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ABSTRACT

The purpose of this article is to demonstrate the capabilities and limitations of systems analysis as applied to the development of a program evaluation plan. A brief review of selected concepts in evaluation theory (Lee J. Cronbach; Michael Scriven; Robert Stake; Daniel Stufflebeam), a description of general systems theory, the development of a general model for educational evaluation, and the application of this general model to a proposed evaluation plan for a regional educational laboratory, the Eastern Regional Institute for Education (ERIE), is presented. (Author/CK)

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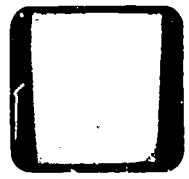

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A Systems Analytic Approach to Evaluation: A Heuristic Model and Its Application

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TABLE OF CONTENTS

Table of Contents (cont'd)

INTRODUCTION

The decade of the 60's has witnessed the investment of billions of dollars by the federal government and private foundations in the attempt to improve education in the nation's schools. What effect has this expenditure had on the improvement of school programs? How wisely have these dollars been spent? What factors contribute to effective improvement of school programs? These questions, among many others, have been asked by the funding agencies; answers must be provided.

The task of answering these questions falls upon educational evaluators and researchers. During the past decade, the profession has reviewed possible means of gathering data bearing on these questions. Existing methodologies and goals of evaluation have not been adequate for the task and consequently are requiring considerable re-examination. Scholars from diverse fields have tried to conceptualize and implement new approaches. Although substantial advances have been made toward the delineation of a new evaluation theory and new methodologies, much remains to be done before answers can be given to the many legitimate questions which have been raised.

Among the new approaches for coping with the emerging problems of evaluation of new curricula and new programs, the concept of systems analysis has great appeal to

educational planners and evaluators. Systems analysis can provide a means for systematizing efforts and conceptualizing approaches in the evaluation of program outcomes (see Schutz, 1969). While the application of the systems analytic paradigm to educational problems involves a considerable amount of "slippage" when compared with its application to engineering problems, the techniques provide valuable insights which may assist the educational planner and evaluator to do a more adequate job.

The purpose of this article is to demonstrate the capabilities and limitations of systems analysis as applied to the development of a program evaluation plan. The authors present a brief review of current evaluation theory, a description of general systems theory, the development of a general model for educational evaluation, and the application of this general model to a proposed evaluation plan for a regional educational laboratory, the Eastern Regional Institute for Education (ERIE).

I. SELECTED CONCEPTS IN EVALUATION THEORY

Lee J. Cronbach

Recent developments in evaluation theory have centered around the function of evaluation in decision making. An influential article, "Evaluation for Course Improvement," by Lee J. Cronbach (1964) formally ushered in this orientation and has had significant impact upon the emerging field of evaluation theory. Cronbach viewed evaluation as functioning within a decision-making framework, and identified three areas of decision making for which evaluation would be useful: 1) course improvement, 2) decisions about individuals, and 3) decisions related to administrative regulation (1964, p. 232). He emphasized that when course improvement evaluation is carried out, one is interested in the multi-faceted effects which a course has had upon pupils, not just upon narrow instructional outcomes. His belief was that the greatest service which evaluation could perform was to identify areas in which a course could be improved. He stated that,

> "Evaluation, used to improve the course while it is still fluid, contributes more to improvement of education than evaluation used to appraise a product already placed on the market." (Cronbach, 1964, p. 236)

In a movement away from the earlier emphasis on terminal evaluation, Cronbach further pointed out that evaluation should engage in process studies, which center on the interactive events of the classroom. According to Cronbach, the analysis of how a course produces its effects should be of equal concern with an analysis of proficiency measures

and attitude measures. He also indicated that follow-up studies should be given greater consideration in planning evaluation studies. A major thrust of Cronbach's article was that comparative studies which attempt to compare outcomes of one course with another course should not predominate in evaluation plans.

Michael Scriven

In a widely received and acclaimed paper entitled "The Methodology of Evaluation" (1967), Michael Scriven took issue with what he perceived as Cronbach's lack of concern for comparative studies and further extended methodological concepts for evaluation. He introduced the terminology of formative and summative evaluation, defining formative evaluation in much the same way that Cronbach talked about evaluation for course improvement. In essence, Scriven's formative evaluation consists of making improvements in a course or an educational "instrument" (broadly defined) while it is in its formative stages of development. In contrast with Cronbach's position, Scriven insisted that comparative studies or summative evaluation must play a major role in educational evaluation. The purpose of summative evaluation, in Scriven's view, would be to provide teachers, administrators, and the public with evidence regarding the value of a certain instructional procedure or curriculum when compared to outcomes achieved by a competing curriculum.

Ultimately, Cronbach and Scriven were to agree that there is need for both types of evaluation; however, Cronbach

(1965) insisted that evaluators who conduct formative studies to improve a course should not also engage in summative studies of the same course because of the diverse nature of the two types of evaluation.

Scriven, in his article, made a number of noteworthy distinctions among different types of evaluation. With an emphasis similar to that of Cronbach, Scriven termed process evaluation as the non-inferential study of what actually transpires within the dynamics of the classroom; he further defined process evaluation as the investigation of causal claims regarding interactive classroom processes and stressed the value of this type of study. Scriven made further distinctions among intrinsic, mediated, and payoff evaluation. He defined intrinsic evaluation as an analysis of the consistency which should exist among the content, the goals, the procedures, and the outcome measures specified for a program; payoff evaluation refers to an analysis of operationally defined pupil behavior outcomes. He identified evaluation that would relate intrinsic qualities to payoff outcomes as mediated evaluation. To conduct a pure payoff evaluation, according to Scriven, can be a very costly endeavor because it may tell nothing about the processes which are intended to bring about those outcomes. Therefore, evaluation should center on the full description of the context in which the evaluation takes place and the processes which are employed to achieve outcomes as well as the outcomes themselves.

Robert Stake

Robert Stake's article, "The Countenance of Educational Evaluation" (1967a) added a further dimension to the goals and the methodologies of evaluation. Stake characterized the two basic acts of evaluation as description and judgment; he defined the purpose of evaluation (1967b) as that of increasing the rationality of decisions which control the inputs and the outputs of educational operations. Evaluators are exhorted to describe fully and to judge fully all components in any evaluation study. In the gathering of descriptive and judgmental data, Stake proposed that the evaluator consider three types of data domains: antecedent, transaction, and outcome data. Antecedent data are information or conditions which may be related in some way to outcomes; that is, the evaluator should consider it his responsibility to fully describe and document all the environmental conditions and influences which he believes may have an effect on any given outcome. With reference to transaction data, Stake demanded that the evaluator carefully observe and record data emerging from the transactional and interactional classroom processes. He broadened the general concept of outcome data to include that which goes beyond immediately evident data and which includes future application or transfer long after the initial observation.

Stake advised that evaluators who are processing descriptive data look for contingencies among the intended antecedents, transactions and outcomes; he further suggested that evaluators look for congruence between intended and observed antecedents, transactions, and outcomes. Stake pointed out that evaluators must look for empirical contingencies among the observed antecedents, transactions, and outcomes. In regard to the judgmental aspects of evaluation, Stake stated that one can judge the characteristics of a program with respect to some absolute standards of excellence as reflected by personal judgments of scholars or experts in a given field; one can also judge a program with respect to a relative standard or comparison between the characteristics or the outcomes of alternative programs. For example, one could evaluate Science--A Process Approach (AAAS) with respect to scientists' and science educators' opinions of what elementary school science curriculum ought to be; on the other hand, one might compare the outcomes of Science--A Process Approach with other elementary school science programs. On the basis of either absolute or relative comparisons, one makes judgments.

Daniel Stufflebeam

Daniel Stufflebeam (1966, 1969) has written extensively on evaluation as a factor in the decision-making process. In 1967, he developed and proposed an evaluation model for

use by Title III programs under the Elementary and Secondary Education Act. The purpose of Stufflebeam's model was to provide information to local school districts, state departments of education, and federal authorities to facilitate the decision-making process. A major assumption of his model is that key decision makers at each of these three levels require diverse kinds of evaluative information in order to facilitate the many types of decisions which must be made. To serve such decision-making functions effectively, evaluative information must be valid, reliable, timely and credible.

Examining the kinds of decisions involved in a typical Title III project, Stufflebeam suggested that needed evaluation might be divided into four generalized stages which he called Content, Input, Process and Product--the components which comprise what he termed the "CIPP evaluation model." Context evaluation is primarily concerned with antecedent conditions and/or needs which must be evaluated in order to plan effectively for any program. This aspect of the evaluation model calls for the delineation of goals and objectives in relation to the needs of a given institution or agency. Input evaluation requires an institute or an agency to assess strategies appropriate to given program objectives and to identify the available resources which might be utilized to achieve the program objectives. Decisions at this level of evaluation are

primarily concerned with the specification of procedures, staffing requirements, budgeting and the like. Process evaluation is defined by Stufflebeam as feedback information to project administrators and others to provide for the continuous control and refinement of plans and procedures. Another important aspect of process evaluation is the identification of potential or actual sources of failure in a project and the initiation of remedial action, where required. Product evaluation is undertaken to determine the outcomes. When considered in relation to context, input and process evaluation, product evaluation provides the decision maker with the information to determine to continue, terminate, modify or refocus a project in part or in whole. As part of this model, Stufflebeam provides a feedback control loop system for the evaluation of federally supported educational programs by local, state and federal agencies.

In a symposium entitled "The World of Evaluation Needs Reshaping" at the 1969 American Educational Research Association's convention, Stufflebeam (1969) presented the outline of an emergent theory of evaluation currently being developed by the Phi Delta Kappa National Study Commission on Evaluation. The Commission has been involved in a three-year effort to develop a new theory of evaluation. Issues to which the Phi Delta Kappa Commission has addressed itself include the following:

What premises are fundamental to evaluation theory?

How should evaluation be defined?

What steps are involved in carrying through an evaluation?

What kinds of questions should evaluation studies answer?

What kinds of designs are required to answer these questions?

What criteria are appropriate for judging evaluation studies?

Stufflebeam identified several premises which form the foundation for this emergent theory; these premises specify aspects of the decision-making process and deal with information theory requirements, the specification of evaluation strategies in relation to different educational settings, and the like. Based on these premises, the Commission has defined evaluation as follows:

> "Evaluation is the process of defining, obtaining, and using information to judge decision alternatives." (Stufflebeam, 1969, p. 2)

Stufflebeam stressed that evaluation is defined here as a continuous process. The first aspect of the definition, relative to defining information requirements, essentially asks the questions:

1. Who are the decision makers?
2. What decisions are to be made?
3. What alternatives are available?
4. What kind of information is important?

The processes of attaining and utilizing the information must be cast within the framework of the decision maker's questions. Evaluative information must meet the scientific criteria which are necessary for all good information, i.e., it must be reliable and valid. The Commission added seven utility criteria which evaluative information must attain. They are relevance, significance, scope, credibility, timeliness, pervasiveness and efficiency. The Commission has tried to provide an evaluation theory and methodology which is scientifically respectable and is of utility to practitioners.

Summary and Conclusions

The evaluation model to be developed in this article will be based upon the following important theoretical concepts presented in the preceding review of evaluation theory:

1. Evaluation is considered to be a facilitating factor in the decision-making process.

2. Both formative and summative evaluation procedures should be included in any overall evaluation plan.

3. Process and longitudinal studies should assume important roles in the planning of a comprehensive evaluation plan.

4. Intrinsic and mediated evaluation studies are extremely important adjuncts to payoff evaluation.

5. Evaluators must take seriously the charge to describe fully all antecedent, transaction and outcome data.

6. Evaluation data must have practical utility as well as scientific credibility and must be delivered to decision makers in time to serve the judgmental processes of evaluation.

In the final analysis, the authors and others agree with Cronbach (1964) that evaluation is, in essence, the art of asking good questions. In any evaluative effort, it is important to determine what questions are being asked and by whom; in addition, it is necessary to determine what kind of data are required and in what form in order to facilitate the judgment of decision alternatives. The effective functioning of any evaluation system will depend, ultimately, upon the presentation of accurate, pervasive, timely data to those who ask questions and make decisions.

II. GENERAL SYSTEMS THEORY AND A SYSTEMS ANALYTIC MODEL

"General Systems Theory seeks to classify systems by the way their components are organized (interrelated) and to derive the 'laws,' or typical patterns of behavior for the different classes of systems singled out by the taxonomy." (Rapoport, 1968, p. XVIII). Since the framework of systems analysis can be traced back to General Systems Theory (Bertalanffy, 1968), certain tenets of this theory are reviewed to provide a foundation for building a systems analytic model for curriculum or program evaluation. This review begins with a definition of "systems" and then moves on to such conepts as environment, subsystem, open system, feedback, and centralization.

Systems

> "A system is a set of objects together with relationships between the objects and between their attributes."
> (Hall and Fagen, 1968, p. 81)

The objects are the components of the system. In an educational system, the components or the objects would include: students, teachers, administrators, instructional materials and media, buildings, etc. The attributes are the characteristics of the objects in the system. Thus a student (object) can be characterized in terms of his attributes (interests, I.Q., socio-economic status,

height, etc.) while the instructional materials presented to him may be characterized in terms of their attributes (level of difficulty, type of media required, length of study time and so on). The relationships (among the attributes of the various objects within a system tie that system into a functioning whole which is characterized by a distinct organization. These relationships are determined by the specific problem being investigated, but they can be abstracted for an education system in general. For example, when organizing for instruction, a teacher may select one teaching strategy to be used with students with certain specified attributes or characteristics while employing a different strategy for other pupils. Thus the teacher's instructional plan relates the attributes of the two objects, pupils and strategies, in a distinct organizational pattern.

Implicit in the definition of system is the notion that "...a system has properties, functions, or purposes distinct from its objects, relationships, and attributes." (Hall and Fagen, 1968, p. 81). For example, two school districts could conceiveably organize instructional programs to serve entirely different ends. While the objects, attributes, and relationships might be essentially identical, the goals of the programs could be distinctly different. What is essential to note is that a system has both

organization or structure and functions or goals which are distinct from one another. To characterize a system, both of these notions must be taken into account.

One issue must be considered before moving on to other concepts of the General Systems Theory. The term system connotes to many people an abstract mathematical model requiring a precision which educational measurement cannot provide. This view represents the conceptual approach to systems characterized by the work of Ashby (1960). However, a system can also be built upon the phenomena of the empirical world. In this approach one would describe the objects and attempt to describe the relationships that exist among their attributes (e.g., Bertalanffy, 1952). In fact, the capability of system theory to characterize the empirical organization of components is one of its outstanding features.

In the preceding definition of a system, the emphasis is on the specification of objects, attributes and relationships of the system (organization), as differentiated from its function or purpose. It should be pointed out that for curriculum or program evaluation, the central "objects" of the educational system are the student and the curriculum. This system shall be called the central subsystem. However, both the teachers and, less directly, the administrator also affect the student's behavior and attitudes. A question then arises as to whether or not to consider these individuals as the "objects" of the central subsystem as well.

This potential ambiguity can be cleared up by introducing a second concept of General Systems Theory, environment.

Environment and Subsystems

> "For a given system, the environment is the set of all objects; a change in whose attributes affect the system and also those objects whose attributes are changed by the behavior of the system"
> (Hall and Fagen, 1968, p. 83)

Thus the environment--teachers and administrators--interact with the student not in and for themselves but, rather for the student. In short, the primary aim of the educational system as a whole is to increase the capabilities of student behavior and to change student behavior. Therefore, teachers and administrators can be considered the environment for the central subsystem and, more specifically, can be considered subsystems.

> "Objects belonging to one subsystem may well be considered as part of the environment of another subsystem. Consideration of a subsystem, of course, entails a new set of relationships in general. The behavior of the subsystem might not be completely analogous with that of the original system. Some authors refer to the property hierarchical order of systems; this is simply the idea expressed above regarding the partition of systems into subsystems.
> (Hall and Fagen, 1968, p. 84)

In general, an "instructional system" would be comprised of three subsystems: the central subsystem, the reference subsystem, and the support subsystem. The central subsystem in curriculum or program evaluation would consist of the students and the curriculum. The reference subsystem

(e.g., the teacher) interacts or interfaces directly with the central subsystem, and thus exerts the greatest influence on the central subsystem of any environmental factor. The support subsystem (e.g., administrators, school board) exerts an indirect influence on the central subsystem by directly influencing the reference subsystem.

Thus far, an educational program may be characterized in terms of its components, the characteristics of its components, and the interrelations of its components. Teacher and administrator components may be seen as "environment" to the student component; and, consequently, an educational program or system may be considered a group of subsystems hierarchically arranged. In order to explain the way in which this hierarchical relationship operates, some additional concepts are introduced:

Open Versus Closed System

> "...An open system will attain a steady state in which its composition remains constant, but in constrast to conventional equilibria, this constance is maintained in a continuous exchange and flow of material. The steady state of open systems is characterized by the principle of equifinality; that is, in contrast to equilibrium states in closed systems which are determined by initial conditions, the open system may attain a time independent state independent of initial conditions."
> (Bertalanffy, 1968, p. 18)

The key to understanding an open system is the concept of equifinality. The open system maintains balance by the assimilation of new conditions rather than having to

return to its beginning state to achieve equilibrium. This concept can be illustrated when one considers a living organism as characteristic of an open system; balance is achieved as the organism adapts to changing conditions in the environment although the initial state of the organism never occurs again. The open system, then, tends to increase its complexity and order while still achieving equilibrium. By contrast, the closed system maintains equilibrium with the initial conditions and the general course of events is toward leveling down differences and states of disorder. The description of an open system most clearly relates to curriculum or program improvement or what has been termed "formative evaluation." For example, as curriculum is introduced into a school, it will undoubtedly undergo formative evaluation; and as a result, changes will be incorporated; the final curriculum product will undoubtedly be somewhat different from the product which entered the school.

Systems with Feedback

> "Certain systems have the property that a portion of their outputs or behavior is fed back to the input to affect succeeding outputs."
> (Hall and Fagen, 1968, p. 87)

In the example given above, the feedback mechanism enables the system to change continuously during evaluation and enables the authors to characterize formative evaluation as an open system.

Centralization

> "A centralized system is one in which one element or subsystem plays a major role in the operation of the system."
> (Hall and Fagen, 1968, p. 86)

With reference to an educational program, the student may be considered as the central subsystem as described above. With reference to evaluation of a curriculum, the curriculum itself would be considered central along with the student.

To summarize the elements of General Systems Theory which have implication for the evaluation model to be developed, the following should be noted:

1. The system will be an open system which utilizes feedback to insure the continued improvement of conditions which will tend to maximize the intended outcomes.

2. The system will be centralized in that one subsystem will play a major role with other subsystems interacting or supporting the elements of the major subsystem.

III. FRAMEWORK FOR A SYSTEMS ANALYTIC MODEL

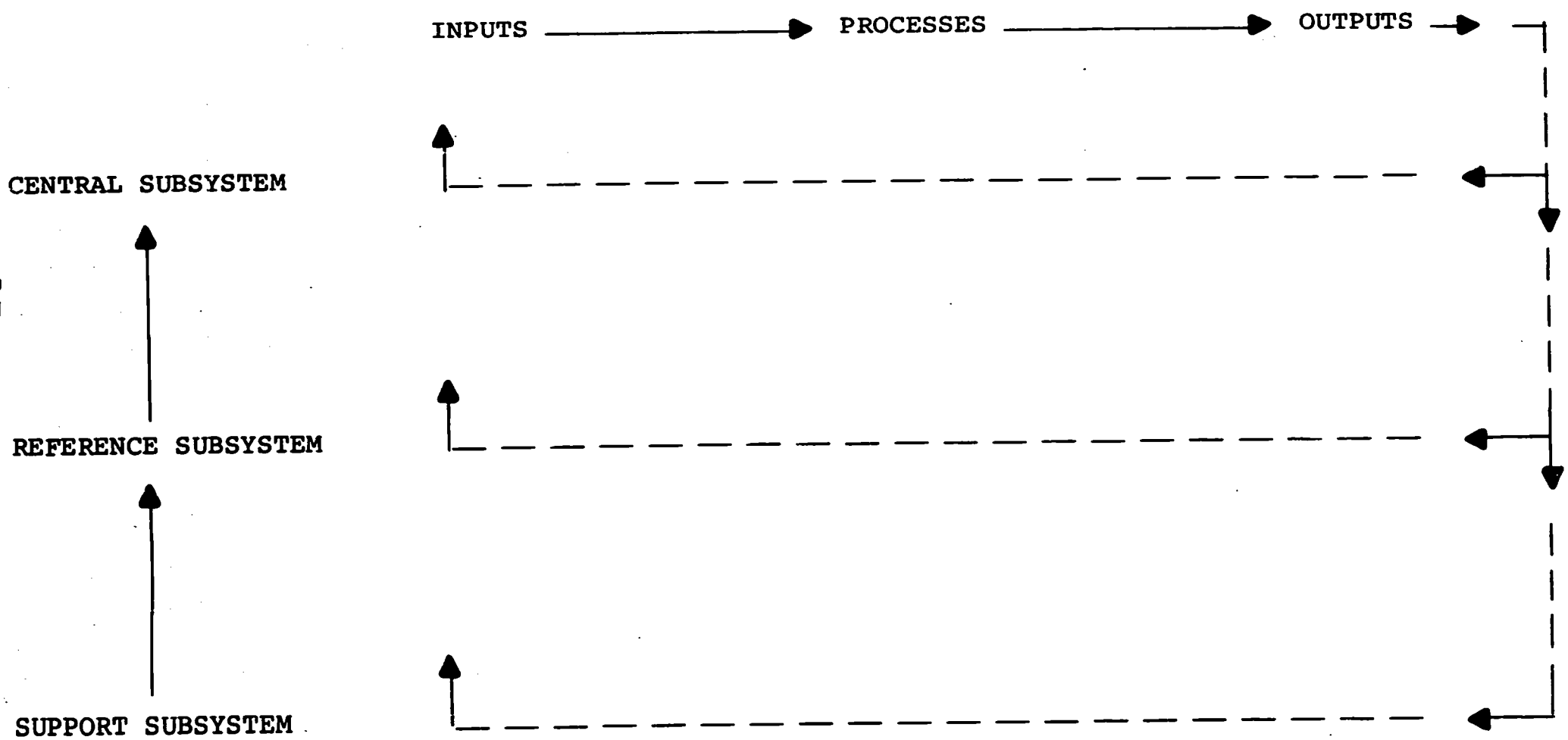
The tenets of General System Theory, described briefly above, serve as ground rules for constructing a systems analytic model for curriculum or program evaluation. In fact, the descriptions presented above serve as the elements put together below.

The Skeletal Model

The system comprises the "processes" through which any person (or thing) entering the system must pass and exit when outcomes have been achieved. Thus a systems analytic model requires identification of inputs, processes, and outputs. In addition, the concept of environment is introduced to explain the hierarchical relation of influences acting directly and indirectly upon the central subsystem. Three types of subsystems are identified to characterize a system: central, reference, and support. These provide the basis for the model shown in Figure 1. The solid arrows show the direction of relationships between flow through the subsystems and flow between subsystems. The broken lines show the feedback throughout the entire system.

This skeletal model suggests analytic procedures for an evaluation program. The first procedure is to determine precisely what is to enter the system at all levels. If a curriculum is being evaluated with certain students,

Fig. 1. Skeleton View of a Systems Analytic Model



both the curriculum and the students must be described in full. In addition, the model indicates that the teachers (reference subsystem) and administrators (support subsystem) must be considered as part of the entire evaluation program. Given the inputs to the system, the processes through which the inputs pass must be identified specifically. It is entirely possible to take the inputs and to design alternative processes for evaluating specified outputs. This would also suggest identification of alternative instructional methods for evaluative research (see Suchman, 1967). The output section makes explicit every type of outcome to be realized by the system. For education, specification of output in terms of performance criteria is necessary but not sufficient. Any behavior, whether or not it is measurable, should be indicated if considered relevant.

A skeletal model of systems analysis has been presented, and examples have been drawn from an abstract educational system. The next step is to consider additional elements of evaluation more thoroughly in order to develop this skeleton model into a generalized systems analytic model for curriculum and program evaluation.

Levels of Decision Making

Evaluation has been presented as the process of defining, obtaining, and using information to judge decision alternatives. A system has been described as a set of objects and

the relationships among the objects and their attributes; a system has been characterized as an open system with feedback comprised of central, reference, and support subsystems with inputs, processes, and outputs specified for each subsystem. Before demonstrating the application of such an evaluation system, it is necessary to introduce a further consideration--levels of decision making within an evaluative framework.

When constructing an evaluation plan or implementing an evaluation system, it is important to determine the different sources and perspectives from which questions regarding evaluation might arise and for which answers must be provided to facilitate the decision-making process (Forehand, 1968). In asking the question, "From whose point of view is evaluative data collected?", Forehand distinguishes between two kinds of evaluation--project evaluation and institutional evaluation. This distinction is useful when one considers the evaluation needs within a complex organization engaged in many activities, sub-programs, or projects. Project evaluation and institutional evaluation are not incompatible; however, Forehand stresses that different perspectives might demand important differences in the way data may be collected and reported.

The primary difference between project and institutional evaluation, in Forehand's terms, is that the institution considers the achievement of any particular

program as a sub-set in relation to the network of other programs and other goals within the institution. Therefore, the perspective of the institutional evaluator will be quite different from that of the program or the project evaluator. The project evaluator would be primarily interested in improving output of a single unit within the institute. The institutional evaluator, however, centers on the study of the institution's overall efforts to achieve its objectives. A good illustration of the difference between project and institutional evaluation becomes evident when one considers the effort and evaluation needs of a curriculum development center or a regional educational laboratory. Such agencies usually have a well-defined set of global objectives or a mission to fulfill. In order to realize their objectives, these institutions typically create sub-divisions to achieve certain specific segments of the mission. Each sub-division or project must then establish a more specific set of objectives and procedures to achieve its goals. The goals for the sub-division or project become a specific sub-set of the more global goals of the institution.

The notion of levels of perspective or levels of decision making is extremely important in the development of an evaluation plan. The distinction between the perspective of a project evaluator and an institutional

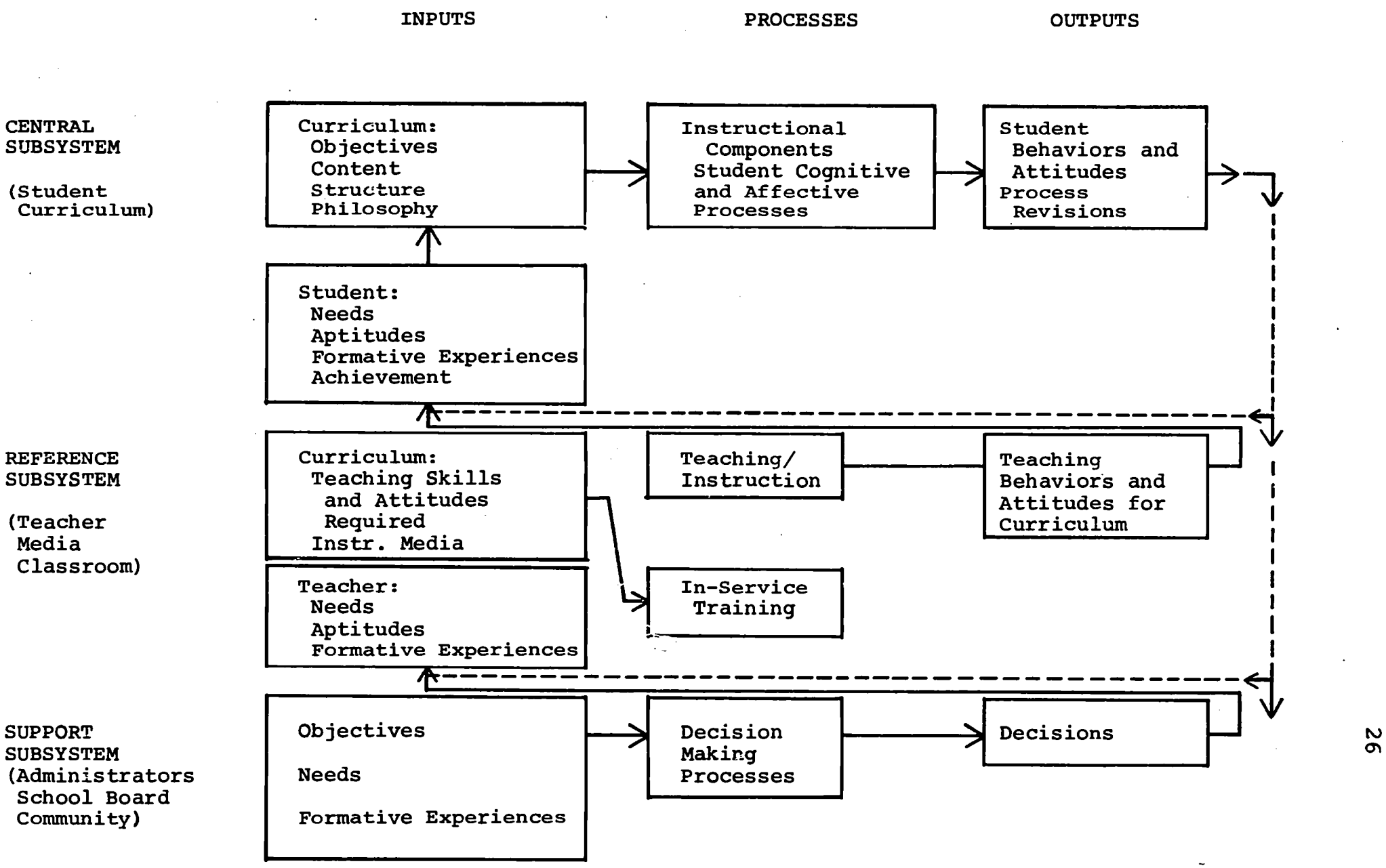
evaluator leads to the necessity for different types of data collection and reporting. A project evaluator, for example, is primarily concerned with formative evaluation; consequently, he will generally need micro data in answer to very specific questions which will facilitate the improvement of programs. The institutional evaluator, on the other hand, deals with a multitude of programs; his needs call for more generalized or macro data to be used in assessing the progress of the entire institution in meeting its goals. At times, evaluative personnel at both levels will require both macro and micro data. In brief, the level of perspective or decision making will have an important influence on the identification of the components of each of the subsystems. Examples provided later in the article will illustrate this point.

The Generalized Model

Figure 2 is an expanded version of the skeletal model previously presented. The general type of information for each subsystem has been identified along with the flow of data through the system. This figure also indicates that pupil outcomes will generally be of prime concern in most evaluation studies.

For the central subsystem, the background, aptitudes, and needs of the students in the evaluation need to be considered in setting the objectives for the evaluative

Fig. 2. Systems Model for Program Evaluation



program. Furthermore, the content, philosophy, and structure (attributes) of the curriculum being introduced need to be specified. The model presented in Figure 2 implies that it is essential to use the appropriate student population for evaluating a curriculum. Once this match has been made, the specific components and alternatives will be reflected in the evaluation. The output for the central subsystem is the behaviors and attitudes of the students against which the objectives of the curriculum may be evaluated. Based on this evaluation, results in terms of revisions are fed back into the central subsystem.

The inputs for the reference subsystem are concentrated on the experiences and aptitudes of the teachers and the types of instructional materials and strategies required by the curriculum. The processes for the reference system are, first of all, the component acts of teaching. In addition, the model recognizes that inservice training of teachers is essential when a new curriculum is introduced. Thus, the components of this inservice training program need to be made explicit. The consequent behaviors, skills, abilities, and attitudes of the teachers represent the output of the reference subsystem. This output serves as an input into the central subsystem.

Finally, the experiences, abilities, attitudes, needs, and objectives of each of the components of the support system need to be identified. Support personnel, facilities,

and funding play an important, though indirect, role in producing the outcomes desired. The primary responsibility of administrators, board members, and the local school district is to make decisions affecting the curriculum, the students, and the teachers. The outputs of the support subsystem, in this case, are the decisions; these decisions influence the central subsystem by inputting into the reference subsystem.

A Note of Caution

Several general comments regarding the application of a systems analytic model to educational evaluation are in order. First, it should be clearly understood that the systems analytic model presented is, at best, a heuristic device for program or curriculum evaluation; it is not a predictive model in the statistical sense. This means that in the development of this model, relationships, objects, attributes, and goals are not necessarily quantifiable--given the present state-of-the-art of educational and psychological measurement. Thus the model encourages the evaluator to consider all relevant information for decision making, whether or not it can be reduced to a specific quantity. Secondly, this is an "empirical" model. This means that it attempts to describe the real world as it exists. The first consequence of this is that the model is applicable to

many different problems. For example, the model's components will vary according to the level of information required in curriculum evaluation. A second consequence of the empirical model is that it may indicate areas to be considered that would not have been perceived in the real world by a less rigorous approach. However, the systems analytic approach is not a panacea for evaluation problems; it is an organizational framework which makes explicit the nature and relationships of inputs, processes, and outputs of a program. A human being with all of his capabilities and limitations must apply this discipline to a problem. At least this method will make explicit what is <u>not</u> being included in a program as well as what is included.

IV. APPLICATION OF THE MODEL TO A SPECIFIC PROBLEM

In a decision-making framework, the evaluator's task in the development of an evaluation system is to determine the levels of decision making within and related to the educational institution. It is then necessary to determine the types of questions which are being asked in order to formulate decision alternatives at the various levels to determine what kinds of information are needed, and when data are needed to facilitate the decision-making function.

To illustrate this process of developing an evaluation system, the Eastern Regional Institute for Education (ERIE), a regional laboratory funded by the U.S. Office of Education, is used as an example.

An Evaluation System for the Eastern Regional Institute for Education

Briefly stated, the mission of ERIE is to improve process-oriented education in the elementary schools of the nation. Process education provides more effective curricula in such areas as reading, mathematics, science, and social studies. A command of basic skills, the development of thinking ability, and the tools to continue life-long learning are important outcomes of process education.

To illustrate the development of an evaluation system for ERIE, three different levels of decision making within or related to the mission of ERIE have been identified.

These levels are termed: program level, institutional leadership level, and extra-institutional level.

The program level of operation within ERIE's structure is charged with the responsibility of testing process-promoting curricula in "laboratory-type" schools, adding needed elements such as adequate objectives and pupil assessment devices, and verifying that each curriculum produces its intended results. Being satisfied with results in a "laboratory-type" school, ERIE then installs each curriculum in a network of pilot and demonstration schools of diverse characteristics. When installing a new curriculum in pilot and demonstration schools, ERIE studies factors which facilitate or impede the successful implementation of the curricula.

The institutional leadership level of the organization is comprised of the executive officers of the Institute and the Board of Directors; the latter group is the policy-making body. The leadership level is responsible for the formulation and ultimate implementation of the policies of the Institute with regard to both programs and personnel.

Related to the effective operation of ERIE are two groups which guide, support and collaborate with the Institute in its efforts to improve process-oriented education. The U.S. Office of Education, and affiliates, comprise what will be termed, for the purposes of evaluation,

the extra-institutional level of decision making. The United States Office of Education, through its Division of Educational Laboratories, reviews and evaluates the general operation of the Institute and provides the major source of funding. The affilitates include the state departments of education, teacher training institutions, and local school districts within the region which collaborate with ERIE and support its work.

The distinctions made among the three levels are critical for evaluation purposes; each group brings a different perspective from which to view the efforts of the Institute. These different perspectives determine the kinds of questions which each group asks, the type of information sought, and most importantly, the types of decisions which each group will make.

Types of Decisions and General Kinds of Questions Asked by the Three Levels of Decision Making

With respect to ERIE's program level-of-operation, component directors and their support personnel are concerned with the application of criteria for the selection of process-oriented curricula and with various program outcomes. Decisions to modify programs in various stages of implementation are made to make more definitive judgments and recommendations regarding program outcomes or installation strategies. Questions asked at this level of organization relate to the full description of the

relationships among both the intended and observed inputs into the program and processes employed to achieve outcomes. Having determined the what and the how of outcomes, program directors and their assistants will also become concerned with questions related to why these outcomes were achieved with a given population.

Questions asked by the institutional leadership, both executive and policy, generally relate to the effectiveness of individual programs and the accomplishments of the Institute in general; these questions are posed regarding the allocation of resources and personnel and to decide to modify, refocus, extend, initiate, or terminate individual programs.

The parties which comprise the extra-institutional groups of ERIE must be considered separately, since each group makes a different type of decision and, consequently, asks a different kind of question.

The United States Office of Education, as represented by the Division of Educational Laboratories, makes decisions about the funding which ERIE will receive. Consequently, the questions asked at this level relate to the efficiency and effectiveness of the Institute in relation to its identified mission; in making judgments about ERIE, the priority needs of education in the country at large must be taken into consideration. Part of the data for decision making for the Office of Education comes

from site visitors who are selected to review the efforts of the Institute. The questions asked by site visitors may range from the broad type of question similar to those asked by the Board of Directors to very specific questions characteristic of the program level of operation.

The extra-institutional group of affiliates is composed of three distinct sub-groups: state departments of education, teacher training institutions, and local school districts; each of these groups makes a decision to collaborate with the Institute in the installation of process promoting elementary school programs. Each of these groups asks questions related to the benefits to be derived from their participation with ERIE, and, on the basis of the answer, determines whether to collaborate with ERIE or not. For example, a state department of education would question the effect to which collaboration with ERIE will further the objectives which the state holds for its elementary schools. Likewise, teacher training institutions and the professors involved in collaborative efforts would ask to what extent collaboration would further their own ends. Local school districts would question the degree to which collaboration with ERIE has a salutary effect on pupils, teachers, administrators, program, and the community at large. It is evident that collaboration means different things when viewed from the perspective of each of the three affiliated groups listed above. While the question

asked by each group may be similarly phrased, the answers required are quite different.

Table I presents a summary of the levels of decision making.

Levels of Data

A brief review of the terms will prepare the reader to analyze the cells in Table II. The central subsystem specifies the subjects of interest in an evaluative investigation. The reference subsystem is comprised of those personnel or materials, instruments, etc. which directly interact with the central subsystem to produce the outcomes. The support subsystem specifies all the indirect conditions in the environment which are necessary to bring about the interaction of the reference and the central subsystems. By inputs we mean all those factors which may influence outcomes. Processes are those encounters or interactions which are the vehicles for producing the desired outcomes. The outcomes are those desired behaviors or expectancies which are the object of the entire effort.

Having identified a level of decision making and the evaluative questions being asked, the next step in the formulation of an evaluation plan is to relate the decisions and questions to the systems analytic model presented in Figure 2. This calls for the designation

TABLE I

DECISIONS AND QUESTIONS: ERIE'S EVALUATION PLAN

LEVELS OF DECISIONS MAKING	GENERAL TYPES OF DECISIONS	GENERAL TYPES OF QUESTIONS RELATED TO DECISIONS
STAFF Program Directors Curriculum Teams Installation Team	• Curriculum selection and/or development • Program improvement • Program validation	...To what extent do given programs meet "process criteria?" ...What, how, and why do the various programs and installation strategies produce their results?
INSTITUTIONAL LEADERSHIP Executive: Directors Policy: Board-Council	• Program modification • Program extension • Program initiation • Program termination • Personnel requirements • Policy determination	...How effective are the program components in achieving their goals? ...What is the total impact of the Institute's programs on the region? the nation?
EXTRA-INSTITUTIONAL		
USOE	• Funding	...To what extent do the individual and collective programs of the Institute assist in the achievement of its goals? In the achievement of the priority goals of USOE?
State Departments	• Collaboration	...To what extent does collaboration with ERIE further the goals of education with the state?
Teacher Training Institutions	• Collaboration	...To what extent has our collaboration with ERIE been beneficial to both parties?
Local School Districts	• Collaboration	...What are the effects of collaboration with ERIE upon pupils, teachers, administrators, and the community at large?

of components of each subsystem in terms of inputs, processes, and outputs. Designating the descriptive data to be collected allows the evaluator and the decision maker to gain a comprehensive view of the scope of the evaluation needs in order to judge decision alternatives relative to a given curriculum or program.

Table II indicates the nine data cells used in ERIE's systems analytic approach to evaluation. Of prime concern will be the data in cell 3; the outcome data with the subjects of central concern, when interpreted in relation with other outcome data provide the substance for formative evaluation.

TABLE II

DATA CELLS FOR ERIE'S EVALUATION SYSTEM

	Inputs	Processes	Outputs
Central Subsystem	1	2	3
Reference Subsystem	4	5	6
Support Subsystem	7	8	9

Before proceeding further to give an example which would illustrate the application of the evaluation system to a specific ERIE program, it is of the utmost importance to recognize that with respect to the information to be gathered and the decisions to be made, the designation of

central subsystem will change depending upon the questions being asked, by whom, at what level of perspective and decision making within or related to the Institute. Depending upon the answers to these questions, the central subsystem will be any one of the following: teachers, administrators, college professors, program components, or the Institute itself.

In Table III which follows, the major components of the central subsystem are the student and the instructional materials; the questions center on the extent to whi.h the students achieve the cognitive and affective outcomes of the elementary school program, Science--A Process Approach. The components of the reference subsystem, in this case, would be the teachers and the classroom environment; the criteria for selecting these components require that they directly interact with the students in the learning process to produce the intended outcomes. The components of the support subsystem would include other physical facilities and support personnel, the administrative support with the school, financial support, and the consultant services provided by ERIE through the Regional Action Network (RAN) of college professors. The criteria for identifying the components for the support subsystem require that they directly interact with the components of the reference subsystem and indirectly affect the central subsystem components.

TABLE III

APPLICATION OF ERIE'S EVALUATION SYSTEM WITH PUPILS AS CENTRAL SUBSYSTEM

SUBSYSTEMS	INPUTS	PROCESSES	OUTPUTS
CENTRAL	-1-	-2-	-3-
Pupil	Biographical Information Educational Achievement Interests, Attitudes	Interaction between pupils and materials	Pupil attainment of specific outcomes Pupil attitudes toward subject and toward interaction
Materials	Description of materials Objectives, procedures, instruments, etc.		Efficacy of materials in producing pupil outcomes
REFERENCE	-4-	-5-	-6-
Teachers	Biographical Information Attitudes toward school environment, pupils, materials Knowledge of content of programs	Interaction with pupils materials in implementing program	Knowledge of content of lesson or lesson sequences Instructional skills required by lesson Attitude toward subject, pupils and interaction Effective use of materials with students
SUPPORT	-7-	-8-	-9-
Learning Environment	Description of learning environment	Interaction of pupil and teachers with environmental conditions	Adequacy of environment
Support Personnel	Description of Administrative and consulting personnel	Interaction of support personnel with teachers to promote program outcomes	Efficacy of interaction in producing outcomes
Plans	Description of plans for orienting or training teachers	Implementation of plans for orienting/ training teachers	Efficacy of orientation or training programs
Financial	Description of financial support for all levels of program	Implementation of plans with respect to financial support	Adequacy of financial support with respect to intended outcomes

As illustrated in Table IV, teachers may be considered the central subsystem when considering questions about teacher effectiveness or teacher training in the evaluation of Science--A Process Approach. In this case, the reference subsystem would be the Regional Action Network of professor-consultants designated by ERIE to conduct the continuing inservice training of teachers. The support subsystem would include the facilities and resources designated by ERIE to conduct the workshops for the training of consultants and teachers. In this case the output of central interest includes the understandings, behaviors, and attitudes produced in teachers as a result of the training program.

In the example in which teachers are considered as the central subsystem (Table IV), one can identify three major direct influences on their behavior: students, consultants, and instructional materials. When teachers are the central focus for investigation, the question arises as to whether or not the students should be included as part of the reference subsystem. In Table III, when students are considered the central subsystem, the influence of pupil behaviors on teacher behavior is accounted for by means of the feedback loop. The existence of this data as part of an overall evaluation effort and the portrayal of student/teacher interaction in this manner preserve the "transaction" aspect of teaching and learning.

TABLE IV

APPLICATION OF ERIE'S EVALUATION SYSTEM WITH TEACHERS AS CENTRAL SUBSYSTEM

Pupils as Central Subsystem (Table III)

SUBSYSTEMS	INPUTS	PROCESSES	OUTPUTS
CENTRAL Teacher	-1- Biographical Information Attitudes toward school environment, pupils, materials Knowledge of content of program	-2- Interactive behavior with pupils and materials	-3- Knowledge of content of lessons Instructional skills required by lessons Attitude toward content of lessons Attitude toward subject, pupil, and interaction Effective use of materials with student
REFERENCE RAN Professor	-4- Biographical Information Attitudes toward program and role of consultant Knowledge of program	-5- Interactive behavior of RAN professor with teacher as continuation of inservice training	-6- Effectiveness of interaction with teacher in producing desired teacher outcomes
SUPPORT	-7- Goals and Plans Financial Support Logistical Support	-8- Implementation of plans for orienting and training teachers and RAN professors Interaction of ERIE assigned personnel with teachers and professors Implementation of training plans with respect to financial and logistics support	-9- Effectiveness of ERIE training, at its termination, in terms of knowledge and behavior outcomes for teachers and RAN professors Effectiveness of training program in terms of logistics and financial support

Consequently, there is no need to include pupils as components of the reference subsystem.

In instances where teacher training is of central importance and pupil behavior is only incidental to overall program evaluation, students would have to be considered as components of the reference subsystem. This would generally be the case when one is solely concerned with teacher behavior outcomes as might be the case in the evaluation of teacher training programs.

Up to this point we have demonstrated the applicability of the model to micro data gathering and to decision making at the program level of operation. The authors contend that the evaluation system will prove to be effective at any level of decision making. A final example portraying the flexibility of the model at a more macro level will be illustrated briefly as follows:

As one views ERIE from the perspective of extra-institutional groups, the Institute itself--its programs and personnel--becomes the central subsystem about which questions are to be asked and data are to be gathered in order that these groups may make decisions appropriate to their responsibilities. For example, a site visitor from the Office of Education might ask the question, "What impact is ERIE having upon its region?" In this instance,

TABLE V

SPECIFICATION OF THE CENTRAL, REFERENCE, AND SUPPORT SUBSYSTEM OF PRIMARY INTEREST TO ERIE'S LEVELS OF DECISION MAKING

LEVELS OF DECISION MAKING	CENTRAL SUBSYSTEM	REFERENCE SUBSYSTEM	SUPPORT SUBSYSTEM
STAFF			
Program Directors	Pupils	Teachers - materials	Facilities - ERIE
Curriculum Teams	Teachers	ERIE	Funding
Installation Teams	Professors	ERIE	Funding
INSTITUTIONAL LEADERSHIP			
Executive Directors	Programs	Program personnel	Institutional organization and structure
Policy: Board-Council	Programs	Personnel, leadership	Interactive structure of the Institute; facilities and funds
EXTRA-INSTITUTIONAL			
USOE	ERIE programs	ERIE personnel	Institutional structure and Board of Directors
State Departments	Local school districts	ERIE	State department divisions, Title III centers, etc.
Teacher Training Institutions	Professors	ERIE	ERIE and other funding
Local School Districts	Pupils	Teachers, materials	ERIE
	Teachers and administrators	ERIE	Facilities funds

the Institute and its programs become the central subsystem, the institutional organizational structure and its internal and external communication systems become the reference subsystem, and the various sources of funding and ancillary facilities become the support subsystem. Table V above provides the reader with general statement of the primary central, reference, and support subsystems from the perspective of each of the various levels of decision making. The elements of this Table V indicate the practical utility and the flexibility of the model for use in empirical and non-empirical evaluation studies.

V. LIMITATIONS OF SYSTEMS ANALYSIS

By this time the capabilities of a systems analytic approach to educational evaluation should be evident. There are, nevertheless, a number of limitations, or at least unfulfilled expectations, inherent in this approach.

Aerospace and other defense industries have developed systems analysis primarily for application to physical systems. Educators tend to think in terms of a direct analogy between the application of systems analysis in engineering and its application in education. Consequently, many educators reject this approach as "dehumanizing" since so much of education cannot be quantified in the manner suggested by the engineering model. One limitation of the model presented in this paper is that it is not predictive in the engineering sense. The data obtained from educational and psychological measurement is not sufficiently precise or sufficiently complete to permit building a predictive model for selection among decision alternatives; in addition, much important educational data is non-quantifiable. However, this limitation does not mean that systems analysis cannot be applied to educational evaluation. What it does suggest, however, is that whenever possible, quantitative data should be collected; when this is not possible, qualitative data should be obtained. Therefore, the model is not limited to

behavioral (Tyler, 1950) or instructional (Mager, 1965) objectives; it also utilizes what Eisner (1969) terms "expressive" objectives.

This leads to the question: "What will systems analysis do for us?" The answer is that systems analysis will enable the evaluator to do a more comprehensive job of planning his evaluation effort. Systems analysis applied to educational evaluation is a heuristic device for organizing the problem in terms of its components and its relationships. As such, it reduces the possibility of omitting the collection of important information, and it forces the evaluator to consider all levels of information required of the evaluation program. Finally, it demands that the evaluation design make explicit what will be gained from the evaluation, and it assures that relevant information will be provided to decision makers. Once an evaluation plan is organized, the question of measurement arises. Systems analysis makes explicit the nature of the data to be collected but <u>systems analysis does not tell the evaluator how to measure</u> the educational outcomes specified; decisions related to instrumentation are beyond the scope of this article. By using this approach, the evaluator can be fairly sure that he has identified what to measure in order to provide information for the various levels of decision making.

SUMMARY

A systems analytic framework has been developed and applied to an evaluation system. The authors contend that this approach may provide a useful device for the planning and implementation of evaluation studies centered on a decision-making basis. Some of the basic notions of emerging evaluation theory and basic tenets of General Systems Theory were provided as the basis for the development of an evaluation system. An illustration of the application of the evaluation system was presented using the program plan of the Eastern Regional Institute for Education (ERIE).

It has been pointed out that systems analysis applied to evaluation provides, at best, a heuristic device for organizing, implementing and interpreting evaluation efforts. The practical utility of the proposed evaluation systems needs to be ascertained; it has proved to be helpful to the authors in construction of evaluation plans. To the extent that it assists evaluators to identify, collect, interpret, and report information of practical utility and scientific credibility to decision makers, it will prove to be a valid technique.

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