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ABSTRACT

Three main sections comprise this brief exploration into the development and use of a general-purpose computer simulation model for diverse sizes and levels of school district organization. The first part of the paper gives an introduction to modeling and simulation theory, providing the school district administrator with a foundation for understanding the roles and possibilities of these techniques. The middle section describes a school submodel reported in several papers published by the National Center for Educational Statistics. Finally, the concluding portion discusses the applicability and mechanics of Opti-planner, a FORTRAN-based computer program being developed at Colorado State University. (Author/PB)

# A RESOURCE ALLOCATION MODEL FOR PUBLIC SCHOOL DISTRICT PLANNING

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## INTRODUCTION

The purpose of this report is to explore the development and use of a general-purpose computer simulation model for diverse sizes and levels of school district organization.

The public school district is perhaps one of the most complex organizations found in society today. With limited avenues for obtaining revenue and strict accountability restrictions, the school administrator is forced to make decisions based on many variables. Little work has been done for medium-sized districts due to the prohibitive costs and limited systems expertise at this level. The model described in this paper seeks to serve as a tool to aid the decision maker to better analyze and consider the entire problem.

The paper is divided into three main parts. First, an introduction to modeling and simulation theory gives the school district administration a foundation for understanding the role and possibilities of this technique. The second portion of the paper describes a school submodel reported in several papers published by the National Center for Educational Statistics. Finally, the applicability and mechanics of the computer program being developed at Colorado State University will be discussed.

## SIMULATION AND MODELING

Modeling techniques have been applied to a wide variety of problems in various disciplines. Analysts have found that modeling via simulation is a useful tool in bridging the gap between technicians and managers. Education is a field with a rich source of problems capable of analysis of this type. Educational facility planners are interested in course activity patterns affected by changing curricula and space requirements. Plans for new facilities require careful analysis of complex systems of activities including instructional space, variable class periods, and available personnel.

Several advantages of simulation models relate to educational administration:

(1) Simulation makes it possible to study and experiment with complex internal interactions of educational systems or subsystems. Organizational and environmental behavior can be observed as systems change is initiated.

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(2) Detailed observation of system variables usually leads to a better understanding of the system by the involved parties. Such a model provides a pedagogical device for administrators new to the system. Indeed, the experience of designing and implementing computer simulation models is often more valuable than the actual simulation due to the knowledge and insights needed to develop the tool. Often variables with unknown importance are uncovered.

(3) Simulation allows the administrator to try out several policies and decision rules without altering the current educational procedures. Dynamic systems can be studied in real time, compressed time, or expanded time.

Models consist of four well-defined elements: components, variables, parameters, and functional relationships (6, p.10). Components of the educational system range from individual schools to district-wide or even larger political divisions. The model in this paper is capable of discussing individual grade levels. Variables are used to relate one component to another and are often classified as exogenous variables, status variables, and endogenous variables. Exogenous variables are the independent or input variables of the model that act upon the system. Such variables might include educational policy or governmental restrictions. Status variables relate the state of component at any given time. These could include number of students, current operating expenses, etc. Endogenous variables are the dependent or output variables and depend upon the interaction of the exogenous and status variables. The model described in this paper is interested in costs relating to "optimal" use of resources.

Simulation models are usually classified as stochastic or deterministic. Stochastic models have operating characteristics based upon probability density functions. Simulation is efficiently used with this type of model. However, the school resource allocation model is currently deterministic since neither the exogenous nor the exdogenous variables are permitted to be random and operating characteristics are based on exact relationships rather than probability density functions.

One author relates the salient features of a systems model to the "black box" concept as shown in Figure 1 (8, p. 7). The purpose of any systems analysis is to optimize the measure of effectiveness by describing a policy for the decision variables in lieu of uncontrollable variables. Where simplifying assumptions are violated, the model may be a poor representation of the system. We must constantly be aware that a simulation model depends upon information collected about a system based upon conditions established by the model builder.

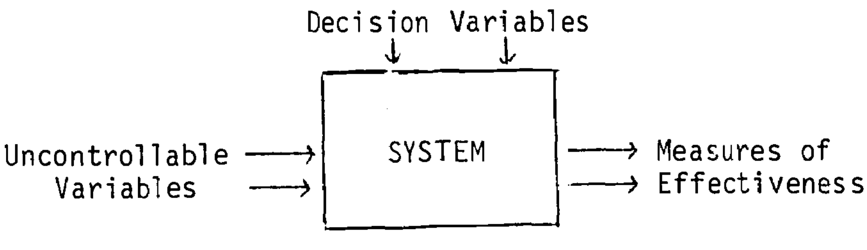



Figure 1.

Output includes anticipated enrollment at various grade levels, in various programs, etc. The model also considers costs associated with the faculty and building, necessary district services, and program-utility costs. Algorithms defined by the National Center for Educational Statistics (Technical Note No. 38) were incorporated to develop facility allocation by regular or supplemental instructional area, and by service and structure area. Staffing for specific program requirements is also considered. In addition the cost submodel incorporates objectives of school program, enrollment considerations, and associated costs.

## MODEL DESCRIPTION

For model development, an initial educational policy relative to school size, location, and facilities is needed. Figure 2 illustrates the basic model components. The urban block (Box 2) measures location and demographic characteristics of the student population. This phase of the model was not included in the current simulation program. The school environment (Box 3) as measured by the facilities, staff, and program of the school plant and the cost (Box 4) incurred by the educational system are included in the model. Interaction between educational goals and indices of effectiveness are ultimately considered for trade-offs leading to final policy decisions.

The school submodel defines the basic input data representing educational policy on facilities, staff, and programs. The school levels for analysis are based on levels where data is feasible and decisions are profitable.

Facilities are defined by the following categories:

1. Regular instructional area
2. Supplemental instructional area
3. Service and structure area

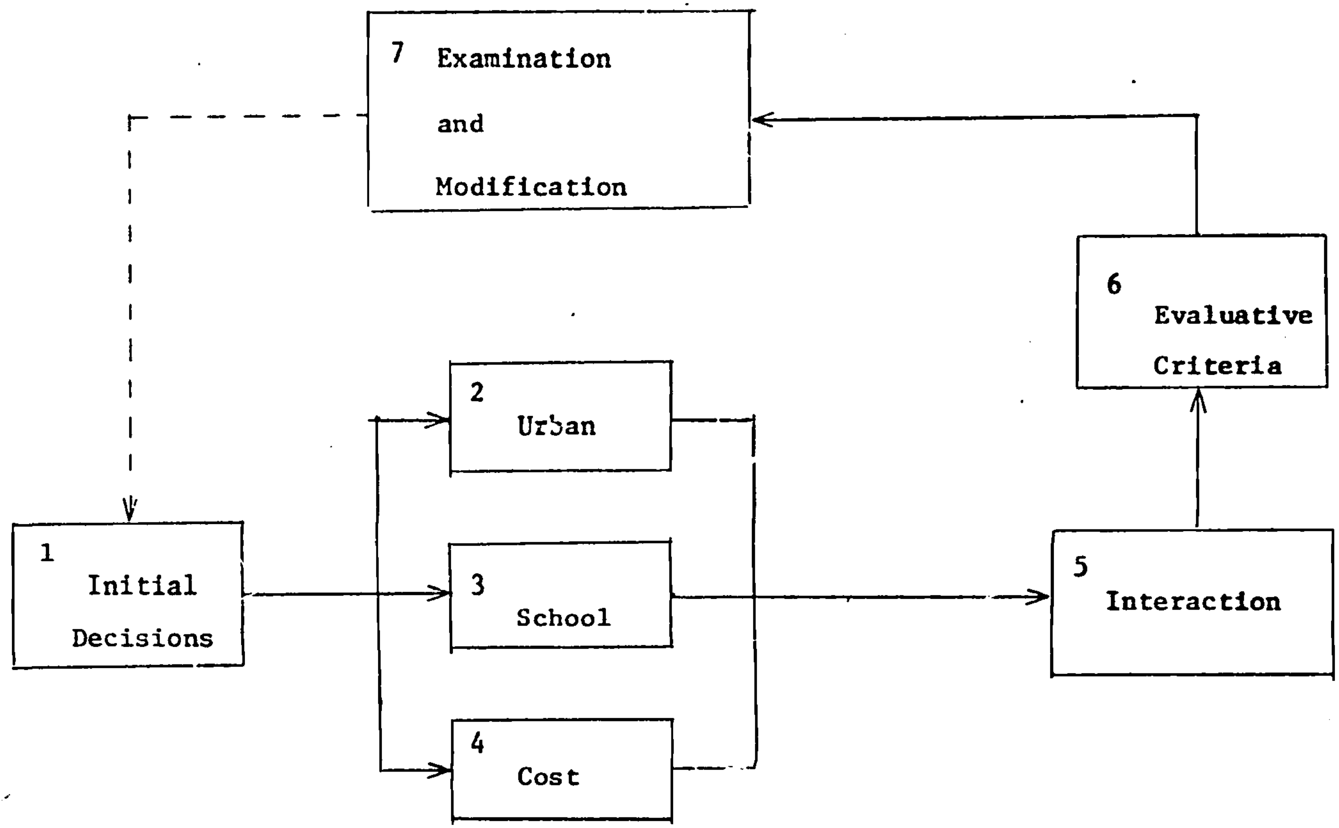
The staffing requirements are based on ratios applied to specified occupational categories such as the following:

1. Administrators
2. Teachers
3. Teachers' Aids
4. Secretaries and Clerks
5. Operations and Maintenance

Resource requirements for a specialized curriculum element or program, such as guidance, honors programs, etc. are also estimated.

The cost model investigates the following initial costs and costs that develop as a function of time:

1. Construction of new plants
2. Personnel staffing
3. Fixed and variable costs
4. Transportation acquisition
5. Capital financing




URBAN EDUCATION SYSTEMS ANALYSIS

Basic Model

Figure 2.

Resources include buildings, land, operating expenses, transportation, and equipment. The generalized model bases data collection either on statistical data or judgment. "Optimal: costs relationships are indicated where costs per pupil are smallest. Additional model input and output will be undertaken when the general model is completely operational and has been satisfactorily validated.

## OPTI-PLANNER MODEL

Several facets of the specific model will be discussed in this section. An initial FORTRAN program that is dubbed the "Opti-planner" was developed at Colorado State University in early 1973 incorporating most of the concepts presented by the Office of Education working papers. Three requisites were set: (1) The program would serve the general purposes discussed in the first two parts of this paper; (2) the program would be flexible and apply to varied educational situations; and (3) user-oriented documentation would be provided.

Validation procedures are currently underway with the local school district to apply the model at the levels of elementary, junior high school and senior high school. FORTRAN was selected as the programming language since the chances for available compiler use are greater with this language than specialized simulation language or other procedural languages such as COBOL. The format flexibility of the Opti-planner is much more difficult to achieve using BASIC.

The Opti-planner deck is self-documenting as almost 50 percent of the cards are FORTRAN "comment" cards. It should be emphasized that the Opti-planner was designed for use on the widest number of computers and to minimize conversion problems.

Input data parameters are clearly described, and blank cards are all that is required between various educational levels. Many reports are optional and may utilize either built-in or user-defined labeling features. The computer run time (ergo cost) is very reasonable for the current stage of development. Thus the small and medium-sized school district will not find cost a discriminator for Opti-planner use. Their efforts will be spent analyzing the benefits or lack thereof in utilizing the model as well as defining the exogenous, status, and endogenous variables.

## SUMMARY

While only a few considerations of the model have been discussed above, it is hoped they will "whet the appetite" of the educational administrator. The results of performing a limited set of experiments demonstrate that the model is useful in evaluating alternative facility planning decisions under varying circumstances. The further development of the Opti-planner can have a significant impact on the planning of new courses and facilities. This analytic tool investigates the effect of various levels of inputs on the educational process and allows the administrator to learn more about the system leading to determination of more effective educational policy.

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