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TOWARD A COMPUTER BASED INSTRUCTIONAL SYSTEM.

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THE INFORMATION FOR THIS REPORT WAS OBTAINED FROM VARIOUS COMPUTER ASSISTED INSTRUCTION INSTALLATIONS. COMPUTER BASED INSTRUCTION REFERS TO A SYSTEM AIMED AT INDIVIDUALIZED INSTRUCTION, WITH THE COMPUTER AS CENTRAL CONTROL. SUCH A SYSTEM HAS 3 MAJOR SUBSYSTEMS--INSTRUCTIONAL, RESEARCH, AND MANAGERIAL. THIS REPORT EMPHASIZES THE INSTRUCTIONAL SUBSYSTEM. THE 3 BASIC COMPONENTS OF THIS SUBSYSTEM ARE--BREAKDOWN OF GRADE-BY-GRADE CURRICULA, BREAKDOWN OF STATIC CLASSROOM SIZE, AND USE OF COMPUTER AND OTHER DEVICES TO PRESENT INSTRUCTIONAL INFORMATION. (MS)

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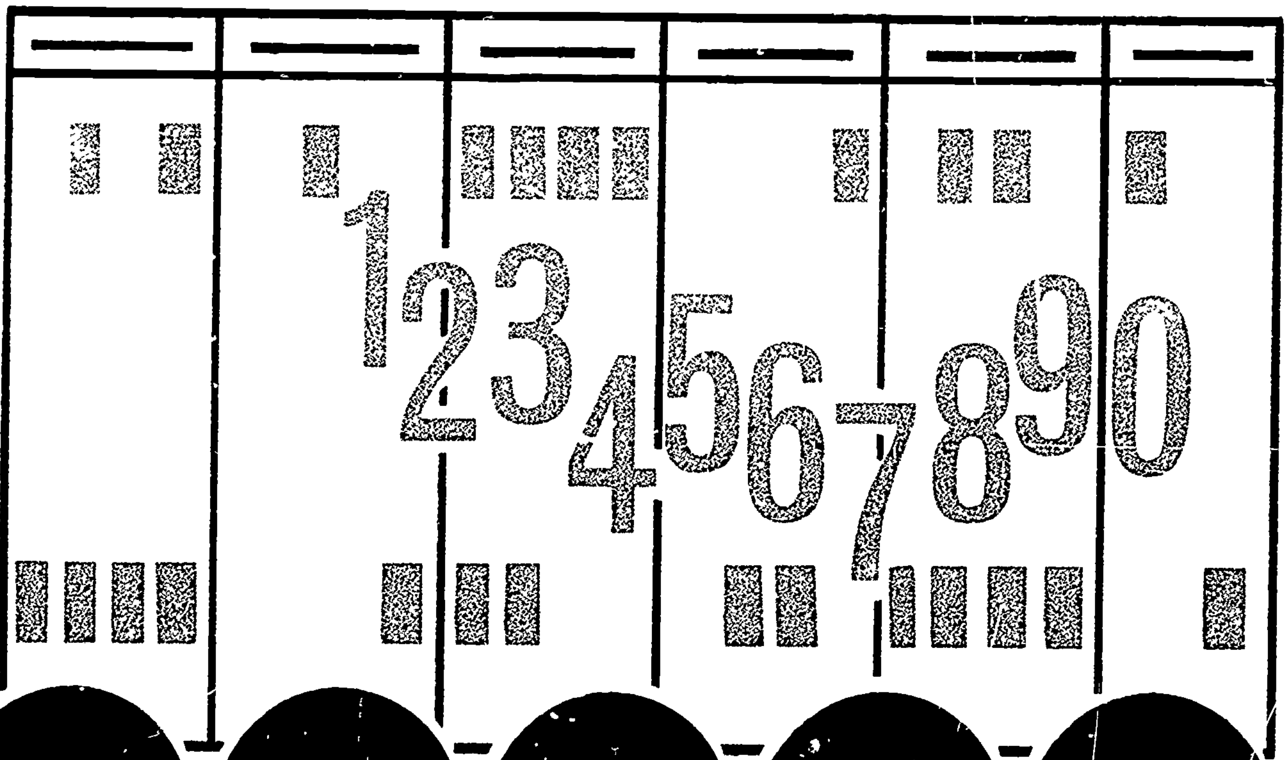
TOWARD A COMPUTER BASED INSTRUCTION SYSTEM



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TOWARD A COMPUTER BASED INSTRUCTIONAL SYSTEM

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Preface

This publication is part of a report on the activities of a Title III, ESEA project entitled INDICOM. The material was prepared by the authors and the Office of Education assumes no responsibility for its content.

We do however believe that the information is valuable to those considering computer-based systems of instruction. Hopefully the authors' experience and insight will be a solid base upon which to launch futher experimentation and dissemination of such activities in an effort to bring about improvement in the education of youth.

Norman E. Hearn
Acting Assistant Director, PSC

Forward

This document was prepared by the authors while serving as PACE Fellows. The PACE Fellows Program is designed to bring to the Office of Education personnel from Title III (ESEA) projects. One of the real benefits of such a program is that it provides a perspective for the visiting PACE Fellow that will give him a better understanding of procedures and regulations that apply to Federal programs. Additional side benefits occur as a result of: informal contacts with personnel; study and examination of other projects; and better understanding of dissemination procedures. A most important benefit to the PACE Fellow is that of becoming more knowledgeable about national problems facing the U. S. Office of Education. It also makes it easier to understand Federal-State-Local relationships. The authors see the PACE Fellows program as another force needed to prepare educators to meet the challenges of a complex age and one of the best ways of disseminating information quickly and accurately to educators throughout the United States.

W.A.R.

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I. Introduction

Now that the Title III of the Elementary and Secondary Education Act has been in operation for two years and many projects have attempted to link technology and education, we believe that a review of what has been done will be helpful for future planning. As one of many areas of concentration which could be reviewed in Title III, this report might serve as a model.

The technique of using a microscope to investigate what has been done in a complex field and then telescoping what can or should be done in the near distant future is a profitable exercise in rational thinking. An area of endeavor like Title III of the ESEA which encourages creativity and divergency needs a way of identifying the features which projects may have in common.

Looking at the Title III projects through "one set of glasses" will, under Heisenbergs' Uncertainity Principle, throw out of focus other aspects of the projects but the advantage for the purpose of this report is deemed worthwhile. This report will focus specifically on the area now dubbed CAI.

While most people are familar with the initials CAI (Computer Assisted Instruction) fewer are familiar with CBI (Computer Based Instruction.) Computer Based Instruction will refer to a system aimed at individualization of instruction in which the computer acts as central control. Under this definition CBI has its emphasis on instruction rather than on the computer.

As a reference to places, people and ideas in the specific area of CBI, Table I has been prepared on page 42. In the recognition that there is a need for a National survey of this field we will not attempt to make this report exhaustive.

It is hoped that this broader interpretation will compensate for operation of the Heisenburg Uncertainity Principle and allow us to evaluate the programs from the point of view of curriculum and the "theory of instruction" which most instructional innovations are trying to implement.

Most of the information for this report was obtained from visitations made to the various CAI installations. *No attempt to rate the installations or experiments is intended!*

II. Overview

The explosion of knowledge[1] and the demand for education on the part of large masses of people are confronting education with new problems begging for solution. Traditionally a person learned his ABC's in a formal school setting and between the ages of 5-18 (or possibly 21 if he continued on to college). When he finished his schooling he went to work, and after that he retired.[2]

This pattern is changing rapidly as advances in technology make obsolete: skills, facts, and concepts learned only a few short years ago. There is a need for a means of continuing education and an equal need for an education that is individualized. Although we could not agree with Ridgeway's description of the State of the Art as not science fiction,[3] he must be given credit for correctly appraising the situation and trend.

On a National Study of Title III programs Miller has this to say:

> A systems aproach to educational technology has been overlooked until quite recently, and everyone has suffered. In its simple^t form, the systems approach calls

1 Gilbert Burch, "Knowledge: The Biggest Growth Industry of Them All," *Fortune Magazine*, 70, (November 1964), pp. 128-131.

2 Richard H. Bolt, "An Overview of Computer-Assisted Instruction," (Cambridge, Mass.: Bolt, Beranek and Newman, Inc., 1966), Vol. 1, No. 1 of *Activities*, p. 1.

3 James Ridgeway, "Computer-Tutor," *Education Digest*, Vol. 32, No. 1, (Ann Arbor, Michigan: Prakken Publications, Inc., September, 1966), p. 8, Reported from the *New Republic*, 154 (June 4, 1966), pp. 19-22.

for a unified effort involving synchronization of technology with the ongoing instructional program, inservice training of teachers and administrators in uses of innovations, and evaluatives of its effectiveness.[1]

There is a need for a total educational system which will allow the formulation of solutions to these new problems. Such a system will be concerned with no less than three major subsystems: (1) an Instructional subsystem, (2) a Research subsystem, and (3) a Managerial subsystem.

The Instructional subsystem is concerned with the storage, retrieval and acquisition of knowledge. The Research subsystem is concerned with the study of the Instructional subsystem. The Managerial subsystem is concerned with the rest of the educational enterprise, including grading, scheduling and other business record keeping functions.[2]

While all three subsystems are important this report will emphasize the instructional subsystem. In the light of advances in technology today it seems contradictory for students to progress through school in a lock-step grade by grade procedure. One of the best attempts made to overcome this contradiction was the continuous progress plan and the ungraded school concept. Basically the ungraded school concept is an administrative-organizational innovation. The ungraded school concept is an attempt to free the teacher and the student from an artificial sequencing of the curriculum through grades, according to chronology.

1 Richard I. Miller, "Catalyst For Change-A National Study of ESEA Title III (PACE)," Section A (under a USOE contract No. 2-7000074-0074, January 31, 1967), p. A-25. (Mimeographed)

2 Bolt, *loc. cit.*

Yet if this administrative aid to the instructional program is not accompanied by two other aids, then an "ungraded" lock-step curriculum remains the heritage of the learner.

One of the aids that should accompany the ungraded concept, has to do with the envirnonment. The physical setting as well as other environmental factors should allow for flexibility in size and arrangement of the learning experiences.[1] For example, inside partitions such as classroom walls may be removed and this idea has direct implications for the design of the building, furniture and other facilities. It should be possible to work in groups of *any* size as well as to work individually. The entire instructional system should be geared to *individualization of instruction.*

As defined by Glen Heathers:

> Individual instruction consists of planning and conducting with each student a program of studies that is tailored to his learning needs and his characteristics as a learner."[2]

It has been known for some time that you can teach large groups but that you learn as an individual.

This brings us to a third aid to the instructional system. An aid that can present the subject matter materials on an individual basis is indeed an instructional innovation, and the core of this innovation has materialized technologically

1 The architectural firm of John Shaver, Inc., of Salina, Kansas, has been an excellent source of consultant help in designing buildings to individualize instruction.

2 Glen Heathers, "Individualization". *Catalyst For Change-A National Study of ESEA Title III (PACE)*, Section B (under a USOE contract No. 2-7000074-0074, January 31, 1967), p. 17.

in the form of an electronic computer. However, while the computer has the capabilities of serving as the core of the system, it is by no means the only device available from technology.

The entire communications field can contribute to individualizing instruction but it is believed that the computer can serve the special function of a central control to the system. With the computer as the center of the communications system, instructional materials can be brought to each individual by the various media — TV, slides, films, Cathode Ray Tube, etc. — at the precise time and place that the student desires it.

With this realization, the school staff should plan for the use of computers as a center of communications network which will link all of the aids of technology in presenting instructional knowledge to students through the various senses.

In summary, the three basic interlocking components of the instructional system for individualizing learning are:

1. The breakdown in the organizational lock-step *grade-by-grade* curricula,

2. The breakdown of the stereotyped static size of classroom and

3. The uses of the computer in programed instruction and other forms of communicational devices for presenting stimuli to the student in the form of instructional information.

It is with these three interlocking ideas that a complete progam for individualizing instruction can be obtained, as well as for rapid feedback and accounting to insure a complete individual program from the time a child enters school until he leaves.

Dr. Nikolaus L. Engelhardt, one of the nation's foremost educational consultants, is quoted in a syndicated article by Robert Cochnar. He notes that Engelhardt, after evaluating eight hundred school systems throughout the country, has developed some very definite ideas about American education, present and future. Engelhardt sees the whole system of American education at the verge of tremendous ("and most welcome") change. "We are finally going to give students a place in which to work as individuals rather than groups, and the so-called teaching-machines, audio-visual retrieval systems, closed-circuit television, computers, tape recorders — these are the things that will make the individual student important," he says.[1]

Developing trends. There is a great deal of discussion concerning "quality education." One of the ingredients implied in this term is excellence in teaching. This important factor is not always attainable because of the shortage of highly qualified teaching personnel. Team teaching has spread rapidly, partly as an effort to use the master teacher as effectively as possible and to use the strengths of all teachers to the best advantage. Team teaching, however,

1 Syndicated article by Robert Cochnar, Newspaper Enterprises Association, New York, dateline of December 20, 1965.

should not be considered simply a system that used large group instruction, for it also involves small group instruction, individual tutoring, counseling, and learning by the individual on an individual basis.

Individualized instruction is also important because students must learn much more than was required only a few short years ago. It is said that the stock of knowledge in today's world doubles in less than ten years, whereas in the eighteenth century it took fifty years. Whatever the rate of change might be, all educators are in agreement that yesterday's education no longer suffices for today. The rate of technological change and the development of new information is so great that education must seek new ways to get persons taught. These and many other factors confront education and industry with the same problem — how can learning be made more efficient?

Hearing and seeing are the two senses most directly involved in learning. A large number of electronic and optical devices which make human seeing and hearing more efficient have been developed. Electronic devices have also been developed which extend the human brain by providing memory storage, recall, and the application of logic.

Although technology has developed these electronic and mechanical devices which can be important aids in improving the efficiency of education, their potential has seldom been fully realized. There are primary reasons for this:

1. An over-all *systems* approach has been lacking. The myriad of audio-visual aids have mainly been directed to performing specific tasks, and their use has been uncoordinated. The A.V. world in education is composed of bits and pieces — moving picture projectors, slide projectors, phonographs, television, etc. The bits and pieces are cumbersome for transportation from point of storage to point of use. They present an obstacle to teachers or non-technical operators.

2. Much of the equipment now offered as "aids to education" was designed for other uses, and came to education from the theater, home use, government, or business. The adaptions to perform functions required by education have not always been good.

3. Educational programs and needs have not been translated into a form which allows their use in electronic devices. There is a gap in "software" development.

Along with the growing use of different types of electronic and communications media in teaching and learning, other developments and trends are also important.

In 1957 there were 52,907 school districts in the United States. As a result of consolidation and unification this number had been reduced by 1961 to 35,676. By 1964 the number was 29,391. The trend toward fewer and larger size school districts will continue. This trend in school consolidation is significant. This trend will permit the design of communication systems which are more practical, sophisticated, and economical.

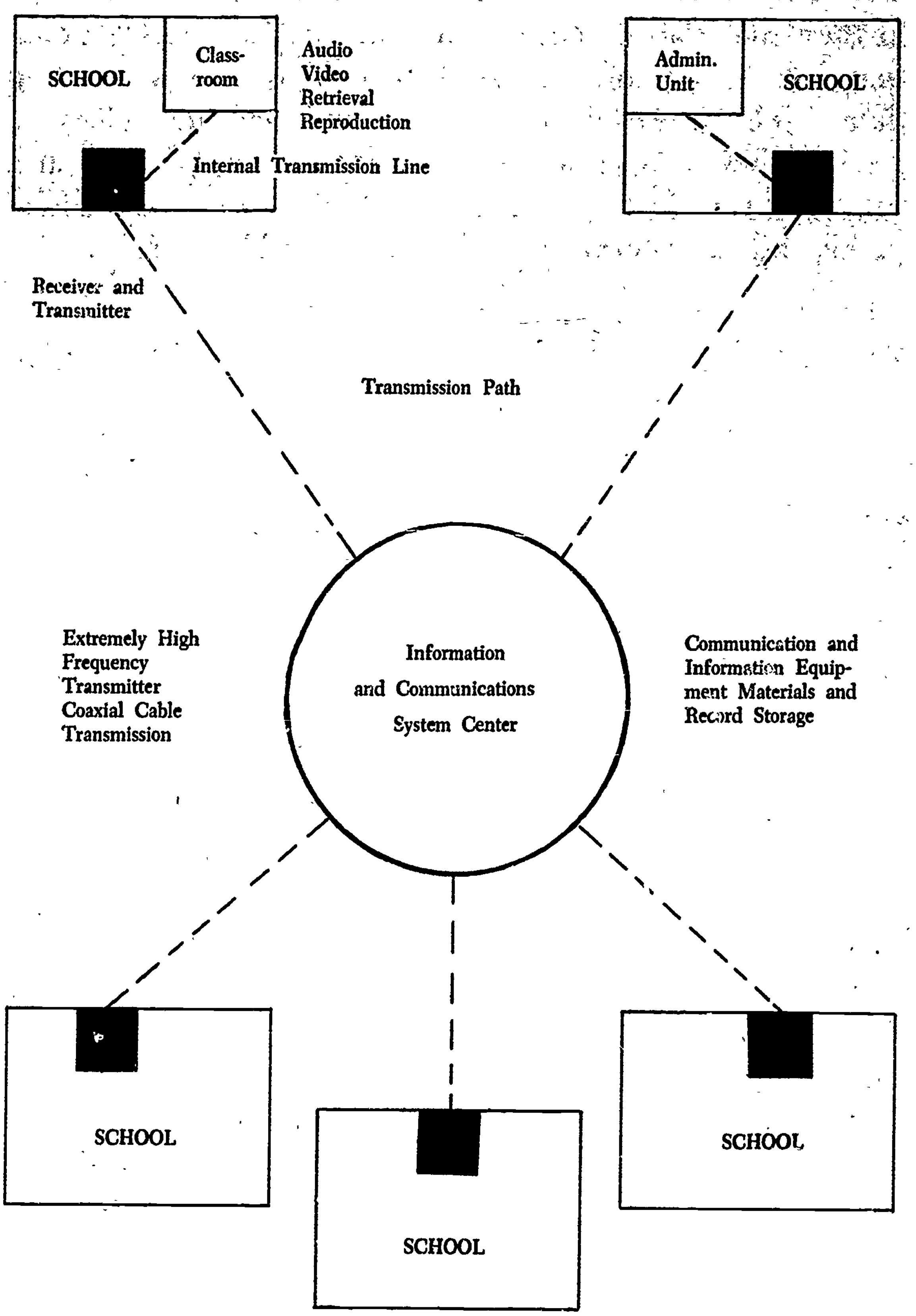
Within a school, the library has traditionally been the information center with books and teachers the media. With the growing use of new media, such as motion pictures, slides, tapes, microfilm, etc., the character of the library and the classroom has begun to change. These materials have become resources as are books and teachers. In many schools, particularly elementary schools, the library has become the instructional materials center with control over all communication and information materials. This is a trend toward the kind of information and communication system which will be required in the future. (See chart on page 12)

The basic technological components required to meet the functional requirements of a system located in a central information and communications center will be:

1. Computer equipment
2. Television cameras
3. Micro-fiche camera
4. Step and repeat camera
5. Random retrieval hardware for micro-fiche
6. Random retrieval hardware for slides, including biological slides and slides containing living organisms
7. Motion and still picture processing equipment
8. Audio-video tape equipment
9. Print out equipment
10. Telemetry equipment

Program and information materials used with this hardware will be produced and stored at this center. The scope of these materials is considerable, ranging from instructional materials to microfilmed student records and accounting data. The essential requirements will be the ability to retrieve these materials at the point of use, simply and on a random basis. The advances being made with Lasers, Holograms and Microforms will add immeasurably to these.

SCHOOL DISTRICT



III. Toward A Theory Of Instruction

Curriculum writers[1] have lamented the fact that there is at present no theory of instruction either of teaching or of learning, around which to develop a body of curricula. Although it is a truism that education is a consumer of the theories of other disciplines such as psychology, sociology, economics and anthropology, it is equally true that to build a theory of education it must rely more and more on its own "discipline," sometimes in the form of pragmatic evidence, if it is ever to establish itself as a unique entity. As it does it will evolve a true educational theory.

The assumption may be made that the primary purpose of preparing educational subject matter materials is:

> To shorten the time of apprenticeship or substitue for it in the event no real experience can be had.

The first portion of the above assumption must be credited to Kish.[2] We add the second portion to cover real situations which cannot be duplicated in the classroom or laboratory. This is the first idea of a very powerful teacher technique not often mentioned in pedagogical texts but one which we believe to be one of the major contributions to the art and

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1 Hilda Taba, *Curriculum Development. Theory and Practice,* (New York: Harcourt, Brace and World, 1962); James L. Mursell, *Successful Teaching* (New York: McGray Hill, 1954); Smith, Stanley and Shores, *Fundamentals of Curriculum Planning* (New York: World Book Company, 1951).

2 Leslie Kish, Survey Sampling, (New York: John Wiley and Sons, Inc., 1965), p. vi.

science of teaching and learning — SIMULATION.[1]

What should be more frequently lamented by theorists from education and related disciplines is the fact that the bulk of the research being conducted is not clearly tied to any theory and is often an exercise in the art of problem solving *per se*.

The reader would be hard pressed to find many research studies, especially in education, which attempt to refute or establish a specified theory of education.

It is our contention that there is one unequivocal theory of education which most attempts at innovation have tried to implement — *individualization of instruction*. This theory is that *we may teach groups but we learn as individuals*. As this paper will show later, innovations are usually directed toward this theory but many times are administrative expediencies rather than improvement in the system of instruction to maximize individual learning.

That the *individualization of instruction* is highly regarded as a worthy objective by the educational establishment is without question: public and private schools, industrial apprenticeships, maintenance training, armed services educational programs and the software world of the publishing

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1 At this point we would like to make a distinction between vicarious experience and simulation. To us, vicarious experience is a one way street as the receiver or recipient cannot manipulate the process which he is receiving. In a simulated experience the recipient has control and can manipulate the sequence of events according to his individual choice, at least to some extent.

Viewed thusly, we might place the terms REAL, SIMULATED, and VICARIOUS on a continuum with vicarious experiences beicng farthest from the real life situation and simulated experiences being closest to the real life situation. To date most of the experinces with subject matter materials in the schools have been vicarious (as for example, through text books) and, while very important should be enlarged by the use of simulated experiences.

companies present ample proof of that assertion. Yet, full implementation has been hampered because of the lack of technology precise enough to complete the job. At this writing it is still not precise enough to do the complete job but it is certainly clear, for anyone who has surveyed the field, that it will be precise very shortly.[1] Such a prediction can almost be guaranteed.

A Curriculum Model

Let us assume for a moment that man's main drive is to understand the world in which he lives. Let us also assume that the world exists as a set of complex relationships. Then it behooves man if he is to understand the world in which he finds himself to decipher what these relationships might be.

Along the lines of Rene Descartes he begins to reason: (1) man relates to himself and other men as an individual, (2) man relates to other men in groups, (3) man relates to the elements, and (4) man relates to the unknown. This model of man's relationship to the World or Universe might be written Symbolically as $f(x)=y$ where y refers to the situation man finds himself whenever x takes any of the patterns cited in this paragraph. Let:

$x = 1$ stand for man vs. man or (Psychological Sciences)

$x = 2$ stand for man vs. society or (Sociological Sciences)

1 John F. Cogswell, "Instructional Management Information Systems," cited in John W. Loughary, *Man-Machine Systems in Education*, (New York: Harper and Row, Publishers, 1966), p. 101.

x = 3 stand for man vs.
nature or (Natural Sciences)

x = 4 stand for man vs.
super nature or (Philosophical Sciences)

Let us further classify man's place in the world as academic or non-academic and postulate that whenever x = 3 or 4 that y is academic and whenever x = 1 or 2 that y is non-academic. With this schema we can define the objectives of the school as being academic or non-academic. Furthermore, when f (1 or 2) = y then the "concomitant-affective" objectives of the school are realized in the categories of values, appreciations or attitudes. When f(3 or 4) = y then the cognitive objectives of the school form a hierarchy of skills, facts, principles, generalizations, and concepts.

Obviously any such schema is wide open to criticism from many viewpoints and we would be the first to say so. Yet the description serves the useful purpose of describing a continuous curricula K-12, for the subject matter of the natural and philosophical sciences rather than the discontinuous "grade-level" curricula now in use. In other words instead of having arithmetic, algebra II, plain and solid geometry, etc., we will have mathematics K-12. Even the 12 will not be binding for some pupils but is merely a landmark for the subject matter specialists and curricula writers.

When the curricula objectives for f (3 and 4) = y are programed successfully the attention can be turned to directly teaching the f (1 and 2) = y objectives. Right now some of all of man's relationships with the world are being included as objectives of the curricula but more by coincidence than by design. This paper calls for a total systems design to the curricula.

When such a design is planned, piloted, and implemented, then perhaps a theory of instruction such as that presented here can be disseminated.

The Ecological System

The second major contribution is the concept of the interrelationships of educational technology and industrial technology. This ecological system is sometimes referred to as Man-Machine System.[1]

The growth in sophistication of the electronics industry to fashion machinery to implement the individualization of instruction is seen in the many utilizations of computer assisted instruction across the Nation. While these research experiments are necessary, they are generally conducted in a vacuum. Each seems to have a parcel of the total instructional system in sight but *none* have even looked at the implementation of the entire package. The fact that a total man-machine system in education is necessary to bring the theory to fruition is a conclusion emphatically stated as the result of a national study by System Development Corporation:

> In fact *it is unlikely that individual progress courses on a large scale within a school would be possible without a*

1 John W. Loughary, *Man-Machine Systems in Education,* (New York: Harper and Row, 1966).

computer-based system to keep track of the progress of the students.[1]

We have known for some time that a master plan which interfaces the many components which go into mass education on an individual basis, is sorely lacking not only in reality but even on paper.

In order to fill that void it is necessary to bring together the resources of government; the technical competence of industry and the professional skills of the entire educational establishment[2] to place, pilot, and implement a total communications system utilizing the computer as the central control. The rationale for such a system can be made on many fronts but Cogswell's statement conveys our findings precisely:

The original idea for an instructional management information system emerged as a result of our analysis of the continuous progress plan school.[3]

Although the concept of the instructional system described by Cogswell is only a part of the system anticipated in this paper it represents the kind of thinking that is needed.

The Brigham Young University Lab School in Provo, Utah under the direction of Dr. Edwin Read was one of the

1 John F. Cogswell, *et. al., Analysis of Instructional Systems* (Santa Monica, California: System Development Corporation, 1966), p. 42. (under a USOE contract No. 7-14-9120-217.)

2 Educational establishment is defined here in the broadest terms and includes any group of people or agency interested in increasing the cognitive, affective, and psychomotor competencies of people.

3 John F. Cogswell, *op. cit.*, p. 93.

objects of the System Development Corporation (SDC) study because of its continuous progress plan to individualize instruction. "Stand-alone" software packages from this and similar schools such as Nova High School in Ft. Lauderdale, Florida, and Theodore High School in Theodore, Alabama, will provide windfalls to schools wishing to break away from the lock-step of graded and group instructional programs. Such programs will help to alleviate a discrepancy between theory and practice that has existed for some time.

Tests tell us that there is wide variation among individuals when they arrive at the educational doorstep,[1] and theory says that this variation should increase as the individuals progress through school. But the *practice* in the schools is to make the students as much alike as possible, to make everyone near the average. Anyone who doesn't rate being called "normal" is classed as a deviate. And from this kind of thinking we get *special classes. Deviation should be fostered, not disclaimed.*

The biggest obstacle to an individualized instructional system at this time is the availability of software. A succinct statement is presented in the abstract to the SDC document, and is quoted at length here because the statement of the problem; the findings and even the recommendations are being confirmed and tried out by the authors in the Saginaw Township Schools:

> Although there is a definite trend in secondary education to search out and introduce ways to alter school organizations so that the individual differences among

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1 Walter W. Cook and Theodore Clymer, "Acceleration and Retardation," Chapter XI in *Individualizing Instruction*, Sixty-first Yearbook of the National Society for the Study of Education, Part I. (Chicago: The Society, 1962.)

students can be accommodated, *no school has yet evolved an organization to successfully meet this objective.* Schools striving in this direction are presently blocked because they lack two major resources: (1) adequate self-study instructional materials and (2) adequate systems to provide information to instructors, counselors, and administrators about the status of students as individuals. Recommendations for attacking these problems, growing out of the study include: (1) continued development of the computer-based system to assist students and counselors in academic planning that was started in the project; (2) continued study of the use of information processing in the classroom to design systems that will collect, store, and display student information so that it can be used in the immediate instructional process; (3) in-service training of influential school personnel in the skills of designing individualized course materials and (4) development and dissemination of procedures for the management of changes in schools.[1]

A longer range objective perhaps not spelled out in these documents is the inclusion in this system of all learners, adult and youth, in school and out of school. Such an objective, admittedly blue-sky thinking, is perhaps attainable within a decade.

When one visions this system he is immediately struck by the affect it will have (or should have) on the physical space being planned. The designs of buildings should take

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1 John F. Cogswell, *et. al., Analysis of Instructional Systems, op. cit., (underlining mine)* abstract page.

these into consideration now because buildings are usually intended to last a long time and must reflect the ways in which the buildings will be used, not just tomorrow, but for the next fifty years. It may be that the centralized space will get smaller rather than larger due to the advances in LASER technology and microphotography. But most conventional building plans today call for *larger* central park facilities.

We cannot wait for all the answers to come in before we begin. We must start now, so that when the total system is capable of implementation it will be an evolution rather than a revolution.

IV. The Continuous Progress Plan (CPP)

It is the purpose of this section to outline a continuous progress[1] plan necessary to meet the philosophic position usually taken by educators but only given lip service in practice throughout the United States.

It should be the policy of the school board and the philosophy of the school staff to *provide an educational environment in which every student can prepare for successful participation in the general society*. This can best be done by determining each individual's abilities, aptitudes and interests and designing (and redesigning) a curriculum specifically tailored to these criteria. This is basically a child-centered curriculum, such a curriculum is not laissez-faire in nature. A detailed program is necessary but the child, not the subject matter, remains the focus for planning.

Specific *terminal and sequential objectives* should be specified by teachers from within the school system with limited use of outside advisers. These cognitive, affective, and motor skill objectives can then be used in selecting commercially prepared instructional subsystems such as filmed or programed instruction or other media — based courses. These same objectives can then be used by the "inplant" programers who can mesh the various commercial materials together into longer sequences or program those

1 Credit for the detailed CPP presented here must be given to John Childs of Wayne State University, and Fred Knirk of Syracuse University, who prepared the paper as consultants to the Saginaw Township Community School District.

areas that are not available. The cost of these systems can be regained by selling the completed programs to commercial interests.

Kindergarten will be little affected by these modified instructional approaches. It can basically remain as it is in schools today, with heavy emphasis on the social needs of the children and on readiness for learning reading and number skills. *Students up to about the age eighteen* will be most affected by this continuous progress system.

Instructional, administrative and guidance communication systems should be tied as closely together as possible. Similar or compatible information systems should be used when possible so a teacher can have immediate access to the instructional programs (for evaluation and surveillance of student activities) and to administrative records which may be needed in the guidance of an individual. Taking attendance and testing should be built into this system so the teacher does not have to physically count heads or check objective tests and record the results.

Non-professional clerks and technicians should be employed as examination indicates that particular educational activities can be performed by less highly trained and specialized personnel. The use of instructional technology in presentation systems will permit and/or demand a larger number of technicians than other group instructional systems.

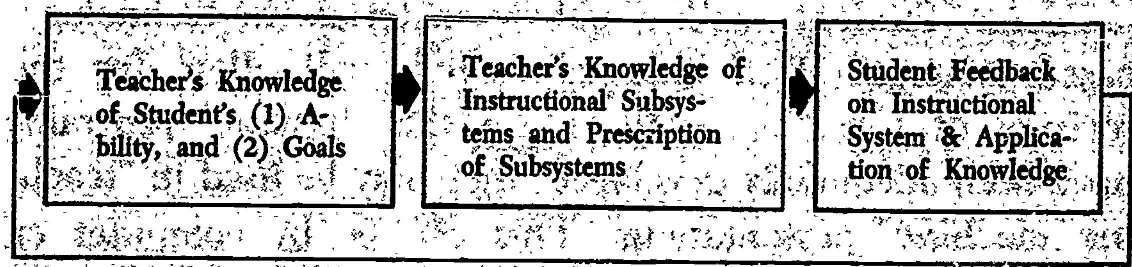
Primary use of the interior school space will be occupied by *individual student study carrels* so the students will have "offices" where they may study with minimal distractions.

These carrels should be constructed to facilitate the modification of the area to accommodate group activities when necessary.

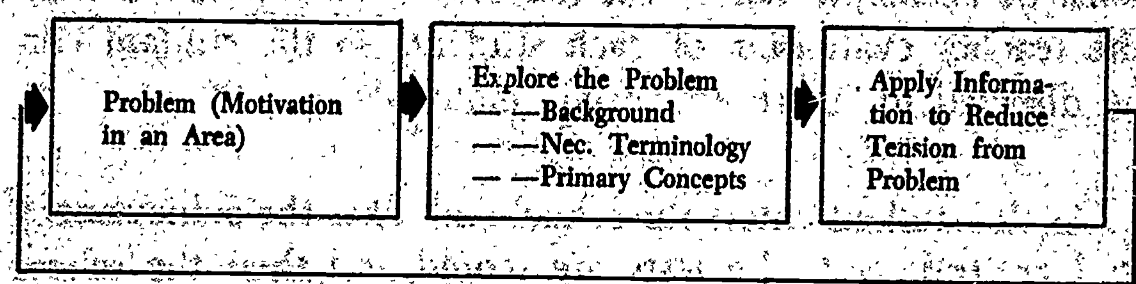
The principle means for achieving an individual child-centered curriculum is a man-machine system; the teacher performs the non-routine (non-programed) and "more creative" functions while technology helps students through the "more routine" sequences.

The educational system must include a communications system which will allow students access to the information they need to solve their problems. They must know how to use the information, and they must be able to have "access" to the teacher when they need assistance.

FLOW-CHART OF THE INSTRUCTIONAL SYSTEM:



FLOW-CHART OF THE LEARNING SYSTEM:



Student *feedback subsystems* must also be provided so the student can have nearly instant access to a teacher for necessary assistance. These feedback systems can also be used to revise or improve instructional subsystems. Systems should provide for an evaluation of a student's understanding of the content so the student can be adequately counseled by the teacher and/or be guided to and through the program. Computerized instructional systems can have a relatively sophisticated internal feedback system; that is, the common error points which can be anticipated by experienced teachers can be provided for and the computer can branch a particular student through a program based on his responses or feedback.

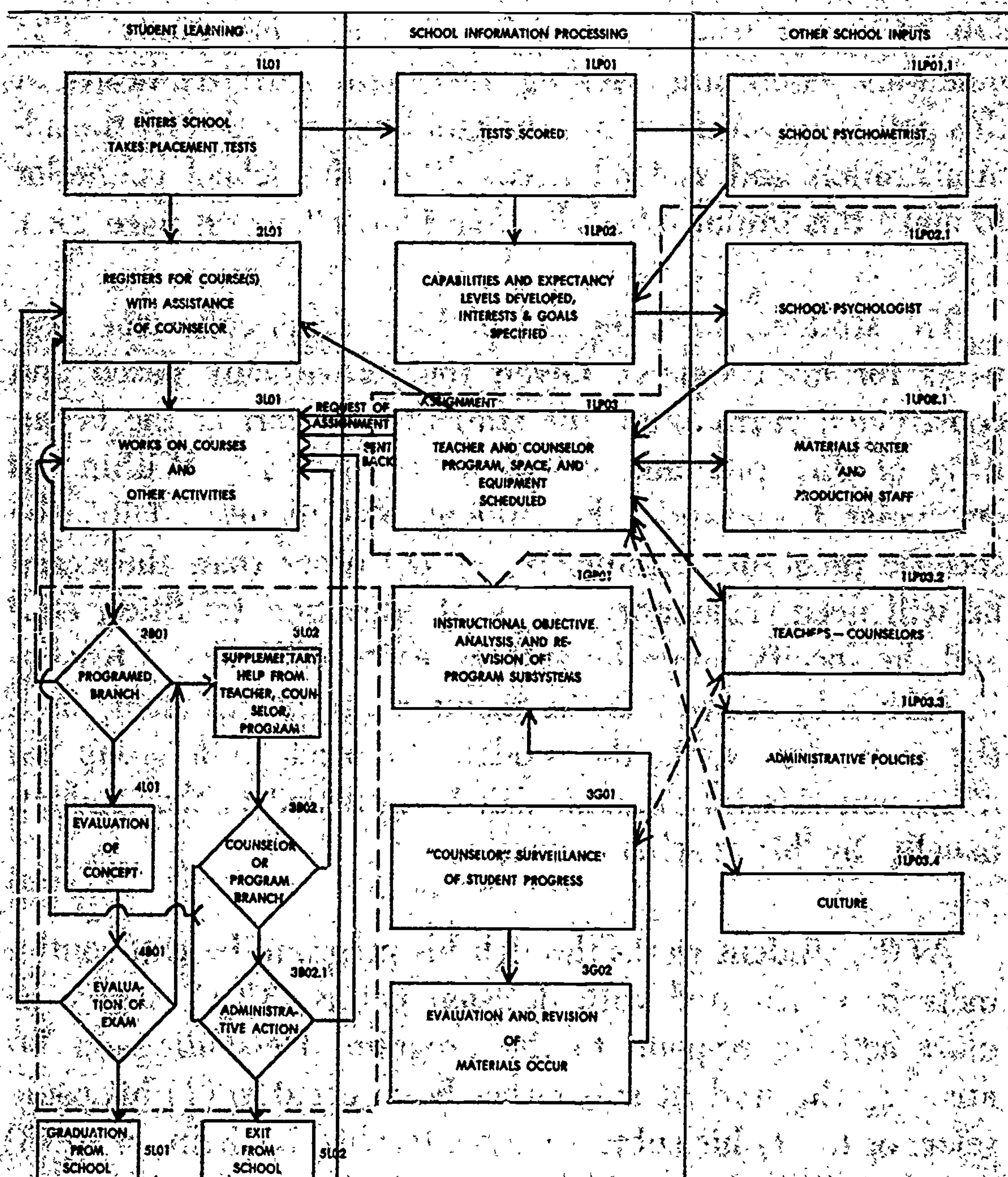
Materials can be revised according to student learning types and ability level as dictated by the student error rate (an indication of inadequate programing) and psychological problems. Students will use these materials in technology-based systems (often grouped) which will allow for the revision of these materials. Once the "inplant" programs have been adequately developed, they may be used in "teaching machine" presentations. This can be by computer or simple text format. *Evaluation* and subsequent revision should lead to a reduction in student learning time and the cost of attaining the desired goal. Evaluation of the materials must be accomplished by each teacher (in conjunction with the teacher evaluation of each student) so the student can be directed to "more advanced" materials.

As the student enters the school and takes the achievement and aptitude test, the tests are scored and then the school psychologist examines the results and makes his recommendation as to the degree of reinforcement and the orientation or instructional methodology most apt to be successful with the particular individual. These test results and the psychometrist's recommendations are immediately acted upon by the school psychologist who specifies the student's counselor, subject matter teachers, carrel, and initial program(s). The materials center and teaching staff (administrative heads, at this point) operating within the guidlines provided by the administration and societal needs allow the school counselor to make this initial schedule. (See Flow-Chart on page 28.)

The student, with the aid of his teacher-counselor, registers for his course(s). Given the individually paced and constructed curriculum, the student can start at the beginning of any program at any point in time. Within his curricular framework, the student will request, daily, the specific programs, equipment, spaces other than the carrel he will need (laboratory, physical education facilities, etc.) and the specific times he anticipates he may need a teacher in each subject area. If the facilities are not available or if the counselor wants the student to meet in a group for discussion this information will be provided to the student, usually by his teacher-counselor.

As the student works through his program, he will continually be confronted with decision points, 3B01, where he must actively respond to the program. Depending on his answers, the student may either be directed to (1) his counselor, or to (2) his subject matter teacher for help, or to (3) a remedial program, 3L02, after which he may either continue working on his course or if he still is not able to work with the program he may be directed to the administrative

Relationship Between Information Inputs and Flow of Student Through the School



staff, 3B02.1, for action. This can result in his being sent back into the program or his being registered for another course (perhaps to help him with background information), or to his dismissal from school 5L02.

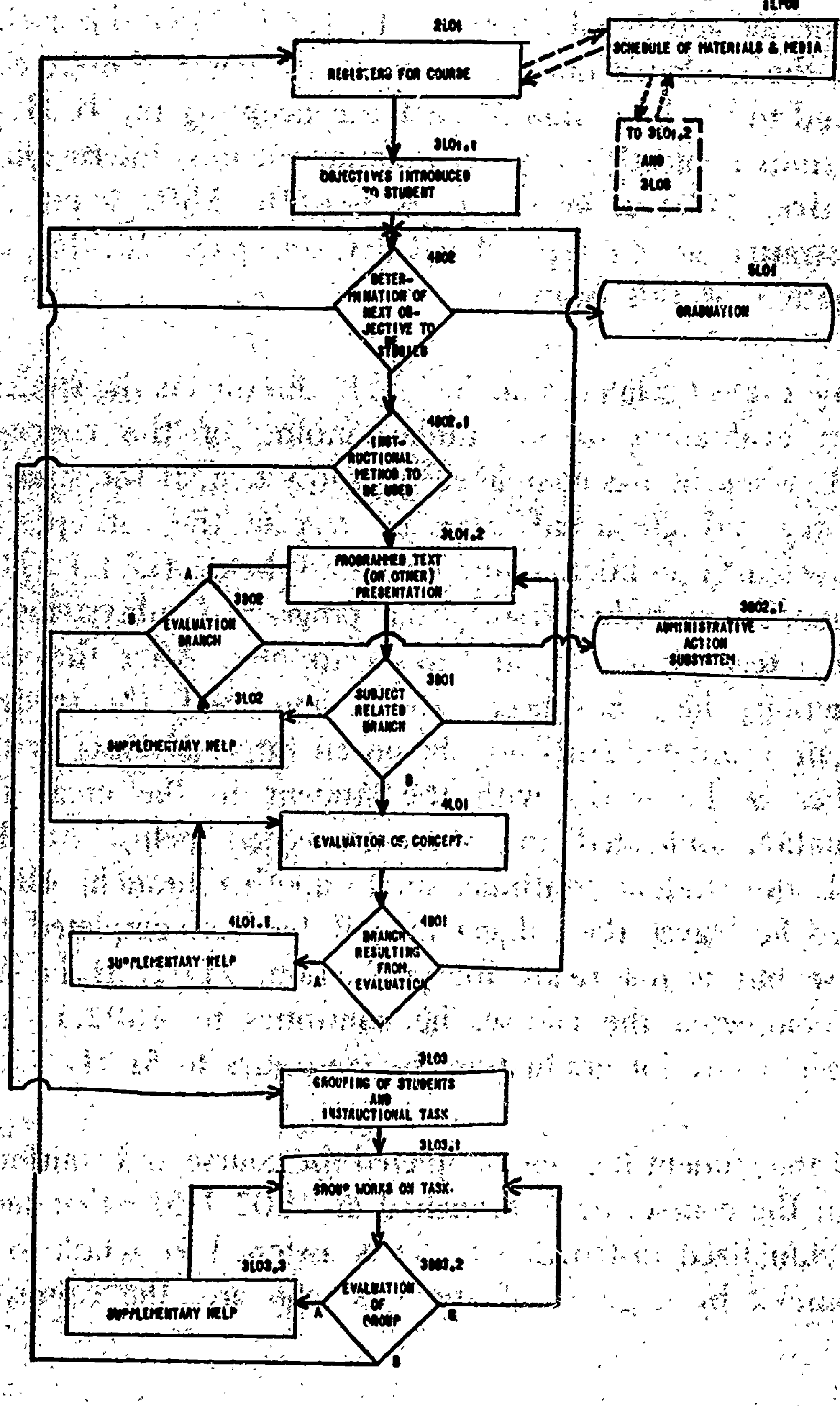
If the student understands the information at decision point 3B01, he will continue working through the program until he finishes the program successfully and he will then be directed to take the final examination, 4L01. If the examination indicates the student needs remedial help he will be directed to 3L02. (This should seldom occur, since if the programs are adequate the students should understand the subject matter and pass the examination). If the student successfully completed the examination and has more courses to take he will register for them, 2L01. If he has completed all his course work he will graduate from the school, 5L01.

At the decision points and remedial branches, the teacher-counselor keeps a close watch on the student. These are places where the highly trained professional teacher is most needed. When the programed instructional system is inadequate for the individual, the teacher must interview and, after analyzing the problem, prescribe remedial help. The result of this analysis of the programed subsystems and the places where the students have difficulty should lead to the instructional subsystems by the personnel in the materials center with guidance by the teachers, counselor and school psychologists.

The Flow-Chart on page 31, illustrates the probable sequence which would be followed by a student as he progresses through the Continuous Progress System. This examination is necessary so the roles to be assumed by the instructional technology subsystems, teachers, and counselors will be understood and coordinated.

Once the student is registered for a specific course, he requests the required instructional materials, media, and space (if other than the carrel space) needed to complete the instructional program from 1LP03. After he has access to the necessary materials, the student proceeds on to an introduction, 3L01.1, of the terminal objectives to be studied. This introduction may be presented on film, tape, paper handouts, or by the teacher on either a group or individual basis. At the completion of this presentation, which should provide a Gestalt of the work to be studied including the presentation of the specific terminal and intermediate objectives, the student proceeds on to 4B02 where the first intermediate objective and the instructional approach, 4B02.1, is determined. If individual technology systems are to be used, the student proceeds to 3L01.2. The study of the concept in this approach involves a prearranged, highly organized presentation. These objectives which are to be studied follow the sequence of intermediate objectives specified by the local teachers at the Planning Session. These objectives will be attained by using instructional technology, such as programed texts, and a check on this attainment will occur for these reasons: (1) positive student reinforcement, (2) guiding student progress through the subsystem, and (3) determining the future instructional subsystems most suited to the individual's interests and abilities. The guiding of the student will occur at frequent intervals (possibly as frequent as once a minute) at 3B01 and result

Expanded Flow Chart of a Student's Progress Through a Typical Segment of a Course



in the student being directed on to the next intermediate objective, 3L01.2, or to supplementary branches in the program, to supplementary programs (subsystems) or to the teacher for additional assistance to 3L02. After this assistance, the student's progress is again evaluated, 3B02, and allowed to (1) be evaluated on the concept again, 4L01, if on terminal objective or to (2) examine the next intermediate objective, 3L01.2, or (3) to be sent to 3B02.1 for administrative action (see Flow-Chart on page 28, for examination of this branch.)

The subject related branch, 3B01, also directs the student to an evaluation of his understanding of the concept, 4L01, when he has completed his subsystem. If the student does not indicate a sufficient mastery of the concept, he is directed to additional supplementary help, 4L01.1. This assistance may either result from programed subsystems or from a teacher or the student's counselor. After the supplementary help has been offered and used, the student is again evaluated (this may be on an informal basis by the teacher as he works with the student in the areas the evaluation indicated the student needed help). At this point, the student continues on to another branch, 4B02, where he leaves the subject area if he has completed the course but is not ready for graduation, 2L01. If he has not completed the course, he continues to 4B02.1, and if he is ready for graduation, he continues to 5L01.

If the student has not completed the course and continues on in the course, he is branched at 4B02.1 to either more individualized instruction or he is assigned to a task to be examined by a group of students who are, the counselor believes, ready to study the same problem. This may lead to laboratory experiences, social research or to a general discussion of what has been studied and its implications. The teacher may or may not provide a great deal of direction depending on the problem to be studied and the composition of the group. This grouping of students at 3L03 may last from a few minutes to several days, depending on the way the group works at the task, 3L03.1, and the evaluation of the group, 3B03.2. If the students need more information to complete the task, they may receive supplementary help, 3L03.3, from either programed instructional subsystems or from the teacher and then again continue to work on the group task(s). When the students have completed their work on the task(s), they continue back to 4B02 where the next concept they are to examine will be determined.

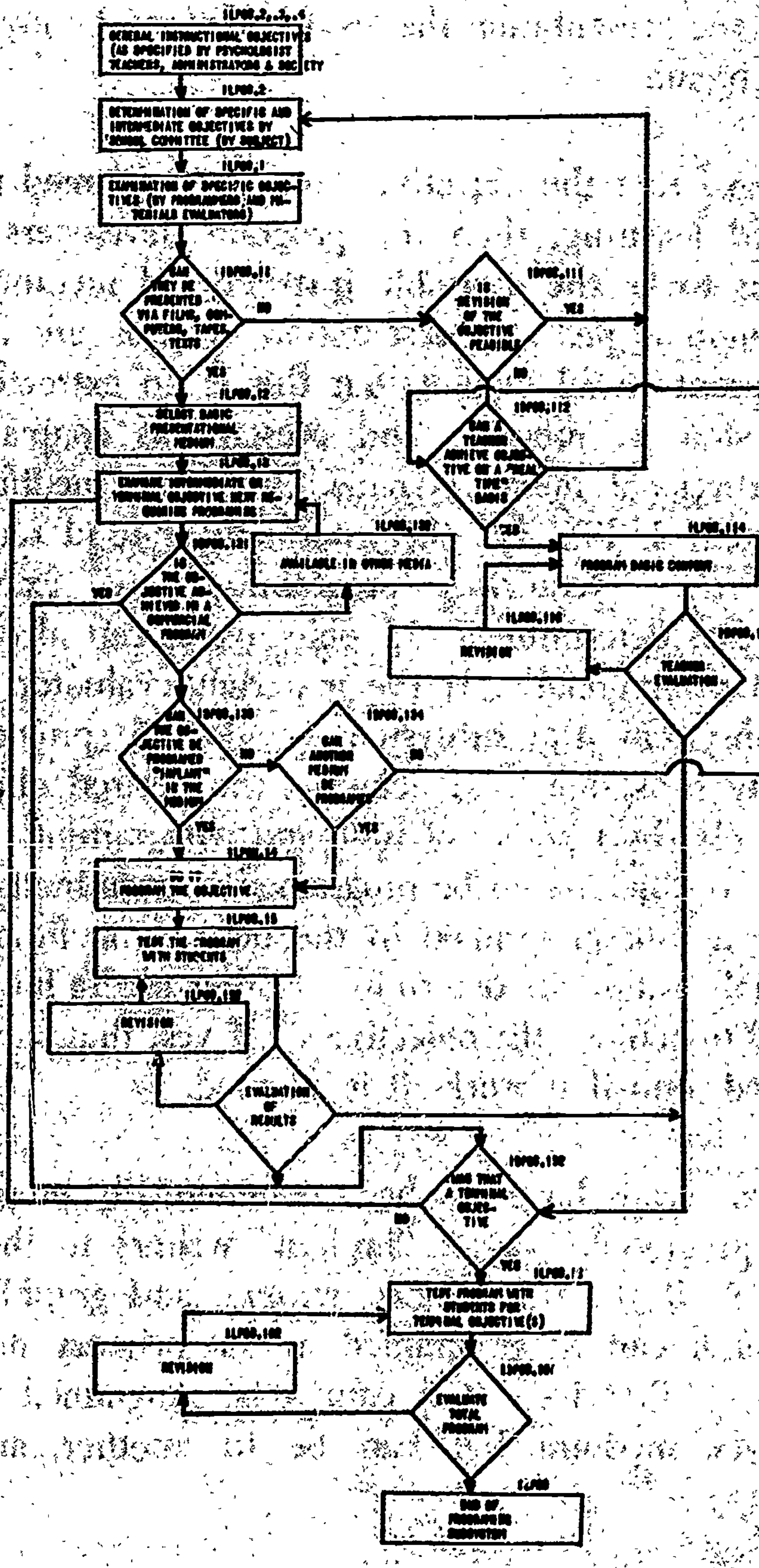
This flow-chart should be used by the programers and the teachers so they can foresee the decision points and those areas where teacher guidance and/or technology subsystems dovetail. The analysis of the student's ability and the adequacy of a specific programed subsystem for that individual rests with the teacher and it is his responsibility to prescribe or mate materials and students. In addition, the teacher continually recommends modification of the instructional subsystems as he identifies areas that need changing.

In the flow-chart on page 35, an analysis of the instructional objectives and the programing and revision of the programs to achieve these objectives is outlined. This flow-chart is to provide a working outline for the programers who will develop the "inplan" instructional subsystems regardless of the presentational medium. This also provides the points at which programers should ask for a representative student(s) to actually work through the program.

Once the general instructional objectives have been specified by the various societal influences, administrative policies, and by the teachers and counselors who will be working with subsystems (1LP03 in the flow-chart on page 35), the specific terminal and intermediate objectives are specified by a committee of educators from the school system with limited assistance from outside curriculum planners from Chem Study, PSSC, AIBS, Modern Mathematics and similar curriculum. This is point 1LP03.2, in the flow-chart on previous pages.

From this point, the materials evaluators at 1LP03.1, and the programers examine the required outputs which must result from the individual instructional subsystems. If the objectives do not appear to be obtainable without either revision or more definition ("to be a better citizen") by instructional technology, the programers determine, 1BP03.111, if the objectives can be revised, 1LP03.2. If the revision of the objectives can, or should not be revised, the objectives are examined to see if a teacher operating on a "real time" basis can probably achieve the desired objectives, 1BPO3.112. If the objectives cannot be obtained by the teacher, then the objectives must be revised or eliminated. If the teacher can, in all likelihood, perform a primary role in helping a student to the specified objectives, then the basic content of the presentation should be developed, 1LP03.115, and suggest revision as necessary. This teacher-presented system should seldom have to be

Instructional Objective Analysis Programing and Revision of Program Subsystems



used (except in some aspects of speech classes, physical education courses and other areas where large groups of students are required) since if a teacher can prepare a lesson outline for the presentation the lesson plan can be presented by other media.

If it seems that the objectives can be programed for individualized learning, then the program developers select what seems to be the desirable instructional medium. For example, motion picture presentation systems are a good way to present visual motion, but this is an extremely expensive system to program and present, as compared to other instructional media systems. After the medium has been selected, 1LP03.12, the intermediate (and terminal) objectives next requiring programing are examined, 1LP03.13, to determine if the objective(s) can already be programed commercially. If the materials evaluators locate such a subsystem, the subsystem is adopted (providing it is a quality subsystem and achieves the desired objectives in a relatively short period of time and with minimal costs), and the next objective to be programed is examined. If the objective was not programed in the desired medium, then the materials evaluators determine if other media have been programed to achieve the objective(s). If yes, that subsystem is examined, and if it works it is adopted.

If the materials have not been commercially programed, then the programers assign "inplant" writers to the task, 1BP03.133. If the programers, writers, and graphics personnel feel it can be programed in the primary medium, they do it, 1LP03.14. If it cannot be programed well in the primary medium but can be in another medium, 1BP03.134, then that medium is programed. If, however, no instructional medium can be programed at this point then the objective is sent to 1BP03.112.

After the program has been programed for individual student use at 1LP03.14, the program is tested with students which represent the probable user population with regard to previous education, ability and maturity level. Based on the result of the evaluation of this testing at 1BP03.151, the program is revised at 1LP03.152, and retested. When the evaluation of the program is satisfactory, in the sense that the objective(s) is obtained within minimum time and cost expenditures, the subsystem is considered completed and the program is examined to determine if it was the terminal objective in the course, 1BP03.152. If the subsystem achieved an intermediate objective, but not the terminal objective, then the programers return to 1LP03.13 to examine the next objective which requires programing. If it was a terminal objective, the entire program is tested at 1LP03.16.

If the evaluation of the total program, 1BP03.161, is not satisfactory, the program is revised and retested, etc. If the program achieves the objectives with minimal input requirements; if the psychological effects on the student appear to be satisfactory; and if sufficient communication channels for transmission of the program appear to be available so the program can be used, the programing of the course is considered completed, 1LP03, and the programers are released for assignment to another "course".

Actually, programing is never completed. The programs can always be improved to reduce student learning time, to increase comprehension over a period of time, and to decrease the cost of the subsystem. As the teachers and counselors find potential points of revision (see 3G01 in flow-chart on page 28) revision of the course will follow (3G02 in flow-chart on page 28).

V. The Computer In An Individualized Instructional System

The writers are concluding a Title III planning project on Computer Based Instruction. Phase I used as its main research tool the technique of on-site visitations. Most of the literature on the use of the computer in education is pure salesmanship and dissolves upon detailed questioning. Many explanations of its use are actually not practical at present or are so costly as to be prohibitive, even experimentally.

The most incisive questions can be asked and the answers best evaluated at an on-site visit. Even then many gleaming generalities are unquestioned and only after the visit, with the experience freshly in mind, is there an opportunity for an interactive critique that brings to light the many possible flaws in the system and exaggerations made in its behalf. Locally produced literature, more factual in nature, is oftentimes only available in a limited amount and is therefore not distributed widely. After the visit this literature can be studied and the short-comings delineated as well as compared with similar type literature from other installations.

Yet, it is evident that the use of computers for instruction in education is just around the corner and so the value of the Planning Grant not only to the Saginaw Township but to the professional community at large is unquestionable.

In an attempt to review some of the experiences we have had in evolving a system to individualize the learning process through the aid of technology, we will turn to the planning project, the state of the art today, and the type of program technically feasible.

Description Of The Planning Grant

Title III has provided funds for the *planning* of a demonstration school for Computer Based Instruction (CBI). The word planning is emphasized because to date no computer based system is complete. This is true mainly because what has developed was of necessity *ad hoc* and secondarily because of the lack of existing hardware (equipment) and software (programs to control the hardware).

Rather than use any available computer and accompanying programs, just to be in on the act, we had visions of planning for the development of a total communications network in which the computer would serve as a central control.[1] We hoped in this way to participate as cooperative inventors with industry to develop both hardware and software which would reflect the needs and desires of the education establishment as it attempts to solve the problem of tailoring the curriculum to meet the needs, abilities and interests of each individual learner.

The project funded since June of 1966, was in a dormant state until September, when personnel were available to give leadership to the program. Since September,

1 Many useful suggestions in the design of such a system have been received from the technical consulting firm in the person of Mr. Thomas Morrissey of Denver, Colorado.

much work went into the rapid use of all available information even remotely related to Computer Based Instruction. Concomitantly with the analysis of existing reports and studies of CBI, representatives of industrial concerns known to be interested in this type of instruction were contacted. Meetings were arranged with the Saginaw Township staff. Finally, a detailed list of places capable of demonstrating on-going activities was compiled and a schedule of visitations was planned.

State Of The Art Today

So far most of the work involving computers and instruction have been experimental and have been inaugurated by universities or industry. Saginaw Township, Saginaw, Michigan, is unique in being the first and only public school system to initiate such a program in the U.S.A. Thus it has the ability to *demonstrate* the interrelationships of the use of modern technology to the educative establishment in which no other agency can compete.*

Some of the places with Computer Assisted Instruction (CAI) are listed in the Table on page 42.

Most of the projects are at the secondary or post high school level and are not expected to take over much of the curriculum at this time. Indeed, this problem of software (curriculum in the form of computer programs) is a limiting factor in the use of the computer in education and a preliminary finding is that there are at least three unique

*Prior to going to press the Saginaw Township Board of Education voted to withdraw the application for the pilot program and plans are being made to allow Waterford Township schools to continue the program.

GOING SYSTEMS AND PROJECTS

Alpha Code	Contact Person	Institution	Address		Phone		
			City	State	A.C.	Ex.	No.
BB & N	Dr. John A. Swets	Bolt Beranek & Newman	Cambridge	Mass.	617	491	1850
BOCES	Dr. Richard L. Wing	North Westchester	Yorktown Hts.	N.Y.	914	245	2700
ERE	Dr. Omar K. Moore	Univ. of Pittsburgh	Pittsburgh	Pa.	412	621	3500
ESD-DSL	Dr. Sylvia R. Mayer	Decision Sciences Lab	Bedford	Mass.	617	274	6100
E T S	Dr. Robert F. Boldt	Educ. Testing Service	Princeton	N.J.	609	921	9000
Florida	Dr. Duncan Hansen	Florida State Univ.	Tallahassee	Fla.	904	599	3430
IBM-ASDD	Dr. Richard S. Hirsch	IBM Adv. Systems Develop	Los Gatos	Calif.	408	227	7100
IBM-FED	Harvey S. Long	Computer Assisted Instr.	Poughkeepsie	N.Y.	914	463	1234
IBM-WRC	Dr. E. N. Adams	Watson Research Center	Yorktown Hts.	N.Y.	914	945	3000
Mass. - BE	Dr. Jesse O. Richardson	Commonwealth of Mass.	Boston	Mass	617	267	9650
MSU	Dr. Robert H. Davis	Mich. State Univ.	E. Lansing	Mich.	517	355	1855
Penn State	Dr. Harold E. Mitzel	Penn State Univ.	Univ. Park	Pa.	814	865	4700
Pitt	Dr. Robert Glaser	Univ. of Pittsburgh	Pittsburgh	Pa.	412	621	3500
PLATO	Dr. Donald Bitzer	Univ. of Illinois	Urbana	Ill.	217	333	1000
SDC - 2	Dr. Harry Silberman	Systems Develop Corp.	Santa Monica	Calif.	213	393	9411
Socrates		Univ. of Illinois	Urbana	Ill.	217	333	1000

GOING SYSTEMS AND PROJECTS

Alpha Code	Contact Person	Institution	Address		Phone		
			City	State	A.C.	Ex.	No.
Stanford	Dr. Patrick Suppes	Stanford Univ.	Stanford	Calif.	415	321	2300
SUNY-SB	Dr. Edward Lambe	State Univ. of N.Y.	StonyBrook	N.Y.	516	246	5000
Texas	Dr. C. V. Bunderson	Univ. of Texas	Austin	Texas	512	471	3434
UCI	Dr. Fred M. Tonge	Univ. of Calif.	Irvine	Calif.	714	833	5011
UCSB	Dr. Glenn Culler	Univ. of Calif.	Santa Barbara	Calif.	805	968	1511
UCSF	Dr. John Starkweather	Univ. of Calif.	San Fran.	Calif.	415	845	6000
UM-CCP	Dr. John Fowler	Univ. of Michigan	Ann Arbor	Mich.	313	764	1817
UM-CBLLB	Dr. Harlan Lane	Univ. of Michigan	Ann Arbor	Mich.	313	764	1817
UM-CRLT	Dr. Karl Zinn	Univ. of Michigan	Ann Arbor	Mich.	313	764	1817
UM-MHRI	Dr. William Uttal	Univ. of Michigan	Ann Arbor	Mich.	313	764	1817
RCAC	Allen Corderman	Radio Corp. of Amer.	Palo Alto	Calif.	415	321	5000
MIT	Dr. R. M. Fano	Mass. Inst. Technology	Cambridge	Mass.	617	864	6900
HU	Dr. A. G. Oettinger	Harvard University	Cambridge	Mass.	617	868	7600
NCR	Mr. Dan C. Brewer	National Cash Register	Dayton	Ohio	513	449	2000
GLC	Francis Keppel	General Learning Corp.	Washington	D.C.	202	657	2610
Brentwd	William Rybensky	Ravenswood Sch Dst	Palo Alto	Calif.	415	322	1586
PHIL	Dr. Sylvia Charp	Philadelphia Schools	Phil.	Penn.	215	443	6491

ways for the computer to be used in the schools and only one of them is very often tried or understood. Fortunately, the other two (conversational progams and simulation programs) are less susceptible to the limitation of available software.

A second preliminary finding which has grown out of the visitation technique is that many peripheral types of equipment can and should be under the control of the computer. Among these are still picture slides, motion films, video tapes, audio tapes, closed-circuit television and the entire gamut of audio-visual technology. It may be possible to convince industry that such devices should be easily programed as part of the learning sequence.

Some Established Programs

Computers being planned for use in instructional purposes are appearing in an ever increasing number of Title III proposals. Programs which plan to utilize computers have already been approved under Title III of ESEA for a total of more than four million dollars. Indications are that many additional millions will be spent in this area to improve instruction in school districts throughout the United States this year. During this year the writers visited many computer programs in the U. S. under a Title III planning grant. A brief description of some of the programs visited follows.

PLATO Project . . . located at the University of Illinois at Urbana and headed by Dr. Donald Bitzer. An interesting feature about the PLATO project is the fact that it is a flexible program, using a Fortran type compiler system with several auxiliary educational technical devices in the audio-visual field such as motion picture films and slides. Another feature is the electrical or photo electrical scanning of slides. At present, 122 slides per programed unit are available in direct access procedure from each of the terminals. This photographic reproduction at the terminals is unique with the PLATO Project and holds great promise for the future in information storage and retrieval. At the time of our visit they did not have audio but it was felt that this would be overcome within the year. Work is being done in the PLATO Project to develop a low cost Cathode Ray Tube that will bring the cost of terminals down to as low as five hundred dollars. At the time of our visit there was much activity at Illinois, in relation to the PLATO Project and a sizeable expansion is occuring with a new organization consisting of Drs. Lee Volpp, Max Beberman, Donald Bitzer, and Elizabeth Lyman.

The Northern Westchester Board of Cooperative Educational Services (BOCES) . . located in Yorktown Heights, New York. Their project is headed by Dr. Richard L. Wing, Coordinator of Curriculum Research. The BOCES is a service Bureau for several communities and not a single public school community. It is located in the backyard of the IBM Watson Research Laboratory. Here you may see a computer aided instructional system, a closed circuit television teacher training program, and a dial selection system. The striking feature of the BOCES group is that an interphase of instructional materials, graphic, audio and visual supplies; Computer Based Instruction; and a dial select system, are all in one central location. This provides the best situation for implementing a CBI system. The BOCES computer based instruction is unique in using the instructional device known as simulation or game playing which has real value in the individualization of instruction.

Learning Research and Development Center . . . located at the University of Pittsburgh, under the direction of Dr. Robert Glaser. There are five projects presently going on in the Center: an individually prescribed instruction project, with J. O. Bovin, director; a computer assisted instruction project with W. W. Ramage, director; a curriculum design group with J. I. Lipsom, director; SUCCEED Project with R. C. Hummel, director; and Response Environments Project, with O. K. Moore, as principal investigator.

The CAI project has two main objectives: first, to provide facilities and services needed to support the research and development efforts of psychologists and educators working in the field of instructional technology; second, to connect research related to the development of CAI. The project has student stations that will provide a high degree of interaction between the student and the subject matter information display. At the time of our visit a touch sensitive surface was being developed by which a student could point with his finger to a filmed sheet on the front of the Cathode Ray Tube and the position identified by the computer.

A unique feature of this program is attention given to the student terminal device. Project personnel are working with elementary children at the Oakleaf School in Pittsburgh.

Penn State University Project . . . located at University Park, Pa., and headed by Dr. Harold Mitzel. Dr. Mitzel and his staff have long acquaintance with CAI and it would be wise for schools interested in the use of this medium of instruction to consult first with them. The remote terminals being used on campus are connected to an IBM computer at the Watson Research Center, Yorktown Heights, N. Y. The terminals did not have a CRT display but only teletype input/output although a video presentation and an audio presentation were local at these terminals. Reports by the staff at Penn State are well written and clearly present the correct concept of individualization of instruction as it relates to computer technology.

Board of Education, Commonwealth of Mass. . . . "Teaching Mathematics Through the use of a Time Shared Computer." This project is headed by Dr. Jesse O. Richardson, science supervisor in education, science and mathematics for the State of Massachusetts. Dr. Richardson has remote terminals located in several communities surrounding the Boston area where computer based instruction is given through a TELECOMP language being developed by BBN. We visited both secondary and elementary schools using computer programs in group instructional modes. Both the high school students and the elementary children, besides being able to use the computer in conversational mode, were capable of writing rather detailed programs that could be stored and operated with general variables. One of the programs by a sixth grade child in a non-mathematical format was especially interesting. It showed that the concept of mathematics was understood and illustrated how to use the computer for non-mathematical situations. A general working knowledge of the concept of programing languages was displayed.

Dr. Richardson has an office located in the facilities of Bolt, Beranak and Newman in Cambridge, Massachusetts, and is an especially good guide to the computer installations at Harvard and M.I.T.

Project MAC . . . located at Massachusetts Institute of Technology in Cambridge and headed by Dr. R. M. Fano. The essential ingredient of this project is time-sharing on computers. M.I.T. has extensive experience with computers using the concept of time-sharing with online terminals. The amount of computer power located here for all kinds of computer related research far exceeded that at any other installation visited. About two hundred terminals will be operating by the time this publication is off the press.

Brentwood Elementary School . . . located in the Ravenswood School District, Palo Alto, California. This installation is under the direction of Dr. Patrick Suppes of Stanford University. The Brentwood School has a portable classroom building equipped to conduct the CAI program. There are presently sixteen terminals with ability to grow to thirty, audio and visual (CRT) on an input/output terminal, and a video slide display unit. The audio may have up to two hours of message synchronized with the program that would come through the Cathode Ray Tube. Actually it is set up so there would be no more than one-fourth of a minute per sequence to fifteen minutes per sequence. It is possible to have the student's voice recorded through a microphone back on to the audio sound track, using as much as forty minutes. When this is the case you do not have two complete hours available for output. This forty minutes of student voice can be played back and would be particularly useful in working with language laboratories, reading or phonics. One hundred and twenty-six characters, plus a space, can be put on the Cathode Ray Tube by the student. Also, there are several different dictionaries available that would allow the use of several different languages in the same program. The light pen is available for use on expensive terminals and can be used to generate characters but it is used only as a probe to point to a location on the screen rather than as a design instrument for architectural designs or curve plotting.

Students respond with the use of a light pen. The program is not truly a remote system since the maximum distance from the computer to the student terminal is about two thousand feet. Consequently, students must be shuffled from the elementary school located a few feet away to the computer assisted instructional terminals and back again to the school. The system is being used quite successfully for reading and mathematics tutoring with heterogeneous elementary children.

Bolt, Beranek and Newman Industrial Company . . . with headquarters in Cambridge, Massachusetts. BBN is a research and development company which does experimental work. If a piece of equipment proves to be satisfactory it is "farmed out" to a subsidiary outfit or to another company for manufacture. Since BBN is not in a position to sell computers it has the advantage of being able to put together several vintages of computers to get the required job done. Most of the work done at BBN is essentially programing and research. In developing conversational languages, BBN can be relied upon to develop programs that would be very useful to the educational establishment. For example, on the basis of what BBN has done with National Institutes of Health and the Massachusetts General Hospital, it may be possible for an administrator to write out a few statements on a terminal, such as: "How many students do we have in the elementary school who came from some geographical area?" and receive immediately a table of all the children covered by this classification. This would now be almost impossible on most computer establishments, but BBN seems to think it is very close at hand.

Stanford University . . . . . . located in Palo Alto, California, with a number of projects in operation under the direction of Dr. Patrick Suppes. One of these projects, coordinated by Mr. Max Jerman, is located in the computer center at Stanford University, and has student terminals in schools surrounding Palo Alto. Modern mathematics is taught via a drill and practice routine from text materials prepared by Dr. Suppes. The drill and practice routine at the center is different from the tutorial routine and requires a tremendous amount of computer memory due to the statistical tracking of the students through the various branches. It should be mentioned that the drill and practice program is highly sophisticated. Responses to the program are time controlled. The student enters his name via the Teletypewriter keyboard as he begins the program, communicates with the computer by his name and receives tests, diagnostic branching, instruction, and daily reports of his progress via the terminal.

Materials in mathematics and spelling are available which have been given considerable validation over the past several years. Introducing teachers to the use of computers in this supplement to instruction may offer the path of least resistance to demonstration and consequent adoption.

System Development Corporation . . . located in Santa Monica, California. This is a research corporation in systems analysis with much experience in using computers in education. Work has been done in time-sharing, instruction, counseling, and systems analysis of innovative ideas in education, especially the continuous progress plan.

Counseling demonstration. Mr. Cogswell had a demonstration of an interview type procedure with a student on the console. This is a very difficult kind of thing to actually produce on a computer, but at least demonstrates its feasibility and the fact that it might serve as a counseling substitute. It might prove to be a powerful research tool for some purposes.

In using the computer for counseling it should be remembered that the student does not have an adult in front of him.

It has been suggested that interaction with a machine may even reduce the student's hostility toward the adult stereotype not only during the interview but subsequent to the interview. This has been a traditional problem for counselors who are not supposed to be known as disciplinarians but who must be both adults in authority and empathetic peers.

The different kinds of modes in Cobol are very interesting. A calc-mode allows a statistical analysis in the middle of a sequence of a programed instruction. It is very convenient to have such a procedure available.

A phonetic mode permits the encoding of sentences even though they are spelled incorrectly and to pick out in a second mode (key-word) what the answer is that is embedded in a student's answer.

Also available was a *formula mode* which permits making any kind of algorithm statement into a formula.

Although the PLANIT System that we observed has a rather direct question-answer type of programing, a second type of pedogogical form of inquiry called "the question" is included within it. This is a type of answering program in which the student may ask the program certain bits of information and the program tries to match that bit of information with a reasonable answer. There are four commands available in PLANIT which are rather interesting.

1 - F: Feedback. The student can ask for certain amounts of information on a particular response and if the programer has anticipated this the student can get extra information in the frames about the question that he is attempting to answer.

2 - An R: A return frame which allows a student to return to the frame that he had just passed, a kind of back space procedure.

3 - A C: A command which allows a student to continue through the sequence of frames.

4 - B: Allows branching. A unique feature of this branching procedure is that the student can branch to another program if that program is loaded on disks. This is a unique way to call programs instead of having them loaded in a conventional procedure.

Two other modes are the verbose and concise modes. The verbose mode is the type that a student uses as he first begins explaining everything and getting everything explained back to him. The concise mode is the type of mode that he speeds up the input/output, and only specific ideas, specific terms would have the characters spelled out.

In the calc-mode you can define functions which are subroutines that can be used further in the program.

Harvary University . . . . . . located in Cambridge, Massachusetts, with a Computer Assisted Instructional program headed by Dr. Anthony G. Oettinger. The program visited was part of a project being conducted between Harvard and the University of California at Santa Barbara. This is a specialized type of CAI, in which the terminals cannot really be programed but in which the keys have special functions like taking the SIN or TAN of some number. The unit called TELEPUTER was developed by Dr. Culler at Santa Barbara.

Time-sharing. Perhaps it would be appropriate at this point to give a brief chronological description of the time-sharing process as we see it today. It is obvious that the ability for many programers or people to interact with the computer almost simultaneously and to have a two-way communication with the computer, might overcome many limitations of computer use. It has been said that Dr. Culler and Dr. Fried, of the University of California, have done a tremendous job in getting this kind of time-sharing started. Bolt, Beranek and Newman have also contributed as have project MAC, Systems Development Corporation and many other Computer Instructed Systems, which perhaps added appeal to the use of time-sharing devices.

2 OF 2

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For users who are not programers the congeniality of the computer is usually related to how quickly and easily you can get to the system. In the first breakthrough away from machine lanquage computing, higher languages like Fortran and Algol made it possible for programers to use English statements rather than numerical codes to communicate with the computer; however, this communication system was still a one-way system with the user communicating to the computer but not able to interact with it. The machine language, although quite efficient in computer-run time, is time consuming for the programer's time.

A newer type of language called Conversational Language, of which the Rand Corporation's JOSS is an example, is a jump higher from the symbolic language to a conversational type of language. TELECOMP, which is a specialized language developed by BBN, is a subset of JOSS and allows this two-way use of the computer.

Most uses of computers, especially innovative types, have been linked with the arts and sciences. Today these systems have wide applicability for use by biologists, psychologists, statisticians, researchers and all the behavioral fields including education.

Technically feasible programs. Finally we turn to technically feasible programs in use in the United States in order to describe how the educational establishment might build a system of individualized instruction with the aid of these devices.

A functional relationship. Figure 2 shows an economic triad. This triad identifies why we believe that technically

A functional relationship. Figure 2 shows an economic triad. This triad identifies why we believe that technically feasible programs prohibitively expensive in the past might be supported today and certainly in the future. The top figure represents a past relationship among the government, military and industry. We think that as the wars throughout the world decrease and more and more money is channeled from defense and military spending to education the lower figure will be a more accurate description.

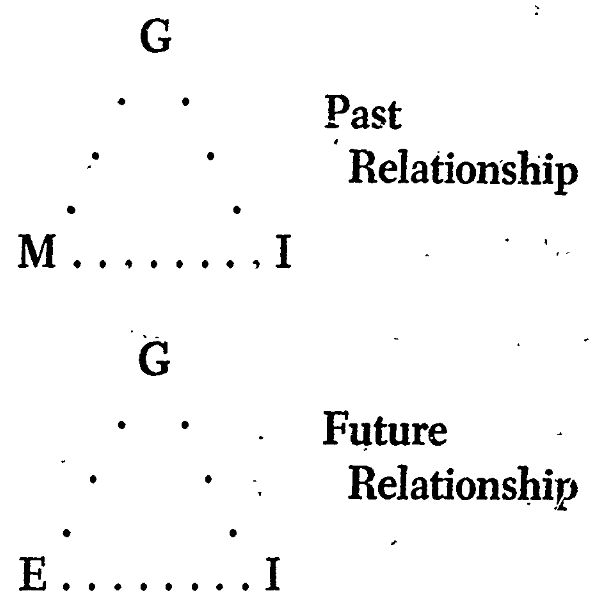


FIGURE 2

THE ECONOMIC TRIAD

The Figure above shows that education (E) replaces military (M) in the triumvirate as military spending decreases and the need for a new market arises. This is, of course, an oversimplification of the situation as both relationships have been in existence for some time and will continue. Yet it is believed that the emphasis will shift, and that as far as

Computer Based Instruction is concerned, we are not advocating the acquisition of technical equipment but the implementation of an instructional theory.

The Instructional Theory

The instructional theory that we are speaking of is captioned in Table I, page 57, "to help the child grow individually." We feel that the many innovations that have been taking place can be classified into at least three headings:

1 - Administrative or organizational innovations

2 - Guidance innovations

3 - Instructional innovations

We prefer to describe grouping, which is a way of decreasing the variance among people, as limited grouping. A truly homogeneous group never exists. Various grouping procedures are usually administrative or organizational innovations. Some of the bases for homogeneous or limited groupings are on size, interest, subject areas, and personality patterns. We think that scheduling, whether the organizational framework is 6-3-3, 6-2-4, 8-4, or 4-4-4, is a way of innovating but it is an administrative or organizational innovation. It is a way of rearranging *for* instruction, rather than a way *of* instruction. Departmentalization, elimination of grades and team teaching have been labeled as innovations at one time or another in their educational history but can be classified as administrative or organizational innovations.

Table 1

INSTRUCTIONAL THEORY

To help the child "grow" individually

Administration or Organizational Innovations	Guidance Innovations	Instructional Innovations
Grouping - (to decrease variance)	Career day	Conversational languages
Homogeneous vs limited Ability Size Interest Subject area Personality patterns	Acting out	Programed texts
	Non-directive counseling	Plays and drama
	Diagnostic testing	Computer based instruction
Scheduling 6-3-3 6-2-4 8-4 4-4-4	Vocational counseling	Cooperative education
		Simulation
		Symposium
Departmentalization		Demonstration
Non Grades vs Many Grades		Lectures
Team Teaching		
Individualization of Instruction		

Some other activities may be classified as *guidance innovations*. Examples of these are career day, acting out, non-directive counseling, diagnostic testing and vocational counseling.

But the really important innovations are *instructional innovations,* among them are conversational languages, program texts, plays and dramas, computer based instruction, cooperative education, simulation, symposium, demonstrations and lectures. All of these innovations could be classified as instructional innovations at one point in their development. They are a different way of presenting the material. When integrated into an instructional system each plays a part in individualizing instruction.

Like all taxonomies this one is incomplete and the fine lines of demarcation are not absolute. One could argue that an activity classified as administrative might be better placed under instruction. The main point is that we envision the use of the computer as an instructional innovation first and foremost. To use a computer as an administrative tool or for pure research is not of first priority.

Problems in building a communications network. Table II, page 59, indicates that if we are to work in the area of individualization of instruction, then we must deal with the area of communications. Since education is the ultimate in communications we have some problems when we try to build a communications network:

1. We have to concern ourselves with the machines, the gadgets, the programs, and the *technology problem.*

2. We have to concern ourselves with a *materials problem*. The content or subject matter has to be decided, as to both the scope and sequence. Also, the subject matter materials must be decided as to text, film, or computer terminal.

3. Another area is the *evaluation problem*. Whatever it is we do in schools we have the final responsibility for deciding whether or not there are any gains: gains in attitude, gains in achievement, gains in skills, or changes in positive values. Criterion instruments must be devised to obtain this data.

Table II

BUILDING A COMMUNICATIONS NETWORK

The Technology Problem	The Materials Problem	The Evaluation Problem
Machines Programs	Content: Text Supplementary Audio-Visual	Gains: Achievement Attitude Skills Values

Computer Based (not Assisted) Instruction. Touring the various CAI installations around the country revealed that many very good uses of the computer were really conventional programed text materials using the computer. While we feel there is a definite place for these activities we think: (1) that they really are not implementing individualized instructional theory, (2) that they are susceptible of obsolescence as micro-photographic storage and retrieval advances, and (3) that this is only one of the modes by which instruction on the computer can be achieved.

This is the reason for differentiating between *Computer Based Instruction* and *Computer Assisted Instruction.* We feel that Computer Based Instruction is a much more encompassing term for this kind of technology, while computer assisted instruction is only one mode of operation.

Figure 3, page 63, shows three separate instructional uses of computers currently possible. Computers may also be used in dialogue, tutorial, standard computer programing, and as a tool like the hand calculator. We feel that the use of languages such as TELECOMP developed by Bolt, Beranek and Newman, (BBN in Boston, Mass.) and the use of simulated games such as those developed under the direction of Richard Wing (BOCES) at Yorktown Heights, N. Y., offer the best possibility as modes of CBI for individualizing instruction. Furthermore, they are most quickly developed for computer use. For instance, the TELECOMP language does not have to wait for the development of a large body of software materials. Game simulation, once devised, can readily be used by a wide range of people.

With the computer storage of statistical data about the individual and the diagnostic and branching capabilities possible CAI is still a very important mode of operation and will for some time comprise the bulk of computerized instruction. However, the CAI mode, even if a very highly sophisticated branching program is designed, can never really be completely satisfactory for individualized instruction because it is teacher-directed. The alternative paths are never infinite and the choices given never exhaust the possibilities. So while a student may learn the material as an individual the program still is not individually tailored for him.

CAI material prepared by author languages will clearly continue to play a part in CAI. Yet it must be admitted that the current estimated high ratio of programer time to student terminal time (100 to 1) will lead people to search for faster routes to make software available at the terminal. We feel that advances made by National Cash Register (NCR) in the microform media field and its photochromic micro-image (PCMI) devices will make it possible to produce large amounts of software which can be used in the conventional CAI mode. Also advances made with holograms in "microforms of microforms" through interference patterns with the reduction possibilities from redundances as developed by researchers will further facilitate storage and retrieval of large amounts of conventional CAI materials.[1]

It only remains for NCR to put its PCMI chips onto its Cram Unit or for RCA to put its holograms on RACE machines (a present possibility) to make a giant step forward in information storage and retrieval. And information storage and retrieval for any purpose should be contemplated in the total educational master plan, as the system is expanded.

The support of the teacher in non-classroom activities offers a wide range of possibilities. The guidance counseling program at System Development Corporation (SDC) illustrates one of these. The group instruction support of CCTV and the monitor screens of a computer terminal are others. Indirect support can be given to instruction through daily or weekly reports of each student or groups of students.

1 See also the cover of the December, 1966 issue of *Science* and the article by Gordon W. Ellis on pages 1195-1197 of this AAAS publication. A very fine explanation of Lasers and Holograms appeared in the December, 1966 issue of *National Geograpic Magazine*, pp. 858-881.

The program could be used at all levels of education, not just K-12.

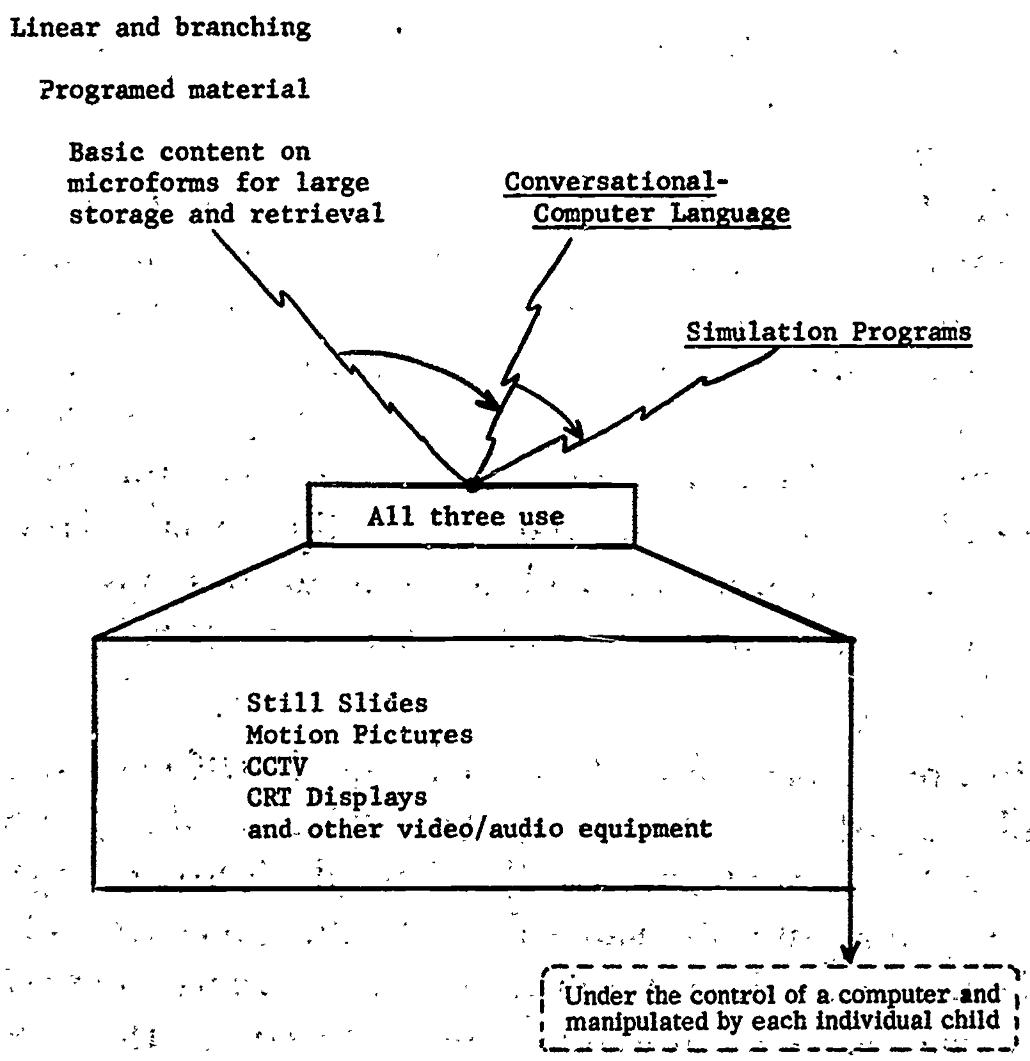
All three modes shown in Figure 3, page 63, should be capable of using still and motion films and slides, CCTV, CRT displays and other video and audio equipment under the control of the computer and *manipulated* by each child.

By manipulating his environment a child is able to learn many things. He did this prior to his formal schooling and he continues to learn in this way outside of school. We believe that manipulation is important to internal motivation to learn and that when a child is able to manipulate the learning experiences of the school with a reasonable degree of freedom greater and more individualized learning will result.

Individual communications network. As all projects these days have mnemonic devices we have dubbed our system INDICOM. It is the purpose of the master plan to describe a total two-way communications system which uses the computer with its unique features as a central control unit. Figure 4, page 65, shows the basic configuration in the computer based instructional program. Included in the software to accompany such a system are materials like those in the Brigham Young University Lab School Continuous Progress Plan and several districts cited in a publication by SDC in 1966.[1] However, that report indicates that these school districts will need a system which can track students

1 John F. Cogswell, *et at.*, Analysis of Instructional Systems, *op. cit.*, pp. 44, 48-49.

CONVENTIONAL CAI



MODES OF INSTRUCTION WITH CBI

Figure 3

as they progress through the program. The needs for bookkeeping, diagnostics, evaluation, and other statistics requires the use of a computerized system.

The results of this study and the Third Office of Naval Research Conference on CAI and the Survey of the Literature on Computer Assisted Instruction distributed by ENTELEK Incorporated, should be on the *"must read"* list for anyone interested in the individualization of instruction through the use of computers. There are also several fine papers available from each of the places visited by the Saginaw Township staff.[1] The special supplement to the *Audio-Visual Communication Review* by Don Bushnell is especially good.[2] The textbook by William Clark Trow[3] is also good. Yet, to do the field justice a survey similar to the SDC document on Instructional systems is needed.

Figure 4, page 65, shows that the INDICOM system really consists of several subsystems as explained in a recent text by W. F. Williams[4] of the General Electric Company. Such components as data collection and processing of an informational retrieval subsystem, the research subsystem and the business subsystem are included in the system pictured in Figure 4, page 65. Basically, any system or subsystem must provide for at least: (1) information, (2) feedback, and (3) process control.

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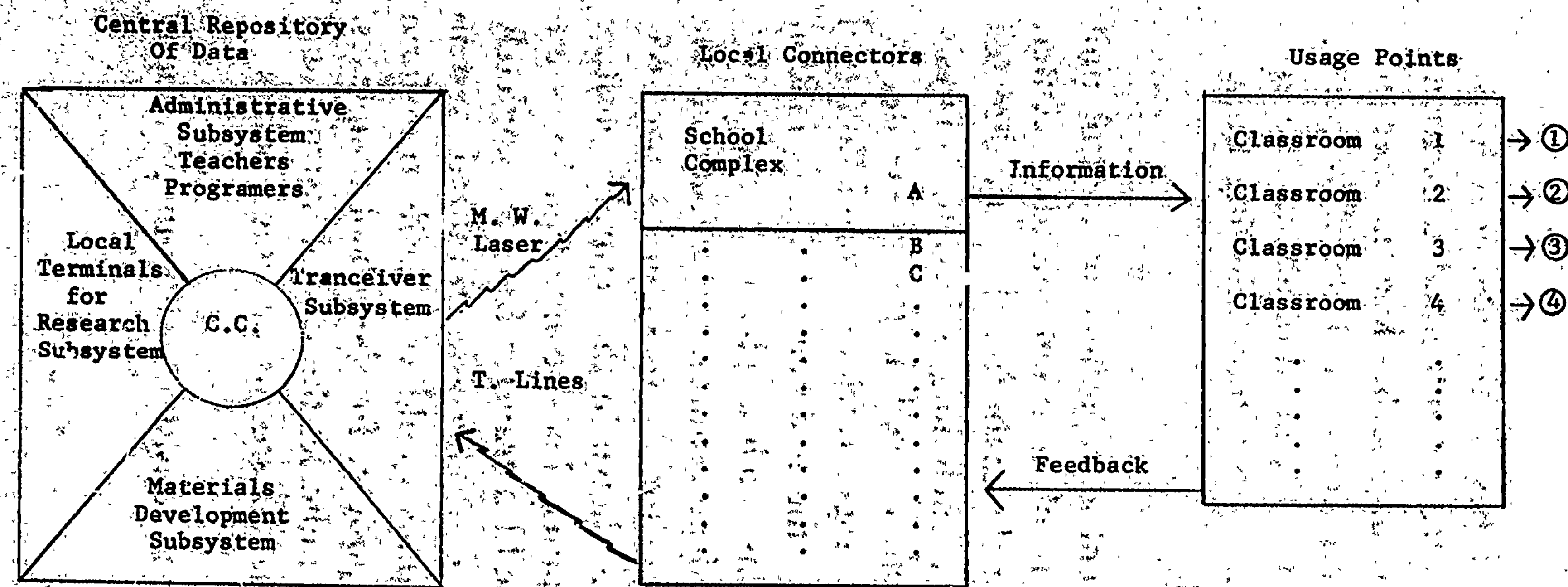
1 *cf.* *ante*, p. 42-43.

2 Donald Bushnell, "The Role of the Computer in Future Instructional Systems," *Audio-Visual Communication Review*. XI, No. 2 (March-April 1963).

3 William Clark Trow, *Teacher and Technology* (New York: Appleton-Century-Crofts, 1963).

4 William F. Williams, *Principles of Automated Information Retrieval*, (Elmhurst Illinois: The Business Press, 1965), pp. 23-24, 34-36.



① Teacher-student terminal-lean terminal with typewriter viewer only. riter

② Library terminal - Micro reader, Printer

③ Laboratory terminal-small in no.-very rich terminal with CRT, keyboard, Video-audio, and light pen, etc.

④ Classroom terminal - medium rich terminal with CRT, keyboard, slides and audio.

INDICOM

A communications Network for Individualizing Learning

Figure 4

The point we are making is well-stated by Williams:

> Although there are many types of information systems, all systems must be oriented to individual utilization of information. Too many approaches lose the user in the complexity of their procedures and therefore perform a disservice — even to the point of attempting to determine needs for him, rather than allowing those needs to be determined.[1]

In stating that the central repository or control unit must exercise the function of a communication center, Williams goes on to say that the main functions are directed to collection requirements, including selection, analysis, evaluation, and transmission, as well as the processing requirements of indexing, storage, retrieval, correlation and dissemination. Furthermore, the maintenace of information controls and business systems, such as planning, improving, and implementing advanced procedures, are considered the functions of the central repository.[2] In Figure 4, page 65, there are several subsystems shown in the central repository as well as the central computer. Local connection boxes are placed in each school. Should a transfer from a completely centralized system to a centralized-decentralized system seem advisable, these locations would very easily transform into a miniature central repository for the school complexes. Finally, Figure 4, page 65, indicates the several instructional modes of computers in the classrooms or usage points.

Various usage points. It is consistent with our philisophy

1 *Ibid.*, p. 37.
2 *Ibid.*, pp. 38-39.

that teachers are central to the implementation of any program. In keeping with this philosophy we plan not only for the different modes of CBI previously explained but also different kinds of terminals to which teachers may relate more readily. In keeping with our belief in diversification, the several types of terminals indicated will each be presented diagramatically with explanations of their possible use.

The quickest and easiest computer terminal to implement is pictured in Figure 5, page 68. This diagram includes a teletypewriter with a monitor screen suitable. The terminal is considered a very lean terminal, of the type that would probably be used by the teacher who prefers to do his own teaching but wishes to use the computer as a teaching tool or "hand calculator". He would probably use a conversational computer language such as TELECOMP. He could allow the students to use the terminal also, a modification of group instruction which may be described as classroom support. This is, of course, not a function of the kind of terminal or of the conversational language, but of the use made of them by the teacher.

The noise level of the automatic teletype machine (Figure 5, p. 68) would exist but is not a serious problem when there is only one unit. The terminal described is being used by a fourth grade teacher in the Boston, Massachusetts, experiment under the direction of Jesse O. Richardson of the State Department of Education.[1]

A second type of terminal is illustrated in Figure 6,

1 Jesse O. Richardson, "CAM News Letter," (Boston: The Massachusetts Department of Education, 1966), Vol. 1, Nos. 2,4,6. (Project funded under contract No. 085-10-320 with the Bureau of Research, United States Office of Education).

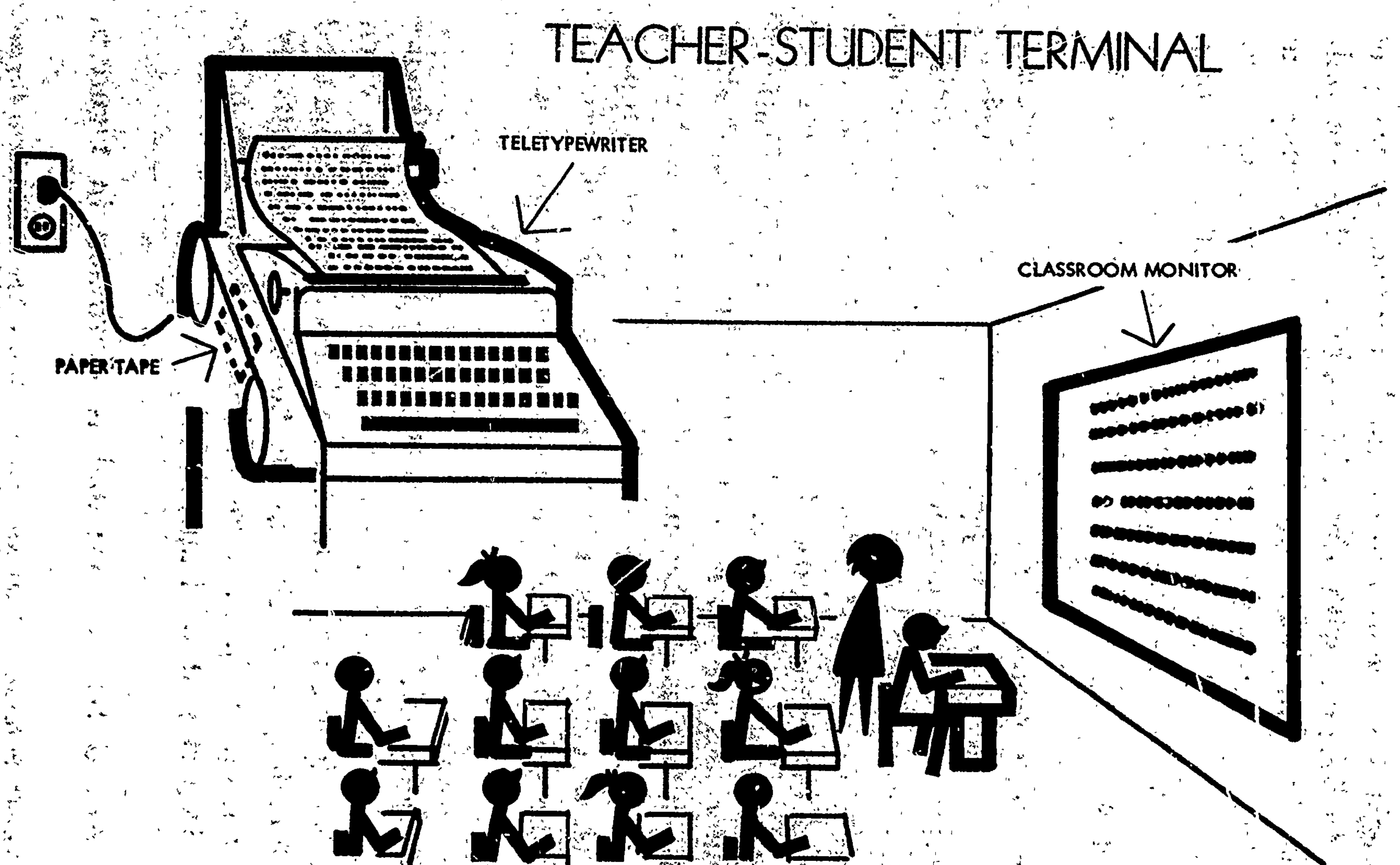

TEACHER-STUDENT TERMINAL
TELETYPEWRITER
PAPER TAPE
CLASSROOM MONITOR

Figure 5

page 70. Since this type of terminal is not yet linked to a computer, no connecting lines from the keyboard to the reader-printer are drawn. However, it plays an important part in the development of the total system and is worthy of separate support due to its very low cost and wide applicability in libraries throughout the United States. A contract might be made with NCR to explore the phasing of the high school library to microforms by means of the PCMI concept. Representatives of the Dayton, Ohio, office of NCR reported that it is possible to reduce a four-year liberal arts college library containing 50,000 volumes and weighing approximately 150 tons to a cartridge of randomly accessible microforms weighing about 125 pounds. It will soon be possible also to have a hard copy of the image shown on the screen. The micro-reader marketable today would rent for about ten dollars per month. The use of this type of equipment would drastically change the space requirements of libraries in the future. Figure 6, page 70, does not show a conventional microfilm-reader. The one pictured is more "a micro of a micro" in reduction and magnification capabilities and, unlike the conventional microfoms resists scratches and dust. The possibilities of using holograms for data reduction is another incentive for choosing this type of terminal. Much of the conventional programed text material might be adapted to this medium to increase the store of available software for the conventional CAI mode.

Since a function of the central repository is to plan, improve, and implement advanced procedures, it should house the laboratory type terminal. Figure 7, page 72, shows the type of research and development terminal that the ultimate system might possess. This terminal is not in existence any-

LIBRARY TERMINAL

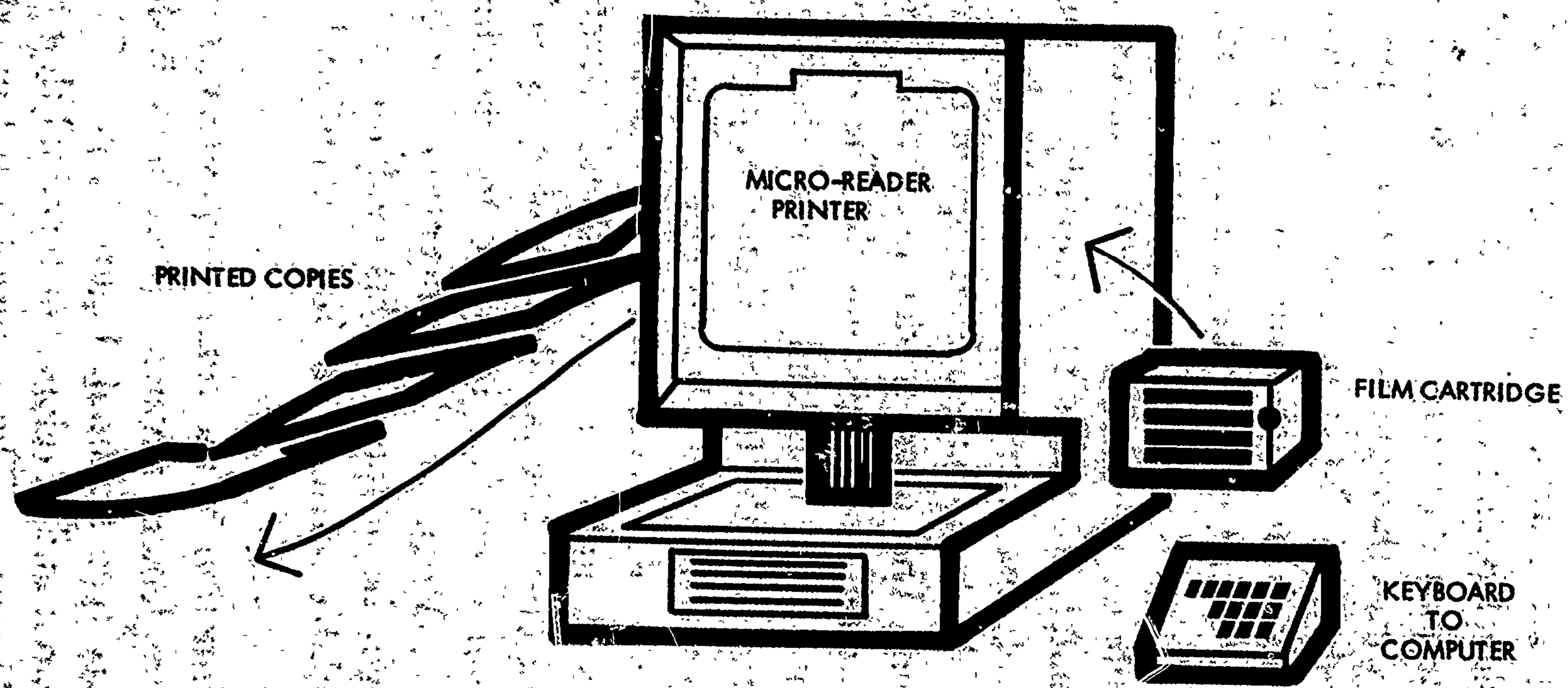


Figure 6

where as a unit, but each component is finished. The component least sophisticated at this time is the speech device for the processing of sound. But much work has been done by the David Sarnoff Research Center at Princeton, New Jersey, under the direction of Dr. Harry F. Olson.[1] Other work has been done by the International Business Machine Corporation (IBM). This terminal also exhibits the light pen such as that used on the IBM 1500 system now in operation at Palo Alto, California.[2] This is the project instigated by Dr. Patrick Suppes of Stanford University and described in the 1966 issue of *Nation's Schools and Fortune Magazine.*[3] The light pen in this installation is used as a probe rather than as a graphic device. It can be used for graphics, but the cost is prohibitive. Using the pointer or probe, the student can indicate locations on the Cathode Ray tube which can be identified by the computer. Its main use is in the identification of the correct multiple choices shown on the CRT. A much less expensive device known as the touch-sensitive display is being developed by the Learning Research and Development Center at the University of Pittsburgh, directed by Dr. Robert Glaser, and the Westinghouse Corporation. This Center houses several innovative programs including the Responsive Environments Project headed by Dr. Omar K. Moore, and their terminal is commonly called the "talking typewriter."

The electronic pencil (E.P.) is used in conjunction with

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1 Harry F. Olson, "Analysis and Synthesis of Speech and Music and Applications" (Princeton, New Jersey: Radio Corporation of America, No date.)

2 William Rybensky and Thelno Knowles, "Computer-Assisted Instruction at Brentwood School," (Palo Alto, California: The School Board, No date), p. 16.

3 Jenness Keene, "Computer at the School Helps Teach Students How to Read." *Nation's Schools,* (New York: McGraw, Hill Publication, 1966), Vol. 78, No. 4, (October, 1966), pp. 81-83; Charles E. Silberman, "Technology is Knocking at the Schoolhouse Door," *Fortune Magazine* (Chicago, Illinois: Time Inc.) Vol. 74, No. 3, pp. 120-125, 198, 203-205.

LABORATORY TERMINAL

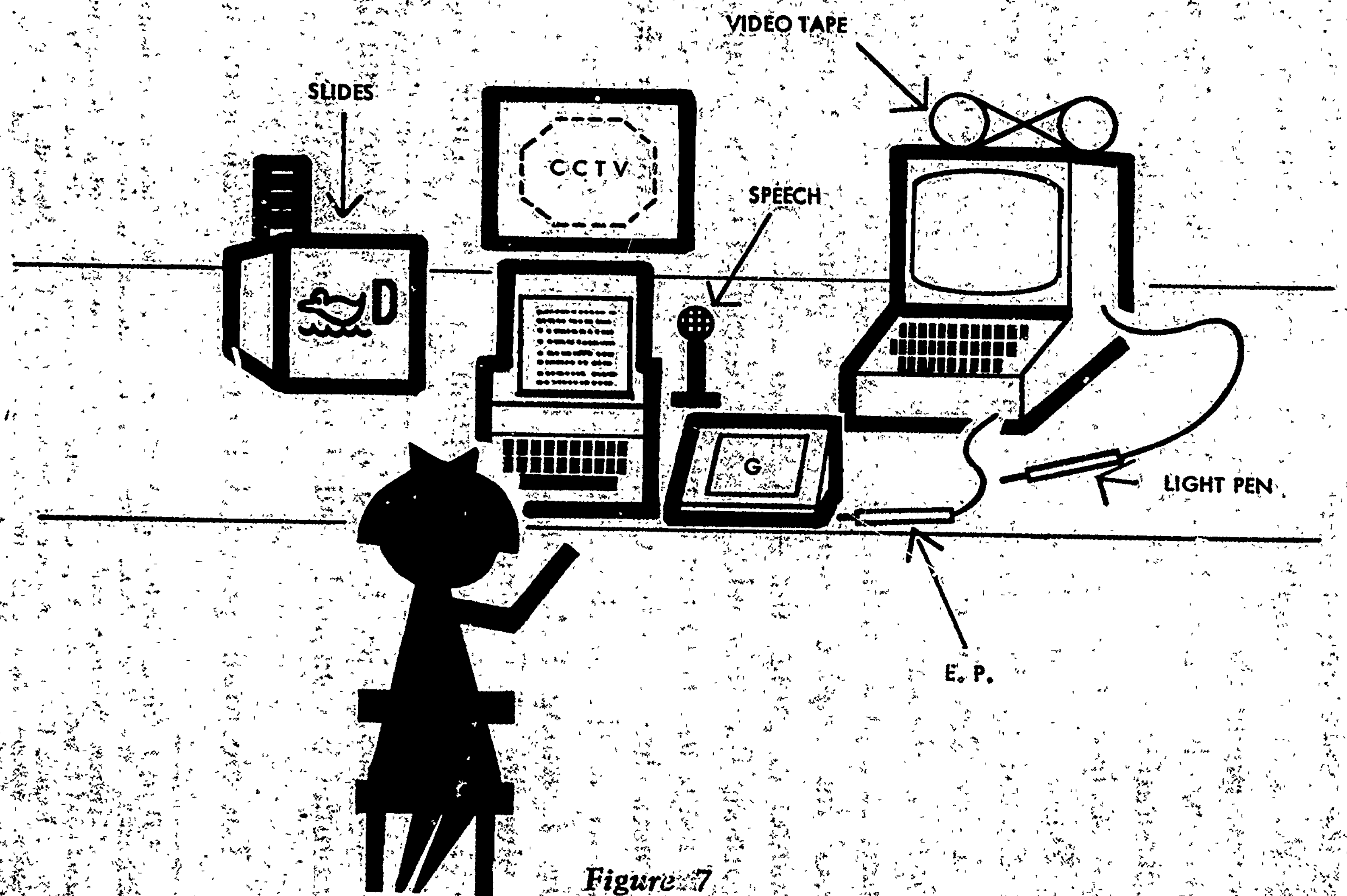


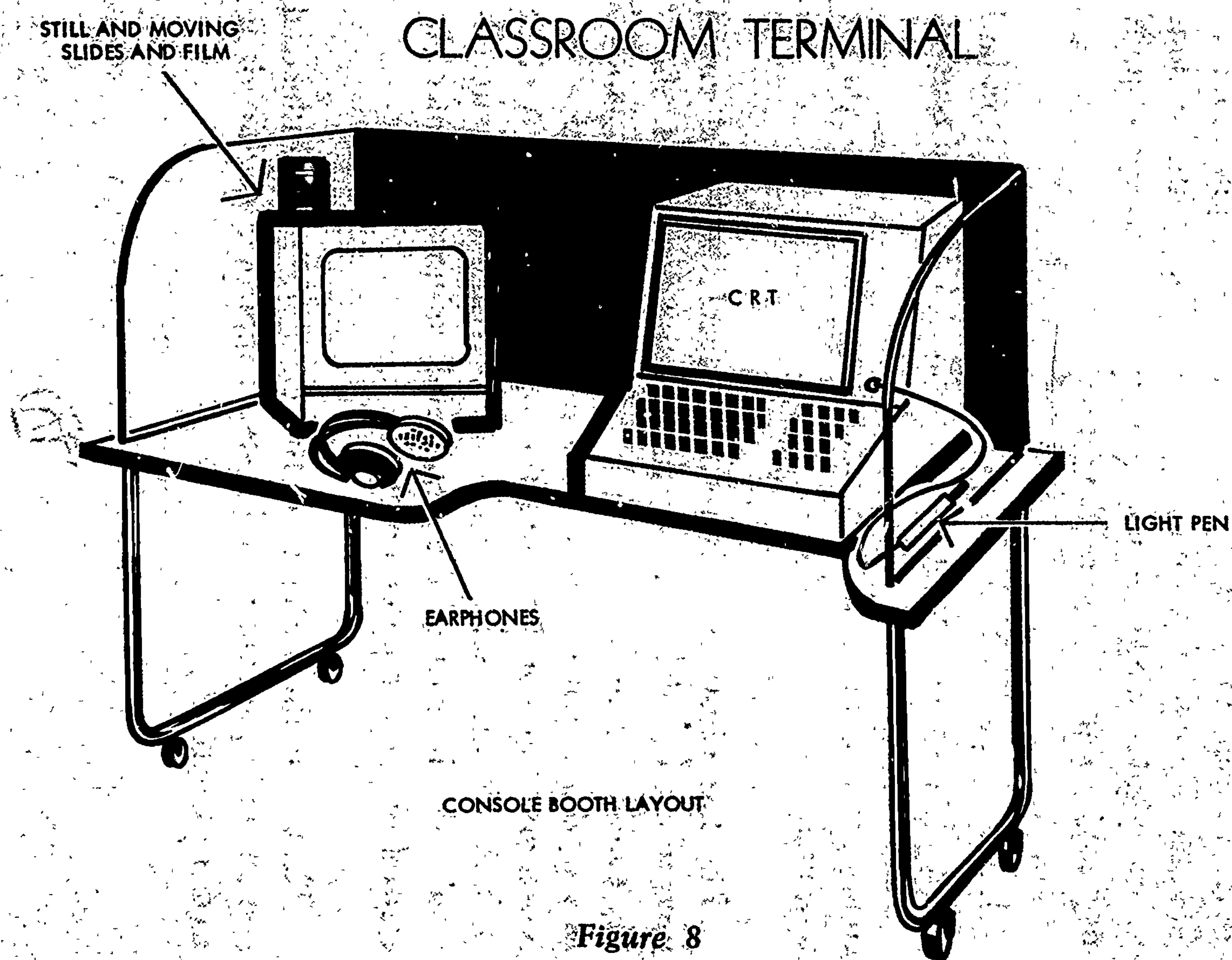
Figure 7

the Rand Tablet or Grafacon (G.). They could be used in such graphic work as building design. Bolt, Beranek and Newman, Incorporated, is now using this combination. It could be used to teach writing skills but requires a considerable amount of computer memory. The writing is done on the Grafacon sketch pad and the results are visually displayed on the Cathode Ray tube.

Figure 7, page 72, shows the use of other more standard audio-visual devices, such as video-tape, CCTV, and random access slides/films, which can be under control of the computer program and manipulated by the student via the terminal.

The last illustration shows the typical individual carrel used in most models of CAI today. Figure 8, page 74, shows the console booth layout which we have previously labeled as a medium rich terminal. This terminal consists of a keyboard and Cathode Ray tube for input and output. A video slide device and a set of earphones for visual-audio materials would also be part of the peripheral equipment under the control of the computer program.

These are illustrations of the capabilities of industrial systems to implement a total systems approach to individualized instruction.



CONSOLE BOOTH LAYOUT

Figure 8

VI.
Summary And Recommendations

For a school to utilize an individualized communications system is in itself new. No project discovered by the writers or by two national surveys contained the proposed design. Although the concept individualized learning is not new, the operational methodology and the technology to implement computer based individualized instruction have only recently become available.

New curriculum programs, innovative organizational patterns, and recent educational research findings should be incorporated in the model. The use of systems design procedures to develop and integrate all elements and component parts of the school program would be enhanced by Program Evaluation and Review Techniques (PERT).

The nationwide use of consultants familiar with current efforts to design, develop, and initiate a systematic approach to education and the development of individual curriculum using technological systems will insure that existing innovative and exemplary programs are included.

Because this field is continually expanding, local educational and cultural agencies should be frequently involved from the beginning of the program.

No educational principle can be applied without the fullest cooperation of the teachers. They don't always have to agree with the innovation but they do have to be open-minded and willing to learn about it. Most teachers are already trying to individualize instruction. They need only help and encouragement. The Miller report says:

> the teachers are the ones who are in daily contact with youngsters. We need to work through them striving to upgrade their skills, stretch their imaginations, provide some inspiration, and extend more tangible evidences of support for the work they are doing.[1]

We do not envision that eighty per cent of the learning activity will be conducted by children sitting at consoles. We do believe, with industry and business, that diversification is a sound policy to follow. Some of the learning will be individual and independent; other learning will occur in groups of various sizes.

The teacher's role will also be diversified. Teaching personnel will include: team teachers and followers, TV studio teachers, teacher programers, teacher aides, group leaders, teachers with responsibilities with computers and other technological devices, teachers in deductive and inductive roles and just plain teacher lecturers. Loughary calls these and other people the support team and describes the teacher's responsibility as one of specifying the learning objectives as well as communicating them to the rest of the team. A *content research specialist* would identify and synthesize subject matter relevant to these objectives. A *media specialist* would determine the best way to design and to present the instructional materials. Large systems would also require

1 Miller, *op. cit.*, p. A-31.

engineers familiar with schools and education in general.[1] Essentially the teacher would become a manager of the learning experience and would orchestrate rather than dictate.

Community

At the outset of all educational endeavors the community should be carefully considered from the beginning so that many hours of time are not spent encouraging and developing ideas and plans which cannot gain acceptance. A statement made to Everett Rogers illustrates this point:

> So who will pick up the tab for our project in 1969? Not our Republican — controlled school board who is opposed to higher taxes in any form.[2]

The Miller report goes on to state:

> Regardless of what the guidelines say or what the project directors write, some projects are going to terminate due to factors beyond the control of local educators. It may be a personality clash between the Title III coordinator and a school board member, it may be that the project espouses a technique or program that is subtly opposed by the superintendent, or any of many other reasons.[3]

1 John W. Loughary, "Preparation of Educators in the Computers and New Media," cited in John W. Loughary, *Man-Machine Systems in Education, op. cit.*, pp. 216-217.

2 Everett Rogers, "Rural Schools and Communication," *in Catalyst For Change: A National Study of ESEA Title III (PACE)*, Section B under USOE Grant No. 2-7000074-0074, January, 1967), p. 118.

3 Miller, *Op. cit.*, p. 149.

It is advisable to get local support early and in writing. This is especially true in dealing with Boards of Education which are subject to personnel changes. Support should come from: (1) the classroom teachers, (2) school officials, (3) curriculum and instructional supervisors, (4) board members, (5) citizens committees, (6) industrial concerns, and (7) higher education.

Communication

A feedback system of rotating personnel among the various levels would be helpful in clarifying relationships and purposes.

On-site visitations are valuable both as a communication device and as an investigating instrument and should be encouraged at all levels. National conferences and the PACE Visiting Fellows Program are especially helpful in establishing and strengthening lines of communications. A program similar to the PACE Fellows Program should be encouraged at the state level so that local educators can better understand problems of the State Office of Education.

Dissemination is part of communication. Visitation or exchange programs should be encouraged. Additional procedures should be made for disseminating materials both at the state and national levels. Much information which might be important in planning programs to improve education is available in the local school district.

Team teaching, flexible scheduling, nongradeness, continuous progress plans, programed instruction, flexible buildings, Computer Based Instruction and other techniques and facilities should be coordinated into a system which will insure each pupil an equal opportunity to learn according to his own individual needs, interests, and abilities. *In other words, we should move from contained classrooms to individualized instruction. Only a systematic approach using the best available technology will get us there.*