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NEW SOLUTIONS TO IMPLEMENTING INSTRUCTIONAL MEDIA THROUGH ANALYSIS AND SIMULATION OF SCHOOL ORGANIZATION.

BY- COGSWELL, JOHN F.
SYSTEM DEVELOPMENT CORP., SANTA MONICA, CALIF.

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A PROJECT WAS DESCRIBED THAT WOULD USE SYSTEMS ANALYSIS AND COMPUTER SIMULATION TECHNIQUES TO FIND NEW WAYS TO IMPLEMENT INSTRUCTIONAL MEDIA. THE FOUR MAJOR STEPS TO BE TAKEN FOR THIS STUDY ARE--(1) SURVEY AND SELECTION OF HIGH SCHOOLS, (2) SYSTEM ANALYSIS OF THE FIVE HIGH SCHOOLS SELECTED FOR STUDY, (3) CONSTRUCTION OF A COMPUTER-SIMULATION VEHICLE TO BUILD MODELS OF THE SCHOOLS AND OF HYPOTHETICAL CHANGES IN THE SCHOOLS, AND (4) SIMULATION AND STUDY OF THE FIVE SCHOOLS SELECTED WHICH WILL RANGE FROM FAIRLY TRADITIONAL TO HIGHLY INNOVATIVE. THE SCHOOLS ARE BEING SELECTED BY ANALYSIS OF QUESTIONNAIRES SUBMITTED TO 200 HIGH SCHOOLS IDENTIFIED BY STATE DEPARTMENTS OF EDUCATION AS BEING INVOLVED IN INNOVATION. AT THE TIME OF REPORTING, TWO OF THE FIVE SCHOOLS HAD BEEN SELECTED. THESE WERE--(1) THE CONTINUOUS PROGRESS PLAN SCHOOL DEVELOPED BY DR. EDWIN READ AT BRIGHAM YOUNG UNIVERSITY LABORATORY SCHOOL AND (2) THE CULVER CITY HIGH SCHOOL IN LOS ANGELES. ANALYSIS OF THE SCHOOLS CONSISTS OF (1) COLLECTING DATA DESCRIPTIVE OF THE HIGH SCHOOL, AND (2) TRANSLATING THE DATA INTO FLOW CHARTS. FOLLOWING THE ANALYSIS, DESIGN CHANGES IN THE ORGANIZATIONAL STRUCTURE TO FACILITATE USE OF THE NEW MEDIA WILL BE SUGGESTED AND THESE CHANGES WILL BE EVALUATED BY USE OF THE COMPUTER-SIMULATION VEHICLE. RELATED REPORTS ARE ED 010 559 AND ED 010 577 THROUGH ED 010 581. (AL)

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New Solutions to Implementing Instructional Media Through Analysis and Simulation of School Organization

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John F. Cogswell, Robert L. Egbert, Donald G. Marsh, and Frank A. Yett
(Principal Investigator, David G. Ryans)

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SYSTEM DEVELOPMENT CORPORATION
2500 COLORADO AVE.
SANTA MONICA
CALIFORNIA

NEW SOLUTIONS TO IMPLEMENTING INSTRUCTIONAL MEDIA THROUGH ANALYSIS AND SIMULATION OF SCHOOL ORGANIZATION*

John F. Cogswell, Robert L. Egbert,
Donald G. Marsh, and Frank A. Yett**
System Development Corporation
Santa Monica, California

INTRODUCTION

This paper describes a project that is making use of techniques relatively new to educational research--systems analysis and computer simulation. The project, partially supported by the U. S. Office of Education under the National Defense Education Act, Title VII, A, is being conducted at the System Development Corporation, Santa Monica, California.

The purpose of the research is to find new solutions to implementing instructional media through analysis and simulation of school organization. Although great strides have been made in the development of educational methodology and technology during the past twenty years, the formal organization or structure of education has remained relatively constant despite obvious weakness in its ability to adjust to instructional innovations.

A major reason for this lack of change is the complexity of designing school organizations that efficiently accommodate modern instructional media. An innovation such as programmed learning, for example, if used on a large scale in a school, has implications for the organization of the whole school. By providing a means for effective self study, it may allow students to progress at their own rates. It provides a means, and even suggests the need, for breaking away from the lock-step system of advancing students once a year only. However, when the full range of factors involved in an organizational plan is considered--the spatial arrangements, the student-scheduling problems, the versatile and effective use of teachers and other resources--the problem of design becomes overwhelming.

At his present level of capability for designing school organizations, the educator formulates a relatively simple plan, tries it in a real school, observes the problems as they arise, and attempts solutions on a piecemeal

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**Robert L. Egbert and Frank A. Yett are consultants of System Development Corporation and are affiliated with Brigham Young University and Pasadena City College, respectively.

basis. It is in this fashion that schools have been designed in the past, and it is the pattern that will be followed in the future unless new solutions can be found.

The SDC project, which studies the use of systems analyses and computer simulation, should yield techniques and provide design recommendations that are more carefully conceived, that involve more pervasive and integrated changes throughout the schools, and that employ instructional media more effectively than do current school-design methods.

The high school is the basic unit for investigation in the study. Four major steps or procedures are involved in the project: (1) survey and selection of high schools; (2) system analysis of five high schools selected for study; (3) construction of a computer-simulation vehicle that will provide the capability of building detailed, dynamic models of the schools and of hypothetical changes in the schools; and (4) simulation and study of the five high schools with the simulation vehicle.

SURVEY AND SELECTION OF SCHOOLS

As the first step in the SDC study, a survey is being made to identify the various kinds of innovations that are being put into practice in our high schools.

Questionnaires requesting description of their activities and plans were sent to approximately 200 high schools identified by the State Departments of Education as significantly involved in innovation. These schools were asked what they were doing, or planning, in the way of using programmed learning, television, language laboratories, flexible scheduling, team teaching, ungraded classes, electronic data processing, and other innovations. All of the questionnaires have not been returned so that a complete analysis is not yet possible, but some interesting characteristics are suggested by the data that have been collected so far.

The language laboratory seems to be the most frequently implemented of the instructional media. Programmed-learning materials are being used in many schools, for the most part without machines, but no school is using this kind of innovation in more than a few courses. Plans to increase the use of programmed-learning materials are evident, probably in the anticipation that more materials will become available. Few schools report that they are developing their own programs.

An interesting trend suggested by the returns is an apparent increase in attempts to modify the organization of instruction. These modifications are aimed at providing greater flexibility in planning and more adaptation to

differences among learners. Trials of, or plans to try, procedures such as ungraded classes (where students are grouped homogeneously in terms of learning needs rather than age), modular scheduling, and continuous-progress plans (where students are permitted to progress at individual rates) seem to be on the increase. A related trend appears to be an increase in the use of team teaching.

The survey, in addition to identifying what is being done in the way of innovation, will be of decided help in selecting the schools for intensive study. Five high schools, ranging from the fairly traditional to the highly innovative, are being selected. This will insure consideration of a broad range of educational media.

SYSTEM ANALYSIS OF SCHOOLS

Two of the five schools have already been selected for study--the Continuous Progress Plan School, being developed by Dr. Edwin Read at the Brigham Young University Laboratory School, and the Culver City High School in Los Angeles. Work is about two-thirds completed on the analysis of the Continuous Progress Plan School and work is just beginning on the collection of data at Culver City.

The analysis consists of: (a) collecting data descriptive of the high schools; and (b) translating the descriptive data into detailed flow charts. Following from the analysis, recommendations are made for design changes in the organizational structure to facilitate the use of media.

Information about instructional activity is collected with the purpose of analyzing the schools at three different levels. At the most general level, an analysis of the over-all system is made. The general analysis includes construction of the usual organization charts and a description of the flow of students through the school. This general flow characteristically includes the sequence of significant steps that students go through from the time they enter school to the time they graduate. A typical flow diagram at the most general level of description would represent steps such as preregistration, registration, programming or scheduling, getting materials, working on courses, being tested, being evaluated, getting guidance, taking extracurricular activities, and graduation.

At the second level of analysis, each of the steps included in the general description is further analyzed. Detailed diagrams are constructed of the flow of activities within each of the major steps, such as registration. Finally, some of the details contained in the second level of analysis are further analyzed by constructing additional flow diagrams to form a third level of analysis.

Figure 1 shows the symbols that are used to construct the flow charts. The activities are represented by rectangles, and the direction of flow between activities is shown by arrows. A smaller box is placed before each activity to represent a queue or buffer. The representation of queues before the activities expresses the possibility that students may spend time between activities in waiting. Finally, decision points or branches are represented by diamond-shaped boxes. The alternative branches or routes are represented by arrows originating from the points of the diamond.

At the most general level of analysis, the first activity might be preregistration; therefore, "Preregistration" would be written in box 1 of Figure 1. Preregistration may lead to two alternatives--rejection or acceptance. If the student is not accepted, he is terminated; if he is accepted, he is registered. Therefore, "Termination" would be written in box 4, and "Registration" would be written in box 3.

The flow diagrams have the value of presenting a diagrammatic picture of a complex sequence of procedures on one page. They tend to reveal inconsistencies, redundancies, and omissions in the organization much more readily than detailed verbal descriptions. They also force a contemplation of the logical possibilities to be considered in analyzing how the system could be improved. The representation of the sequence of events and the flow from event to event help to emphasize the interaction between different activities in the analysis.

In the design phase, hypothetical changes in the organization are made by constructing additional flow diagrams. Design recommendations may include any number of changes. Generally speaking, the intent is to suggest new combinations of media and personnel that will accomplish the task of education more efficiently. In addition to considering how instructional media and personnel may be used more effectively, the study is concerned with how space may be arranged more efficiently and how information-processing technology can be used to facilitate the implementation of media. For example, analysis of the Continuous Progress Plan School has resulted in the design of a centralized information-processing center. One of the major functions of this center is the Surveillance and Detection System, which automatically analyzes student performance data. If a student appears to be having trouble, appropriate school personnel are alerted by the System and can take action to remedy the problem.

The Surveillance and Detection System would process inputs such as the following: achievement test scores on course work and the dates the tests were taken filed by a testing clerk; reports filed by teachers and teaching aids providing information on student interest, learning problems, emotional and social problems; and requests for materials, classes, and activities filed by the student. The computer in the information-processing center would periodically scan the inputs, compare them against criteria stored in the computer such as student performance expectancies based on past achievement, and provide displays to be transmitted to

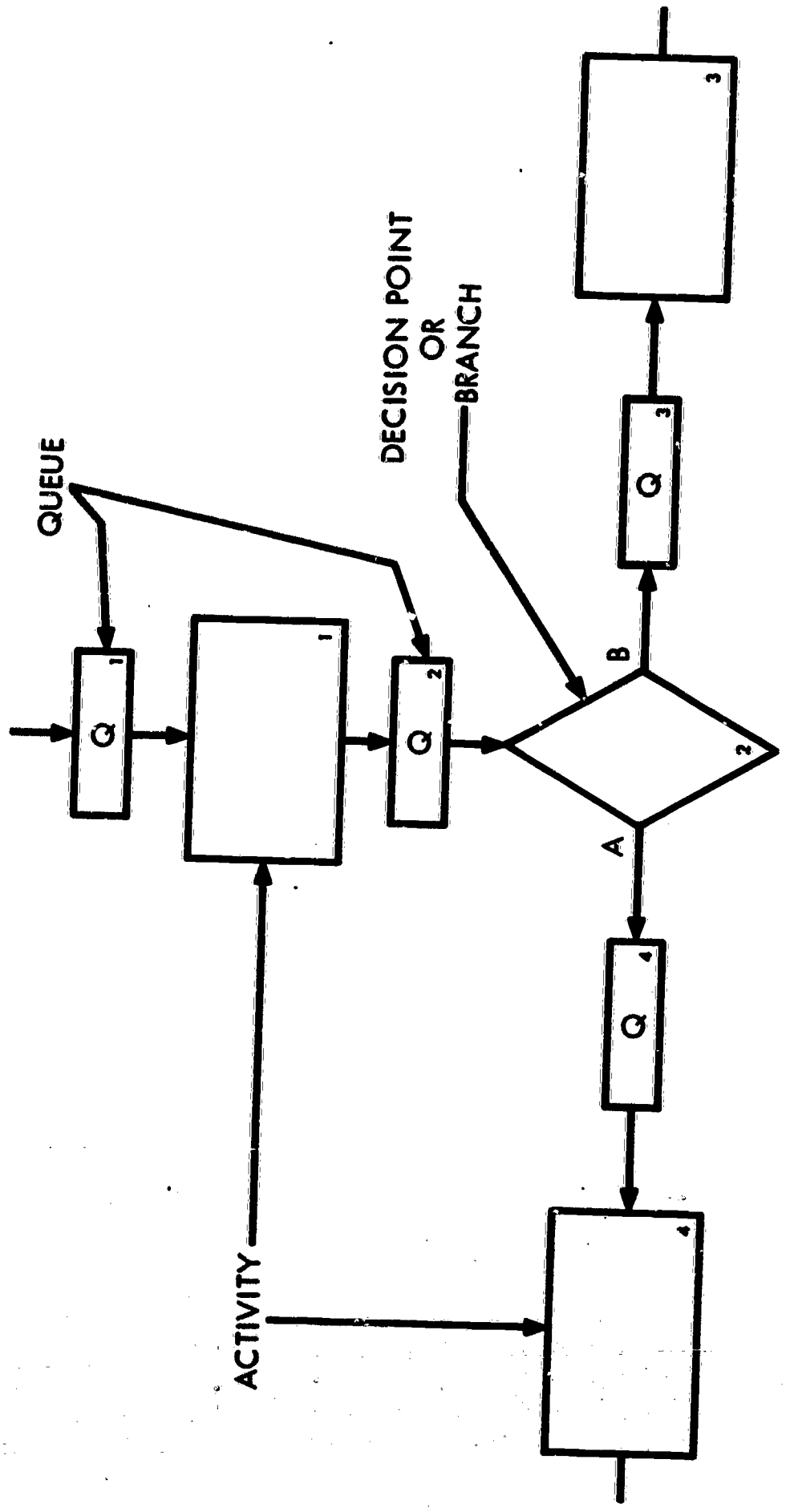

FIGURE 1. BASIC SYMBOLS USED IN FLOW DIAGRAMMING

appropriate persons. The displays would indicate the names of the students who may need help, the kind of help that might be needed, and the names of the persons who should be alerted. Teachers, students, counselors, or administration might be alerted by the System.

Analysis and design usually stop when the design recommendations have been made. If the design recommendations are accepted, the new plan is implemented and tried out in the school. If they are not accepted, the designer may go back to the analysis, or he may give up. If the design recommendations call for extensive changes involving numerous hard-to-predict effects, there is a good chance that they will be resisted by the school administrators. However, the level of this resistance may be lowered if complex design changes can be provisionally tested on a dynamic model of the school constructed in a computer.

CONSTRUCTION OF A COMPUTER SIMULATION VEHICLE

Work on the development of a school computer-simulation vehicle is presently in progress. A set of computer programs is being developed that expresses the flow diagrams constructed in the analysis phase of the study in algorithmic form (i.e., in terms of coded computer instructions). The vehicle is being designed so that students, their progress through school in time, and the school's use of resources can all be simulated. The completed simulation vehicle should make it possible to represent the progress of samples of students through any kind of school that can be described. It should provide information regarding the changes that may occur in students and in resources through time. It should provide the capability of getting a report on changes in the students and resources at variable time intervals. For this purpose, it should be possible to get a report as often as every ten minutes or as infrequently as every semester. It should permit the simulation of resource depletion and should show the effects on students when resources are not available. It should provide a record of any student's history through the school, and it should yield detailed, summarized reports on each activity, showing the student load on different activities in different time periods.

The simulation vehicle is being programmed in JOVIAL computer language and the Philco 2000 computer is being used for the research. The logic for representing sequences of educational activities has been formulated, and preliminary studies to test the logic have been conducted. A number of computer runs have been made simulating 1,000 students going through the equivalent of a semester's work in one course. The course is designed to allow students to progress at their own rates. It includes individual study and group work. Students are given individual help from a teaching aid if they need it. They are periodically tested and evaluated, and some of the students receive counseling. Two hundred of the students are designated as "fast," 600 of the students are labeled "medium,"

and 200 of the students called "slow." The "fast" students receive less help and take less time to finish their work whereas the "slow" students take longer to complete their work. The "slow" students also receive more individual help, and more of them are referred to counseling. In approximately one second, the computer can run a simulated student through a semester's work, which includes going through as many as 470 steps in the program (such as registration, testing, getting help, working, and having counseling interviews).

The logic for simulating time and using resources has been completed, and the programming of these functions is in progress.

USE OF THE SIMULATION VEHICLE

When the simulation vehicle is completed, it will be used to simulate the five schools that are being analyzed. The major focus in this part of the study will be to use the model as a provisional test of the design recommendations that are made in the analyses.

The simulation vehicle will permit minor or extensive revision to the models, so that solutions can be tried out to problems such as bottlenecks. For example, a Continuous Progress Plan School could be simulated. It could be assumed that in a mathematics course students spend 60 per cent of their time in individual study using TEMAC programmed-learning materials. The remaining 40 per cent of the time they meet with the teacher in small groups consisting of no more than three students, all of whom are at the same place in the program. It also could be assumed that there are 70 students in the course, that there is one teacher, that the teacher spends an average of 25 minutes with each group, and that the teacher must see every student each week. The computer display of the simulation trial might indicate that for the time allotted to mathematics in the schedule, one half of the students would not meet the teacher in a week.

It might also be assumed that the teaching plan requires students to schedule a session with the teacher at certain points in the program, and that they cannot continue work on the program until they have met with the teacher. In this case, the display of the computer trial might indicate that, for 30 per cent of the students, the average time spent waiting (in queue) for the teacher would be six hours.

To solve these problems, variations in the design of the model could be made. For example, another teacher could be assigned to the mathematics course; students could be assigned to teaching assistants who would act as a filter by helping some students and referring others to the teacher; the teacher could reduce the time spent with each group; the size of the groups could be enlarged; when the queue line exceeded a critical number, students could be assigned to work on other courses rather than wait. Combinations of these changes could be tried in the model.

Thus, by iteration of the sequence of (a) design formulation, (b) model construction, (c) computer cycling of the model to represent dynamic changes in time, (d) analysis of the results of the computer runs, and (e) revision of the model, the design can be further developed.

SUMMARY

A study that is aimed at finding new solutions to implementing instructional media through analysis and simulation of school organization has been described. Five schools are being analyzed and a school computer-simulation vehicle is being developed. Design recommendations developed in the analyses will be provisionally tested with the simulation vehicle.

It is expected that this research will yield findings that can be generalized to other schools.

The study should help in recommending essential roles for various personnel in schools that apply different types and configurations of educational media. It should provide estimates of the effect of media and organizational plans on such variables as the amount of teacher-pupil and pupil-pupil interaction.

The characteristics of students graduating from schools in which the organization of instruction is markedly changed should also be suggested by the study.

In addition, it is expected that recommendations for new arrangements of space and new uses of information-processing technology will result from the study.

Finally, it is hoped that the simulation vehicle will provide educators with a valuable conceptual tool for planning more effective school systems.