirement of a technology for such a delivery system is that it must
serve as a relatively unobtrusive and relatively neutral part of the learn-
ing process. That is, it must not force a teacher to adopt some arbitrary
and unnatural mode of expression, to present all material in a single un-
changing format, or to abandon the teaching skills learned patiently after
a number of years of experience at a chalkboard in front of live classes.
For the essential purpose of an educational delivery system is not to force
a change on education, but rather to facilitate education - by respecting
the special idiosyncratic qualities of individual experienced teachers.

The Audiographic Learning Facility meets these requirements by making
it possible for a teacher to record a lesson in virtually the same manner
in which the material would be presented in either a classroom or a tutorial
setting. The process of recording a lesson for the Audiographic Learning
Facility is in most respects the same as the process of delivering a lecture
at the chalkboard or of using a scratchpad to work problems with an individual
learner.

For purposes of discussion, an example of a lesson prepared for delivery via audiographic technology is given below.* It is a discussion of a topic appropriate to a first course in bookkeeping, and is built around a simple graphic showing the journalizing of business transactions in a cash journal.

However, before reproducing this lesson it may be desirable to summarize the lesson documentation prepared to accompany it. Accordingly, the lesson description is as follows: "A step-by-step presentation of recording business transactions in a cash journal. Proving equality of debits and credits in the journal. Proving cash." Prerequisites for the lesson are simply: "An ability to analyze business transactions." Finally, the behavioral objectives associated with this lesson are: "1. Students will be able to record business transactions in a cash journal. 2. Students will be able to prove the equality of debits and credits in the cash journal. 3. Given the necessary information, students will be able to prove cash."

The transcription of the lesson, developed from the script prepared prior to recording, is given below. In this script, cues for entering new parts of the graphic are given in capital letters and contained within brackets. The completed graphic for the main part of the presentation is shown as Figure 4.

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/WRITE "JOURNALIZING BUSINESS TRANSACTIONS"/

All business transactions can be journalized in a two-column

general journal. However, many businesses find it more efficient

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* The lesson used for this example was developed from standard textbook materials by Mrs. Jane Bradley, Bremen High School.

to use a special journal to record cash transactions. A special journal saves space in journalizing and also saves time in posting.

Cash journals may have any number of amount columns. Today we will look at one with five amount columns.

/PAGE CHANGE. DRAW JOURNAL COLUMNS AND WRITE COLUMN HEADINGS/

The first column on the left /POINT/ is the Cash Debit column. The next column is the General Debit column /POINT/. This column /POINT/ is the Date column. The wide column /POINT/ is the Account Title. This narrow column /POINT/ is the Number column. This /POINT/ is the posting reference column. The first column on the right /POINT/ is headed General Credit; the next amount column is Service Sales, Credit /POINT/; and the last amount column /POINT/ is Cash Credit.

Although the form of the cash journal is different from that of the general journal, the entry for each transaction is still divided into two equal parts – a debit part and a credit part. The analysis of the transaction is still the same. Nothing is different except the mechanics of recording the entry.

Let's record these transactions in the special cash journal.

Transaction 1. September 1. Received cash, $20, from the sale of an old adding machine. Issued Receipt No. 1.

Step 1. Record the date. /WRITE "1972, Sep. 1"/

Step 2. What account is debited? That's right. Cash. Since we have a special Cash Debit column, it is not necessary to write the account title. All we need to do is write the amount in the special column. /WRITE "$20"/

Step 3. What account is credited? Office equipment. Since there is no special column for Office equipment, we must write the title of the account in the Account Title column. /WRITE "Office Equipment"/

Step 4. Describe the source document. The No. column is used to record both receipt numbers and check numbers. This is

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Cash Debit	General Debit	Date Mo/Yr	Date Day	Account Title	No.	Post Ref.	General Credit	Sales Services Credit	Cash Credit
20.⁰⁰		72 Sep	1	Office Equip	R1		20.⁰⁰		
	200.⁰⁰		4	Ace Equip	CK1				200.⁰⁰
1,000.⁰⁰			5	John Doe	R2		1,000.⁰⁰		
25.⁰⁰			10	✓	R38			25.⁰⁰	
	200.⁰⁰		15	Rent Expense	CK2				200.⁰⁰
1,045.⁰⁰	400.⁰⁰		30	TOTALS			1,020.⁰⁰	25.⁰⁰	400.⁰⁰
				Cash Proof					
				Beginning Balance					1,000.⁰⁰
				Plus cash receipts					+ 1,045.00
				Less cash payments					2,045.00
									- 400.00
				Equals amount of cash that should be on hand					1645.00

FIG. 4.   COMPLETED ALF GRAPHIC FOR LESSON ON JOURNALIZING
BUSINESS TRANSACTIONS

receipt number 1. /WRITE "R1"/

That is all there is to recording a cash receipt transaction in the cash journal.

Let's record a cash payment transaction.

Transaction 2. September 4. Paid cash, $200, to Ace Equipment Company in part payment of the amount owed. Issued check number 1.

Enter the date. /WRITE "4"/

What is debited? Ace Equipment Company. Since there is no special column for Ace Equipment Company, we must write it in the Account Title. /WRITE "Ace Equipment Co."/ and we must enter the amount in the General Debit column. /WRITE "$200"/

Cash is credited and since there is a special Cash Credit column, all we need do is enter the amount in that column. /WRITE "$200"/

The last step is to enter the check number in the No. column /WRITE "Ck 1"/

Transaction 3. September 5. Received cash, $1,000, from John Doe, the Owner, as an additional investment in the business. Issued receipt number 2.

Write the date. /WRITE "5"/

Write the debit part. What account is debited? Cash, because an asset is increased. Write $1,000 in Cash Debit column /WRITE "1,000"/

What account is credited? John Doe, Capital. Is there a column for this account? No. How do we handle this? That's right. We write John Doe, Capital, in the Account Title column. /WRITE "John Doe, Capital"/ Where do we put the amount? In the General Credit column. /WRITE '$1,000"/ Describe the source document. /WRITE "R2"/

Transaction 4. September 10. Received cash, $25, from dry cleaning services. Issued receipts numbers 3-8.

Write the date. /WRITE "10"/

Cash is debited. Enter $25 in Cash Debit column. Service

Sales is credited. There is a special column for Service Sales
so enter $25 in that column.   /WRITE "$25"/

Since both the debit part and the credit part of the entry
are in special columns, it is not necessary to write an account
title. Place a check mark /MAKE CHECK MARK/ in the Account
Title column to indicate that no account title need be written.
Describe source document.   /WRITE "R3-8"/

Transaction 5.....

****

The remainder of the lesson will not be reproduced in this report,
except for the short passage which follows:

Before the amounts are posted from the cash journal, we must
prove that debits equal credits. You remember that each journal
entry contains a debit amount that is equal to the credit amount.
Since this is so, the total of the debit footings should equal
the total of the credit footings.

On a piece of scrap paper, prove the equality of the debits
and credits. Add the total of the Cash Debit column, $1045, and
and total of the General Debit column, $400, together. Did you
get $1445? Now add the total of the General Credit column, $25,
and the total of the Cash Credit column, $400, together. Did
you get $1445? We have proved that debits equal credits in the
journal.

If the debits had not equaled the credits, we would know
that one or more errors had been made. The error or errors should
be located and corrected before proceeding any further.

After proving the equality of the debits and credits in the
journal, the next step is to prove cash. Proving cash means
determining that the amount of cash on hand agrees with the
bookkeeping records.

Follow this procedure in proving cash ....(etc.)

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The Dynamics of Graphic Illustrations

One of the important pedagogic features illustrated by the lesson excerpted above is the capability of audiographic technology for capturing the dynamics of a graphic illustration. In a textbook, the usual method of presentation of a graphic is to show only its finished state; thus, a textbook illustration for the lesson excerpted would probably look exactly like Figure 4, and would therefore fail to convey how the transactions were actually recorded in the journal <u>one step at a time</u>. Even if some attempt were made in the textbook to suggest the dynamics of the journal by showing a series of snapshot reproductions of the journal at various moments in time, the result would still be incomplete unless a separate snapshot were given after each and every step - an impractical suggestion. In addition, the essential lifelessness of such snapshot reproductions cannot help but give them a diminished reality in the mind of the learner.

In contrast, audiographic technology allows the teacher to show a learner exactly how an illustration builds up, using the same teaching methods that would be used at a teacher's chalkboard or on a tutor's scratchpad. Whether it is used for journal entries, sentence transformations, equation solutions, or numerous other kinds of exercises, this dynamic capability can be used to extremely good effect.

The Level of Graphic Detail

At the present state of equipment development, the graphics capability of the system is limited somewhat as to the level of detail which can be presented. The writing area on the Electrowriter receiver is simply not large

enough to allow an extremely detailed or lengthy illustration. Thus, the
simplified journal shown as Figure 4 can be taken to give an approximate
representation of the limit of detail which can be effectively presented in
one graphic illustration (i.e., without a page change which, while provid-
ing more writing space, will also remove from sight what is already on the
screen).

Virtually all the teachers who have worked with the system have ex-
pressed the desirability of having a writing area which allows a somewhat
greater level of graphic detail, and this consensus has provided a valuable
input to the developmental effort. The eventual solution to this problem
will probably lie not in the enlargement of the actual writing surface,
but in a system modification which incorporates a receiver capable of re-
ceiving and clearly projecting more complicated and more finely detailed
illustrations than are now possible.

On the other hand, the participants in the experiment agreed that en-
hancement of receiver capabilities was, though desirable, not essential to
the effective use of the system. The limited size of the graphics surface
is a constraint like any other constraint: even with a chalkboard a teacher
can wish for more space. The real answer is careful lesson planning; with
a well planned lesson a teacher is seldom seriously hampered by insufficient
writing space. To the contrary, the division of particularly complicated
graphics into logical segments can enhance the clarity (as well as improve
the pace) of the presentation.

Self-Testing Via ALF

The second segment of the lesson excerpted above gives some suggestion of the way audiographic technology can be used for self-testing. The method is simplicity itself: it is to ask a question and wait for the answer (while it is perhaps being worked out on scrap paper). In a narrow sense this is no different from a textbook self-test which asks a question in the front of the book and answers it in the back. However, audiographics technology offers the following definite advantages over textbook self-testing: it can literally <u>pause</u> for the student, and it can <u>reward</u> him (or correct him) with a dynamic version of the problem solution presented after his response. (A teacher-prepared solution to the problem is not presented in the extremely simple example included in this excerpt, but that technique has been used successfully in a number of lessons presented via ALF on various subjects.)

At a later stage of development, the central Audiographic Learning Facility at Georgia Tech will be used in conjunction with computer control programs which will monitor student responses to self-tests, evaluate those responses, and suggest remedial, sequential, or enrichment materials for the student based on that evaluation.

THE FUTURE OF ALF IN GEORGIA EDUCATION

The principal indicators of whether a technology-based instructional delivery system is likely to make an important contribution to education are: its economy; its administrative flexibility; its potential for facilitating individualization of instruction; its ability to allow re-use and interchange of learning materials; and its technological compatibility with an extended network of remotely connected learning resource centers. As is indicated by the following discussions of the past year's experiment, audiographic technology continues to appear extremely attractive with respect to each of these characteristics.

Economy

In addition to system hardware costs it is necessary to consider equipment maintenance costs, cost of materials, and software costs (including especially the cost of preparing instructional materials for use on the system).

Currently, the cost of a complete cassette-version portable system is approximately only $4,300, including graphics transmitter, stereo recording unit modified with a specially designed compensator, graphic receiver unit, and projector. (In a remote application a typical learning station would be equipped simply with a data set, a receiver and a projector, and would thus be even less expensive than a self-contained portable unit; total cost of such a learning station would be under $2,000.) Since none of the components of the present system are yet produced in large quantities, it is

projected that future versions of the system will be available at dramatic cost reductions. The projector, for example, now costs approximately $600, which is approximately ten times what it would cost when mass-production techniques are applied in anticipation of full-scale implementation.

Cost of materials consists essentially of minor expenses for ink, paper, acetate, and ordinary stereo cassettes. The cassettes, of course, are re-usable -- both in the sense that they may be replayed for any number of learning groups, and in the sense that they can be erased and used for new instructional purposes.

However, the most powerful example of the economy of audiographic learning technology is to be found in software costs. Thus, contrasted with the exorbitant requirements of, for example, either video production or the production of well-designed programmed instruction materials, audio-graphic technology is virtually cost-free, for the cost of producing a (re-usable) ALF lesson is no higher than the cost of carefully preparing an ordinary classroom lecture. No special computer "author" languages need be learned; no elaborate staging techniques need be mastered. All that is required is an instructor's interest and acquired teaching skill.

The one cost item which the past year's experience indicates to be (at present) too high is the cost of system maintenance. However, mainten-ance costs have been high not because of the equipment itself, but because non-technical instructors do not have the specialized expertise to make the quite minor frequent adjustments normally required for any kind of prototype first production equipment. The result has been an undesirably large num-ber of maintenance trips by Georgia Tech personnel. (Another unfortunate

result of this situation has been that it has sometimes tended to negate the system's simplicity of operation, by needlessly requiring the teacher to be concerned with and frustrated by seemingly mysterious idiosyncracies of the machine).

There is nothing unusual about the fact that an innovative and newly developed complement of machinery requires frequent minor technical adjustments. Equipment-tuning is a normal part of the "system debugging" process. However, the experience of the past year suggests the strong desirabibity of consolidating the continued experiment in an environment more amenable to technical supervision by Georgia Tech staff and/or other technically qualified personnel.

Flexibility

When considering the ability of ALF to contribute to administrative flexibility, a distinction needs to be made between conditions of use in an experimental setting and conditions of use in an established operating program. Since the former conditions have existed during the past year, the scope of administrative concern was of course enlarged rather than reduced; that is to say, the administrator of an experiment must pay attention not only to the outcome of the experiment, but to the experiment itself. However, the experience gained during the past year corroborates the view which sees that audiographic technology carries a strong potential for enhancing administrative flexibility. The fact that on various occasions during the experiment ALF lessons were successfully supervised by substitute teachers indicates that audiographic technology holds the promise of having a high impact on school administration, particularly in

regards to class scheduling, to the employment of different levels of teachers for different purposes (lecturing, tutoring, etc)., to the more effective use of substitute teachers, and so on. Further, the system's (still largely untapped) capability for economical use or re-use at any hour of day or night offers an extraordinary opportunity for remarkably extending the utilization of existing educational resources.

Consider a small school system effecting a change to the quarter system. Resources are such that some courses can only be offered once a year, and often a student who gets out-of-step is lost. However, with ALF media, a program could be devised to support such a student.

Individualized Learning

Audiographic technology allows economical individualization of instruction in several different ways. One important system capability is its "instant replay" feature, which allows a portion of a tape to be replayed, if desired, immediately after its first use. This capability is particularly important for slower students, who may need to see a presentation over again in precisely its original form. The facility for instant replay was used extensively by a number of participants in the experiment.

However, perhaps an even more important contribution which audiographic technology makes to individualization of instruction is its ability to allow the teacher to extend his or her own "presence" simultaneously to two or more groups. Thus, for example, an algebra teacher reported: "Due to a wide range of abilities, I have recently let the students groups themselves into two groups so that some can go at a slower pace than others. So the tape was used for only part of the class.... I was free to continue with the

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slower group." Another instructor said: "ALF left me free to help other students instead of presenting the material in a standard format," and another summarized the feeling of many with the general comment: "Excellent for individualized instruction." This same conclusion reappeared in the words of yet another teacher as: "The machine is invaluable. It is good for individualized study. A substitute could easily carry on a class."

And so, from the past year's experience it appears that the only limit on the system's ability to provide new dimensions in individualized instruction has been due to the fact that no one school has had more than two ALF units, for with only two units at a location extremely limited student access is inevitable. With a larger number of units at the disposal of a single school, individualization of instruction will increase impressively.

Interchange of Materials

Opportunities for interchange of learning materials between schools and school systems could be explored only tentatively during the past year, mainly as the result of the impact of several largely unanticipated adjustments to the project schedule. However, the eventual prospects for such exchange seem bright indeed. In one instance where some cassettes made at one school were sent to another school in another system, the principal's response was: "Our teacher is delighted with the cassettes you sent us. We would very much like to use the full collection of cassettes for the entire course - and thank you."

Such exchanges will in the future no doubt prove to be extremely beneficial to the cause of education in Georgia, by promoting variety,

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cross-fertilization, and superior instruction.

Remote Applications

One feature of audiographic technology which was not evaluated during the past year's experiment was the capability it provides for effecting economical remote transmission over ordinary telephone lines. In future experimentation with the system, however, it will be both appropriate and necessary to attempt an integration of remote use with local use, since one of the distinct advantages of the ALF concept over many other kinds of educational technology is that it can be used to capture the best of both possible worlds: (1) the world of media experts and subject matter authorities, and (2) the world of the individual learners and their classroom teacher. With an extended network of telephone-linked and computer-controlled audiographic learning stations, the system will eventually be able to deliver, from a central location, authoritative instruction prepared by leaders in every subject area. On the other hand, the special importance of the individual classroom teacher is uniquely recognized in the conceptualization of the Audiographic Learning Facility. The individual classroom teacher familiar with the special characteristics of his or her students will always have a position of preeminence regarding utilization of the system. The classroom teacher will always decide how and when to use the system, and will always be able to prepare special materials tailored locally to the needs of the specific local environment.

SUMMARY AND RECOMMENDATIONS

The experiment described in this report has confirmed the proposition that audiographic technology presents a wide range of opportunities for improving the quality and increasing the flexibility and scope of Georgia education, while at the same time holding the costs associated with instructional delivery within acceptable bounds. A school system which accepts the promise offered by audiographic technology will be able to extend its resources, diversify its curricular offerings, and maximize opportunities for individualization of instruction — and will be able to achieve these benefits in the context of special local requirements.

That last consideration is important. Any instructional technology (e.g., video cassettes, film strips, educational television, and so forth) adds to the instructional resources of a school; the uniqueness of audiographic technology is that it allows individual classroom teachers to amplify and extend <u>their own</u> presence. Media can be economically prepared <u>by</u> and <u>for</u> local systems to meet specially perceived local needs.

And so, recognizing the desirability of encouraging local initiative and responsibility, it is believed that the further development of audiographic technology in the service of Georgia education should remain focused on the challenge of enriching and extending educational programs through the use of media prepared not by media experts but by practicing teachers. However, it is believed that the impact of audiographic technology on such programs will be greatest if the programs themselves are comprehensive, and if the nature of use of audiographic technology in these programs is both

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intensive and extensive.

Therefore, it is recommended that, as the project now changes from an experimental to a developmental status, effort should focus on just one kind of comprehensive instructional program - namely, a program of vocational and technical education. Specifically, it is recommended that a relatively substantial effort be directed to the implementation of a vocational and technical training program that is managed by the Coosa Valley Vocational-Technical School and that involves the active cooperation of several of the Rome-area vocational and technical programs at the secondary level. In addition, it is recommended that a smaller center of audiographic-supported vocational and technical education be established in the Appling County System. (A tentative budget for such a deployment of resources is outlined in the appendix to this report.)

Thus, with virtually the entire thrust of future development of audiographic technology directed to programs of vocational and technical training, the resourceful administrators in that sector of education would have a new opportunity to once again demonstrate their excellence and their willingness to cooperate in the hard work necessary to make innovation work.

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APPENDIX I

PROPOSED CONTINUATION OF THE PROJECT

The foregoing report demonstrates that the audiographic recording
technology employed in the Georgia Tech Audiographic Learning Facility has
a high potential for enriching public education in Georgia. The findings
of the experiment reported show clearly that:

*Teachers in rural, urban, elementary, secondary, post-secondary,
 technical, and non-technical settings can produce viable, effective,
 useful media tailored to their environments and supportive of their
 goals at a cost (in their time) only slightly greater than the normal
 cost of lesson preparation.

*A substantial percentage of the teachers, once provided with the re-
 sources of an ALF recorder/player system, will continue to use the
 media they have developed.

*Audiographic recordings produced by master teachers can be used
 beneficially by other teachers in pursuit of course enrichment or
 increased individualization of instruction for the gifted.

*Audiographic recordings are applicable to a wide variety of courses
 normally taught in classrooms principally supported by chalk and
 chalkboard.

Having demonstrated the richness of the potential of audiographic
recordings, it is incumbent on the State of Georgia to provide a setting
in which the current investment in the audiographic technology can con-
tinue to be used to provide educational advantage. It is toward this end
that this proposal is addressed.

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Summary of Proposal

The Coosa Valley Vocational Technical School has been shown to be a hospitable environment with a high capability for exploiting the audio-graphic technology. For this reason, it is proposed to establish, at the CVVTS, an ALF media development and distribution center. This media center would initially serve vocational high schools and comprehensive high schools in the Rome area by developing and distributing media designed to offset needs in those schools. In addition to serving the Rome area, vocational high schools in Appling County where the technology has already been introduced could also be served.

The media developed at the CVVTS would be designed and developed to meet the needs of the schools served in the areas of CVVTS strengths. In the Rome area, distribution to selected cooperating high schools would be by telephone connection and by mailed **cassettes**. Appling County would be served both by mailed cassettes and by locally developed media.

(In addition to the work proposed above, continued experimentation in elementary education will proceed at Fairyland School, which has been making imaginative use of audiographic technology to instruct boys and girls in science. Support of the Fairyland program for the coming year will be possible without additional equipment of any sort.)

Method of Approach

Phase 1. (1st quarter fy 1973-1974)

Georgia Tech personnel in cooperation with Coosa Valley Vocational Technical School personnel will assess needs of cooperating schools and systems for audiographic support media. These identified needs will be

reviewed in the light of CVVTS strengths. Through this review, areas of
concentration will be identified and dimensionalized.

For each area of concentration, specific objectives will be developed
and reviewed with participating schools.

Phase 2.   (2nd quarter fy 1973-1974)

Having established the objectives and schedules of needed media for
each of the participating schools, a media production schedule will be estab-
lished and appropriate CVVTS personnel identified and assigned. Release
time for such key personnel will be accomplished through part-time employ-
ment by CVVTS of teacher aids.

During this interval, telephone connections with participating schools
will be established. Orientations and demonstrations will be conducted; and
schedules and requirements checked.

Phase 3.   (3rd quarter fy 1973-1974)

Media developed during Phase 2 will be delivered against scheduled re-
quirements. Media development will continue concurrently. Evaluation data
will be gathered.

Phase 4.   (4th quarter fy 1973-1974)

Media developed during Phase 3 will be delivered to participating schools.
Continuing program evaluation efforts will result in the production of a
final project report.

Tentative Budget for fy 1973-1974

Personal Services

    Technical Personnel   15,000

Contract Services

    CVVTS Support   20,000

Materials & Supplies   2,000

Capital Equipment

    1 Stereo Cassette Duplicator   500
    4 Receiver Stations (4 VERB Receivers +   7,000
                     4 Projectors)

Equipment Maintenance   3,000

Travel   1,000

Overhead @ 20% Personal Services   3,000
                                      52,100

APPENDIX II

THE DEVELOPMENT OF ASSESSMENT TECHNIQUES FOR
COMPETENCY BASED PREPARATION AND CERTIFICATION IN GEORGIA:
A Proposal to the Georgia State Department of Education*

ABSTRACT

Because CB preparation and certification is based on the operational
assumption that it "should be concerned with whether or not the individual
can demonstrate performance rather than how competencies are achieved"
(4.2.2), it is clear that the success of any program of competency-based
preparation and certification is dependent upon the development of sound
performance measurement and improvement procedures--procedures which will
optimize state, local-system, and community resources for the continued
improvement of education personnel (5.2.2.1), which will provide a mech-
anism for wupporting education personnel in their efforts toward continuous
improvement activities in areas of identified need (5.2.2.2), and which
will provide an objective process for deciding whether or not performance
has been demonstrated at the minimum level (5.2.2.3).

The School of Information and Computer Science, Georgia Institute
of Technology, proposes a developmental effort to support the CB program's
study of techniques for developing such measurement and improvement pro-
cedures. The School of Information and Computer Science proposes to use
audiographic learning technology as a basic instrument for facilitating
a Competency Based Evaluation (CBE) process.

Audiographic learning technology has been tested in a wide variety
of educational settings encompassing basic Adult Education, science for
gifted elementary school students, secondary education, vocational educa-
tion, undergraduate, and graduate courses in information and computer
science, and graduate programs in continuing education. The central

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* Reference numbers are from the Third Board Draft, June 21, 1972, "A
Plan for Moving to Competency-Based Preparation and Certification in
Georgia by 1978," Georgia State Department of Education.

instrument of the technology is the audiographic recording. These record-
ings impose (by way of standard frequency modulated electric signals)
dynamically synchronized speech and line-graphic information on a standard
stereo audio cassette. The information stored on the audio cassette com-
prises the speech and line-graphic information that a teacher would generate
in a black-board supported classroom. When audiographic recordings are
played, the speech and line graphics generated by the teacher are reproeuced;
the dynamics of speech inflection, emphasis, rate of line production, etc.
are preserved.

Audiographic technology is ideally suited for the improvement and
measurement of classroom teachers for the following reasons:

1) Economical, self-contained audiographic learning units can be
created and used by any teacher after a few minutes of instruction.

2) A teacher who is able to lecture effectively in a live classroom
situation will be able to prepare and deliver effective audiographic learn-
ing materials. The technology is able to capture the teacher's actual
classroom teaching style.

3) Once recorded, a lesson prepared by a teacher will be available
for evaluation and for permanent record. The evaluation can be scheduled
at a time and place convenient to the evaluating educators. The objec-
tivity of this type of evaluation is enhanced by the fact that the teacher's
identity need not be revealed to the evaluators. (Since only the voice
and line graphics are presented, racial and ethnic prejudice can be
ameliorated.) The evaluation process might include presentations to
selected student groups of prescribed composition---learning gain
measured, and aspects of accountability satisfied.

In summary, audiographic technology offers a mechanism which allows
a teacher to demonstrate actual classroom teaching competence through the
preparation of media which can be economically created and retained for
purposes of objective evaluation. Such permanent records provide an audit
trail of performance by which progress can be measured, and prescriptions
for teacher improvement developed. These assertions are predicated on the

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fact that the ability to produce effective audiographic media pursuant to the guidelines included as Appendix III is one useful indicator of teacher competence.

It is also worthy of note that the units of media derived and evaluated as effective through the processes of CBE comprize a self-refining, self-expanding body of learning materials which might well be copied into a Learning Resource Center for use in improving education in Georgia.

The School of Information and Computer Science will be pleased to submit a detailed proposal for the development of a pilot operation to evaluate the managerial, economic, and operational problems of a CBE Center employing audiographic technology. Preliminary discussion of any or all points discussed above will be welcomed.

APPENDIX III

GUIDELINES FOR THE PREPARATION AND RECORDING OF LEARNING MATERIALS
FOR THE AUDIOGRAPHIC LEARNING FACILITY (ALF)

I. PREPARATION OF ALF LESSONS

a) Natural Units. To the extent possible, each ALF lesson should
be restricted to a single concept, and should run no longer than
15 minutes. By "single concept" is meant nothing more than that
the lesson should form a natural unit. To take an example from
a course in grammar: a discussion of what a "noun phrase" is
would be such a unit, as would a discussion of what a "verb
phrase" is -- whereas the two types of discussions would normally
not be included in one and the same lesson. (Of course, a
separate lesson could explain how noun and verb phrases combine
to from sentences, but basic discussions of different kinds of
phrases should be assigned to different short lessons.)

If a single concept requires a relatively long explanation
(e.g., one hour of lecture), divide the lecutre into a sequence
of shorter lessons by identifying and explaining subconcepts.
In other words, always break learning materials into natural
units of no more than 15 minutes of explanation; it is largely
irrelevant whether a particular natural unit is devoted to a
single concept, a single subconcept, or a cluster of related
subconcepts.

b) Modularity. Plan ALF lessons so that they will be as self-con-
tained (as "modular") as possible. This requirement does not
mean that an instructor preparing a lesson cannot presume that
a student already knows certain material. It merely means that
the instructor should not assume that the student has learned
the material from some particular lesson or course.

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To illustrate modularity, perhaps it will be useful to choose an example close at hand: these Guidelines and the transmittal letter which accompanied them. Both of those documents presume some familiarity with the ALF system (and neither would make much sense to someone who had never heard of ALF); however, the Guidelines are modular because they do not presume to know how, where, or when the reader learned of the system. In contrast, the transmittal letter refers to specific memorandums and mettings, and would be inappropriate to send to persons unfamiliar with those memorandums and meetings; as a result, it is less modular.

c) Use of Graphics. Effective use of ALF requires an active graphics presentation, and the lesson should therefore be planned around the graphics. Write the notes or the script for the lesson in the following format:

* Page Change
* Identify the main topic
* Begin graphics and accompanying explanation
* Introduce next item of discussion (e.g., "Now that we have discussed the Legislative and Executive branches of Government, let's next consider the Judiciary.")
* Page Change
* Begin graphics and accompanying explanation. (e.g., "The Judiciary ...")

etc.

Plan graphics so that the illustrations will be as simple and as large as possible; don't crowd too much visual information on one page. In general, adjust your illustration so that it will be large enough to fill up the whole page -- even if it is only one word (e.g., "Polynomials").

Most important of all, don't leave the page blank for long periods of time. Even the simplest graphics are preferable

to an empty screen. Develop dynamical graphic illustrations
to the extent that the illustrations support and explain your
topic of discussion. Use simple graphic devices: 🧍 meets 🌼
         . Avoid creating graphics which become ends-in-themselves.

II. RECORDING TECHNIQUES

Recording skill will come only after a few hours of experience. The following suggestions are meant merely to provide some very general guidance for your consideration as you proceed to develop your own styles:

* Speak in a natural voice, as you would speak to a class. To help you retain naturalness, you may find it preferable to speak from notes rather than from a word-for-word script. Practice psycho-cybernetics; picture yourself speaking to your class or a particularly enjoyable and interested student -- and communicate.

* Write or print with smooth strokes, keeping the pen in touch with the paper as much as possible. Avoid jerky motions, and try not to write too fast.

* When you are not writing, slowly move the pen to the lower margin of your pad. Put it down completely or hold it still, so that meaningless motions do not distract the student.

* The tip of the pen on the transmitting unit corresponds to a writing point which is not at the tip of the stylus on the receiving unit. Therefore, to point at something, one should aim the pen about three-fourths of an inch below the object intended. (The best way to learn to do this is to record with the projector on, and to watch the projected graphics as you point. After you develop this facility, record without the receiver, and concentrate on your content.)

* Don't talk during a page change. Follow the format suggested previously: i.e., introduce the next item of discussion, then make a page change, then begin the discussion.

III. DOCUMENTATION OF LESSONS

After each lesson has been recorded, enter the following information on a Lesson Documentation Form (see example on the following page):

* **Classification of Subject.** (Final classification of the learning material will be made by the system librarian. However, the teacher is requested to suggest a classification informally, as an aid to the librarian.)

* **Topic.** Enter brief title of the lesson.

* **Level.** Characterize the approximate level of difficulty by entering grade level(s) of typical students for whom the lesson was prepared.

* **Running Time.** Enter running time of lessons (in minutes.)

* **Description.** Describe the courses with terms or phrases which will suggest the content of the lesson.

* **Prerequisites.** Identify the prerequisites of the lesson -- not by referring to other lessons or courses, but by describing in words what knowledge you assume the student to have.

* **Behavioral Objective.** Include a statement of the behavioral objective of the lesson to indicate what a student who has taken the lesson should be able to do.

* **Lesson Prepared By.** Enter your name and identify your school.

* **Date.** Date of preparation.

* **Validation.** Name of colleague of student who may have reviewed the lesson with you; comments you deem important; results of any tests you have made. (Validation information should be written on the reverse of the Lesson Documentation Form.)

LESSON DOCUMENTATION FORM

CLASSIFICATION:

_____

TOPIC:

_____

LEVEL:

_____

RUNNING TIME:

_____

```
┌─────────────────────────────────────────┐
│              --OFFICE USE--              │
│                                          │
│   LESSON NO:      ┌─┬─┬─┬─┬─┐           │
│                   └─┴─┴─┴─┴─┘           │
│                                          │
│   CLASSIFICATION: ┌─┬─┬─┬─┬─┬─┬─┐       │
│                   └─┴─┴─┴─┴─┴─┴─┘       │
│                                          │
│   LEVEL:          ┌──┬──┐               │
│                   └──┴──┘               │
└─────────────────────────────────────────┘
```

DESCRIPTION: _____

_____

_____

_____

_____

PREREQUISITES: _____

_____

_____

_____

_____

_____

BEHAVIORAL OBJECTIVE: _____

_____

_____

_____

_____

_____

LESSON PREPARED BY: _____ DATE: _____

IV.   DOCUMENTATION OF STRATEGIES OR "COURSE" PROFILES

Previous comments have pertained to "LESSONS"; this section will deal with "STRATEGIES" for learning.

A strategy will be defined by recording a specific sequence of lessons which a "tutor" suggests that a learner follow in order to reach some learning goal. The ALF system recognize the need to allow for "tutoring" by three different kinds of individuals:

* The Course Designer. The individual in this role produces a sequence of lessons for an identified course in the curriculum of one or more schools.

* The Tutor. This individual prescribes a sequence of lessons for particular students whose needs or abilities suggest the desirability of special learning plans.

* The Self-Learner. In the ALF System, the learner is permitted to browse through the learning materials and discover learning strategies of how own.

Documentation of strategies will consist simply of completing a form which requires the identification of: the learning goal; the suggested sequence of lessons to arrive at the lesson goal; and various control information (strategy number; name of strategist; and date). An example of a form can be found on the following page.

STRATEGY DOCUMENTATION FROM

GOAL: _____

_____

_____

_____

_____

OFFICE USE
STRATEGY NO. ☐☐☐☐☐
STRATEGIST ☐☐☐☐☐

LESSON SEQUENCE OF STRATEGY FOR THIS GOAL: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

STRATEGY SUGGESTED BY: _____

☐ Course Designer

☐ Tutor

☐ Learner

DATE: _____

STRATEGY EXPLAINED: _____
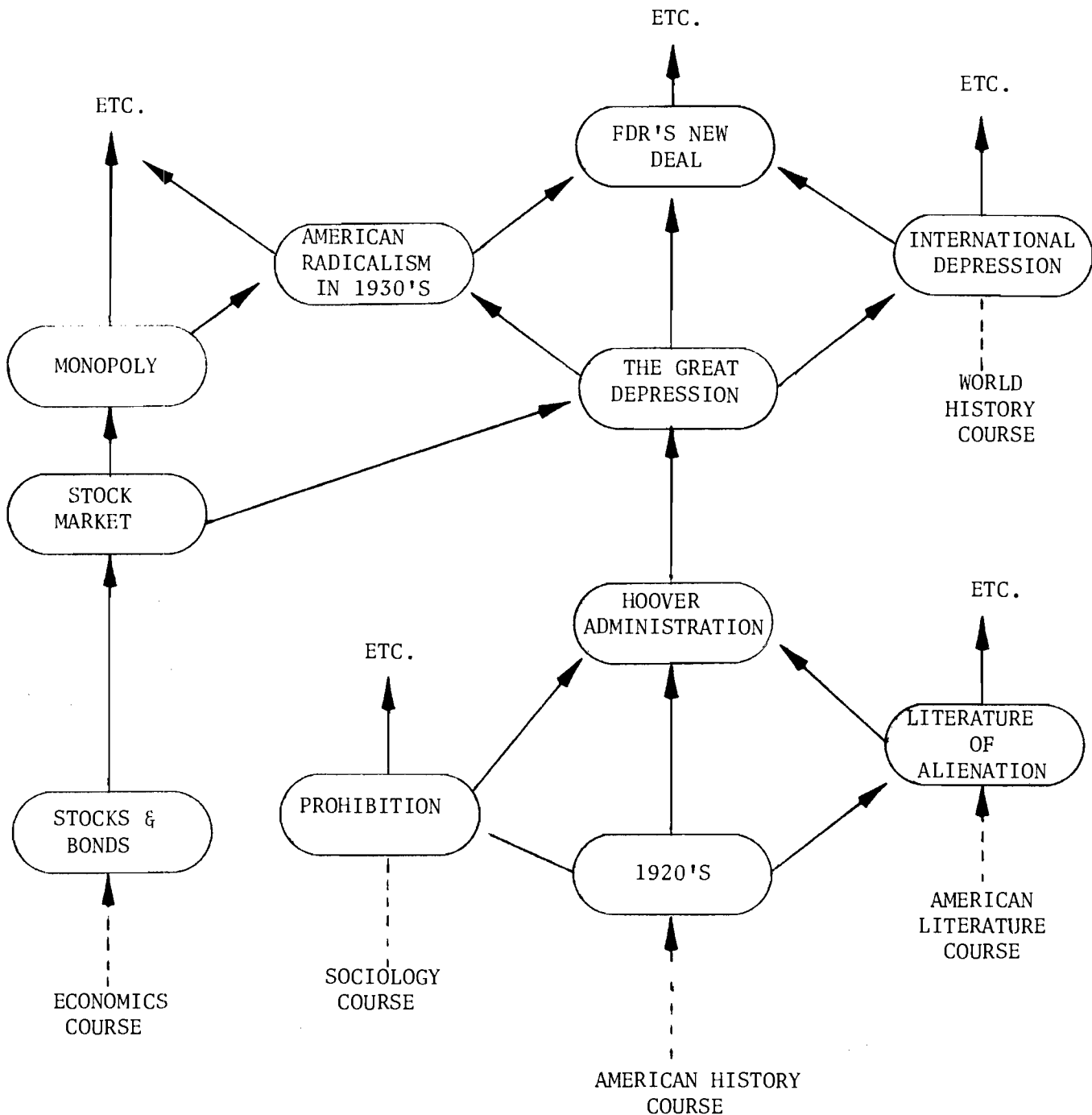
IF SO, GIVE LESSON NO: _____

V. OVERVIEW OF THE SYSTEM

Once the implementation of the ALF system has reached a more mature state of development, course designers, tutors, and learners will interact with the system as follows:

1. Each user or group of users will have a catalog of ALF learning materials. This catalog will be updated four times a year, and will provide descriptions of all lessons in the system and outlines of all documented learning strategies. (The format of the catalog will be discussed subsequently.)

2. After reviewing the available offerings listed in the catalog, a course designer who wants to introduce new material into the system will plan, record, and document the lessons and forward master copies of all work to the "central office" (School of Information and Computer Science, Georgia Institute of Technology.)

3. At the central office, the material will be classified and lesson numbers will be assigned. The documentation will be used to update the catalog at the time of its next printing.

4. The central office will store the master tapes, and advise the course designers of the control numbers which have been assigned to each lesson.

5. The course designer will then document one or more learning strategies which he believes appropriate to certain identified learning goals. He is not restricted to the use of his own materials, but may exploit linkages to lessons found in other courses. (The partial set of linkages shown in Figure 1 shows that the designer of a course in American History has "borrowed" lessons from courses in Economics, Sociology, World History, and American Literature.)

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FIG. 1

Example of Linkages Identified Between Lessons Prepared for Different
Courses. Additional Courses or Strategies Could Be Defined to Meet Other
Specific Learning Goals.

6.   The strategy documentation will then be forwarded to the central office, for conversion to magnetic tape and subsequent inclusion in the catalog.

7.   A tutor or learner wishing to use the system will first consult the existing documented strategies found in Part I of the catalog. If he is unable to find a documented strategy suitable for his particular learning goal, he is permitted to browse through lessons in the system in any order he chooses. He uses Part II of the catalog (lesson documentation) to guide his selections.

8.   Tutors and learners who are pleased with the results of their strategies will be permitted to document those strategies for inclusion in subsequent issues of the catalog. Those who fail to receive goal satisfaction will be requested to indicate and document the nature of their goal and the reasons for being unable to achieve it through the resources available.

IV. DESCRIPTION OF THE CATALOG

The user catalog will be printed four times yearly in the following format:

PART I

Part I will provide a listing of all documented strategies. The listing will show: learning goal, strategy number, and the name and position of the strategist. If the strategist has prepared a special lesson explaining the strategy, this lesson number will be identified.

The strategies will be listed in an order determined by the classification of the last lesson in the sequence. In addition, they will be listed in strict numerical sequence according to lesson number.

PART II

Part II will provide a listing of all the lessons available through the system. The main listing will be in an order dependent upon the classification assigned to the listing.

The printout for each lesson will be comprised of the full documentation entered for that lesson, including Topic, Level, Running Time, Description, etc. It will also identify every strategy in which the lesson has been cited; for example:

Strategies for Background Research: 01121, 04333
Strategies for Continued Study: 21131

CATALOG SUPPLEMENT

As new system features are eventually made available, appropriate user instructions will be added as a supplement to the catalog. An example would be a capability for the following kind of search of the data base of lesson documentation: "Find all lessons of levels 8, 9, or 10 which contain the terms 'Hoover' AND 'Depression' AND 'Election'."