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AUTHOR Borgen, Joseph A.; Davis, Dwight E.
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ABSTRACT

As part of the Phase II report of the Illinois Occupational Curriculum Project, this document summarizes efforts made to: (1) gain a familiarity with the terminology and theory of systems modeling, (2) study the application of systems modeling in various management settings, and (3) identify factors to be considered in selecting and developing a systems modeling technique for use by occupational administrators. Ultimately the contents of this report will be combined with data gathered in two other major areas of investigation to form the basis for the development of a system model and related guidelines for occupational curriculum development and evaluation. Findings, based on a review of the literature and the opinions of consultants, include: (1) The development of a model should involve the identification of factors relating to the occupational curriculum, whether within the institution or outside the institution, and relating these factors to each other and to the curriculum system as a whole, and (2) The selection of a modeling technique should consider the purpose the model will serve. After careful consideration, it was decided that the flow chart modeling technique using Logos language would be used for this project. Related documents are available as VT 014 774 and VT 014 776 in this issue, and ED 050 270. (JS)

An Investigation Of Systems Designs And Management Techniques With Implications Toward A Systems Approach To Curriculum Development And Evaluation In Occupational Education

A Part of the Phase II Report of

Research and Development
Project No. RDB-B1-002

THE DEVELOPMENT OF SYSTEMS MODELS FOR DECISION MAKING IN OCCUPATIONAL CURRICULUM DEVELOPMENT AND EVALUATION

Funded Jointly by the
Board of Vocational Education and Rehabilitation
Division of Vocational and Technical Education
and the
Joliet Junior College
Joliet, Illinois

AN INVESTIGATION OF SYSTEMS DESIGNS AND MANAGEMENT TECHNIQUES WITH IMPLICATIONS TOWARD A SYSTEMS APPROACH TO CURRICULUM DEVELOPMENT AND EVALUATION IN OCCUPATIONAL EDUCATION

As Part of the Phase II Report

"The Development of Systems Models for
Decision-Making in Occupational Curriculum Development
and Evaluation"

PRINCIPAL INVESTIGATORS: Joseph A. Borgen, Dean
Occupational & Technical Studies

Dwight E. Davis, Curriculum Coordinator

PROJECT COORDINATOR: David A. Anderson, Ed.D.

RESEARCH COORDINATOR: Urban T. Oen, Ph.D.

ILLINOIS OCCUPATIONAL CURRICULUM PROJECT
Joliet Junior College
Joliet, Illinois 60436

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STATE OF ILLINOIS
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Joseph A. Borgen

Dwight E. Davis

PREFACE

This report focuses on one area of emphasis undertaken by the Illinois Occupational Curriculum Project in developing a model for occupational curriculum development and evaluation. It is only a part of the total Phase II report on the research and development project entitled The Illinois Occupational Curriculum Project, heretofore referred to as the Research and Development Project in Occupational Education entitled "The Development of Process Models for Decision-Making in Curriculum Development and Evaluation." This project is currently in progress at Joliet Junior College, Joliet, Illinois, with present efforts directed toward the initial development of a systems model designed to assist administrators in decision-making related to the development and evaluation of occupational education programs. The project is funded by the State Board of Vocational Education and Rehabilitation, Division of Vocational and Technical Education, Research and Development Unit, State of Illinois.

Purpose of the Project

This project is based on the assumption that more systematic means must be developed to assist curriculum planners in the development of new programs and the continuous evaluation of on-going programs in occupational education.

The following questions serve as the basis for the project research and development activities:

1. Can generalizable systems models be developed to provide curriculum planners with a systematic decision-making procedure for program identification, development, implementation, and evaluation?

2. Is it possible to develop guidelines for the identification and utilization of resources and evaluative criteria in accomplishing the activities specified in the systems model?

Objectives of the Project

The following are the overall project objectives:

1. To develop systems models for curriculum development and evaluation in occupational education.

2. To develop guidelines for the utilization and application of the systems models.

3. To test the applicability and usefulness of the systems models in a pilot situation at selected institutions offering occupational programs.

4. To develop a plan for dissemination and in-service training for curriculum planners in the utilization of the systems models.

5. To promote research in related areas.

Overview of the Total Project

The project is divided into four distinct phases. These are:

Phase I: Project Planning

Phase II: Initial Systems Model Development and Preliminary Evaluation

Phase III: Pilot Testing of the Model

Phase IV: In-depth Evaluation of the Project and Dissemination of the Findings

Phase I focused on a review of the literature, while Phase II involved the comparison and evaluation of systems, models, and decision-making and the development of a systems model for curriculum development and evaluation in occupational education. Phase III and Phase IV are proposed for further development, implementation, and evaluation of the model.

Phase I: Project Planning

Phase I was initiated March 1, 1970, with a grant of $24,550.00 from the State Board of Vocational Education and Rehabilitation. This grant combined with $6,916.00 in local funds providing a total budget of $31,466.00 to conduct the project through June 30, 1970.

The project planning activities centered around three major areas of concern identified as being particularly important to the establishment of a firm basis for the project:

1. Review of the literature on models for curriculum development and evaluation.
2. Review of current thinking on the effects of planned curriculum on social and economic conditions.
3. Study of potential consultants and resources agencies qualified to assist in subsequent phases of the project.

Phase II: Initial Systems Model Development And Preliminary Evaluation

Phase II was initiated July 1, 1970, with a grant of $67,178.00 from the State Board of Vocational Education and Rehabilitation. This grant combined with $16,950.00 in local funds providing a total budget of $84,128.00 to conduct the project through June 30, 1971.

This phase of the project focused on research and development activities in four major areas of concern directed toward the initial development and validation of a systems model for curriculum development and evaluation in occupational education. The following topics served as the focus of investigative activities for Phase II of the project:

1. Investigation of Management Systems
2. Investigation of Curriculum Models
3. Identification of Decision-making Practices in Occupational Education
4. Initial Model Development and Testing

Developmental efforts were executed to coordinate the findings from the aforementioned areas of investigation with the objective of developing an initial systems model for decision-making in curriculum development and evaluation.

Future Phases of the Project

Two additional phases of this project are planned. Upon completion of Phase II, Phase III is proposed for pilot testing the model. This pilot test will provide orientation workshops for the application and use of the model, field testing of the model under actual conditions, and implementation of the model in selected institutions. Phase IV will provide for an in-depth evaluation of the project and the dissemination of findings to other institutions for their use in developing and evaluating occupational curricula.

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CHAPTER I

INTRODUCTION

As educational institutions become more complex, and the necessity increases for accountability, there is an increasing need for a more systematic technique for effective management of curriculum development and evaluation. This is especially the case in vocational education where for some time state plans and federal legislation have mandated change in existing programs and expansion of program offerings not to mention improvement in program output.

The vocational education amendment of 1968 strongly implied past practices in vocational education have not been effective or comprehensive enough to meet the needs of young people in preparation for employment. To execute the mission put forth in this legislation many new programs must be identified, developed, and implemented to insure compliance with contemporary needs of the student clientele and employer consumer. In addition, the need for improved evaluation methods exists to give direction to the modification or termination of many on-going programs.

As stated in the preface to this report, it is the concern of the Illinois Occupational Curriculum Project that a more systematic method be developed for use by local school administrators for program identification, development, implementation, and evaluation. The assumption held by the Illinois Occupational Curriculum Project is that the application of systems management techniques to planning and decision-making can have a marked effect on improving and expanding quality occupational programs.

This report is intended to present one of the major areas of investigation undertaken by the Illinois Occupational Curriculum Project to:

1. gain a familiarity with the terminology and theory of systems modeling;
2. study the application of systems modeling in various management settings; and
3. identify factors to be considered in selecting and developing a systems modeling technique for use by occupational administrators.

The contents of this report combined with data gathered in two other major areas of investigation undertaken by the Illinois Occupational Curriculu Project will form the basis for the development of a systems model and related guidelines for occupational curriculum development and evaluation. Other areas of investigation are reported in the Illinois Occupational Curriculum Project reports entitled: "An Investigation of Curriculum Development and Evaluation Models with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education", and "An Investigation of Decision-Making Practices in Illinois Junior College with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education."

The procedure followed in completing this investigation included the following:

I. Review of the Literature to:
   A. clarify the meaning of the term "systems",
   B. identify different categorizations of systems,
   C. identify different levels of systems,

D. identify factors to consider in the development and testing of a system,

E. clarify the meaning of the term "modeling",

F. identify factors to consider in modeling the system,

G. identify factors to consider when applying systems modeling to various management problems,

H. show examples of systems models.

II. Visitations with consultants to give direction to review literature and analysis of information gathered through this review;

III. Attend conferences and training sessions on systems modeling to gain the expertise necessary to develop a systems model for occupational curriculum development and evaluation;

IV. With consultative assistance identify implications important for the development of a systems modeling by the Illinois Occupational Curriculum Project;

V. After reviewing the other Illinois Occupational Curriculum Project reports entitled: "An Investigation of Curriculum Development and Evaluation Models with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education", and "An Investigation of Decision-Making Practices in Illinois Junior Colleges with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education", and a related report titled, "The Application of Organizational Systems Theory to Curriculum Development and Evaluation", complete the selection of a systems modeling technique and the development of a systems model for use by occupational administrato

CHAPTER II

REVIEW OF LITERATURE

This chapter represents a review of selected literature in an attempt to better define the terms "systems" and "modeling" and identify factors to consider in the application of systems modeling to various managment problems.

Part I

What is a System?

Defining the term "System"

The term "system" is now being used frequently in nearly all disciplines and occupational areas, for example, electronic systems, servo-control systems, production systems, financial systems, management systems, teaching or instructional systems, social systems, and Cybernetic Systems. At the outset, one could surmise that "system" is either a broad term or it is being used very loosely. The following constitutes definitions of the term as offered by selected authors.

Hall and Fagen(15) define a system as:

> . . . a set of objects together with relationships between objects and their attributes. Objects are seen as parts or components of a system, attributes as properties of objects, and relationships as the wherewithal to tie the system together.

Ryan(31:8) defines a system as:

> . . . a bounded organization of interdependent interrelated components maintained in a stable state of relatedness to each other, the total system and the environment by standard modes of operation and feedback from the environment for the purpose of accomplishing stated goals.

Silvern(36:1) defines a system as:

> . . . the structure or organization of an orderly whole, clearly showing the interrelations of the parts to each other and to the whole itself.

Heinich(19:4) refers to operational systems. He states that:

> An operational system synthesizes and interrelates the components of a process within a logistical framework, insuring continuous, orderly, and effective progress toward a stated goal. . .

In his book, "Instructional Systems", Banathy (4:12) defines system as:

> . . . assemblages of parts that are designed and built by man into organized wholes for the attainment of specific purposes. The purpose of a system is realized through processes in which interacting components of the system engage in order to produce a predetermined output. Purpose determines the process required, and the process will imply the kinds of components that will make up the system.

Reviewing these definitions, one can note minor differences in terminology and scope of the definitions. For example, Hall and Fagen refer to the parts of a system as "objects" whereas Ryan and others used the term "components" to mean the same. Heinich, Ryan, and Banathy suggest qualifications for an effective and efficient control of a system as a part of their definitions.

Each of the definitions reviewed show the use of the term "system" in a generic sense referring to a whole in which components and the relationship of the components to each other and to the whole have been identified. The application of the term "system" can thus be made with respect to <u>any</u> whole, natural or man-made. Silvern supports this contention when he concludes "A system is what the person identifying it says that it is" (36:;24).

Boulding (7) offers additional support when he conceptualizes general systems theory as a skeleton of science providing a framework on which to hang the contents of particular disciplines and areas of subject matter in an orderly body of knowledge.

Von Bertalanffy(40,41)further points out that there are models, principles and laws which are generalizable to systems without regard for the nature and relation of the elements.

All of this is not meant to suggest that there is a lack of general principles and theory that apply to all systems. Ryan(31:8) states that systems can be characterized as:

1. organized and orderly;
2. comprised of objects, elements or components and relationships among components and between components and the whole;
3. functioning as a whole by virtue of interdependence of its parts;
4. synthesized in an environment to accomplish progress to a goal; and
5. possessed of structure, function and development.

Ryan(31:9-10) goes on to offer four general principles that have been applied to the study of operating systems or in the design of a new system.

> Principle 1: The greater the degree of wholeness in the system, the more efficient the system — In any system, some degree of wholeness must exist. Wholeness is defined by the degree to which every part of the system related to every other part in such a way that a change in one part causes a change in other parts and in the total system. . . .

> Principle 2: The greater the degree of systematization, the more efficient the operation of the system -- Systematization refers to degree of strength in the signal paths or relationships among parts of the system. In a system in which the parts are only loosely tied together, replacement or retooling of system parts may be in order if the desired level of tightness in the system is to be achieved. . . .
>
> Principle 3: The greater the degree of compatibility between system and environment, the more effective the system -- Compatibility refers to the extent to which a system is geared to a particular environment. A system should be constructed in such a way as to match a given environment.
>
> Principle 4: The greater the degree of optimization, the more effective the system -- Optimization is defined as the degree of congruence between system synthesis and system purpose. A system should be adapted to its environment in such a way as to secure the best possible performance for a given purpose.

Categorizations of Systems

From the writings of the authors providing definitions of systems it is also apparent that systems can be categorized as natural or man-made. Scientists have long devoted their efforts to the better understanding of such natural systems as the solar system, weather system, plantlife and animal systems. They have formulated theories as to the components of these systems and relationships of these components to each other and to the whole.

Man has also constructed systems in an attempt to order the components of a production process, training program, research study, etc. Examples of man-made systems will be presented later in this chapter.

Literature also establishes that in theory systems can be categorized as open and closed. A system is closed if there is no exchange of energies or materials in any form, such as, information, heat, and physical materials between the system and the outside environment.

A closed system may also be referred to as an independent system or a system having a closed boundary.

Authors studied offer no real examples of closed systems which suggest that most systems do not exist independent of some import or export of information, objects, etc. However, for analysis many systems or aspects of these systems are considered as closed systems.

Open systems on the other hand are ones in which there is an exchange of materials, energies or information between the system and its environment and may be called a dependent system. For example, living systems (animal or plantlife) are open, characterized by intake and output of both matter and energy, achievement and maintenance of steady homeo-static states, increasing order over time, and transactional commerce with the environment (2).

Forrester (12:15-18) writing about the importance of structure in a system offers the following four significant hierarchies of structure:

1. Closed Boundary - The behavior models of interest are generated within the boundaries of the defined system. What crosses the boundary is not essential in creating the causes and symptoms of the particular behavior being explored.

2. Feedback Loops - Within the boundary, the system is seen as one composed of feed-back loops. Every decision exists within one or more such loops. The loops interact to produce the system behavior.

3. Levels and Rates - Loops are themselves composed of two classes of variables called levels and rates. Levels are the integrations, accumulations, or states of a system. Rates are the policy statements, activity variables, or flows that depend on the levels and are integrated to produce the levels.

4. Variables - (Goal, Observed Conditions, Discrepancy between Goal and Observed Conditions, and Desired Action) Level variables are generated by the process of integration and have no significant sub-substructure except for the rates flowing into them. Rate variables are the policy statements of the system and do have an identifiable sub-substructure. Within each there is explicitly or implicitly a statement of the goal of that decision making point in the system, the observed condition, a discrepancy based on the relationship of goal and observed condition, and the desired action that results from the discrepancy.

The first hierarchy refers to what has been defined as a closed or independent system. The term closed system should not be confused with a closed-loop system or closed-loop within a system. A closed-loop exists when a portion of an output is fed back to an input point affecting succeeding outputs. The system itself may be a closed loop and/or the system may have several closed loops within it. The closed-loop, consisting of elements and their signal paths, of course, could be thought of as a subsystem.

The nature, kind and intensity of feedback determines to considerable extent the degree of stability of a system. The feedback loop is considered to be positive or negative depending on how it affects the system. This depends on the polarity or algebraic sense of influence around the loop.

Positive feedback has polarity around the loop such that the output fed back to the input causes an increase in output (12:11). Positive feedback can cause a system to become very unstable.

Negative feedback causes the loop to be goal-seeking. A departure from the reference point or steadystate condition produces action tending to return the system toward an equilibrium position that is the goal. This type of system tends to maintain a constant output with varying input (12:11).

Looking further at the categorization of systems, one finds that the differentiation of linear and non-linear systems exists with some authors. Forrester (12:11) states that:

> A system is non-linear if it contains a multiplication or division of variables or if it has a coefficient which is a function of a variable.

According to this definition, the concern for linearity or non-linearity would exist primarily with systems that are represented in a mathematical form and has little application to other systems except in a very theoretical sense.

Levels of Systems

Almost any system that you want to identify could be considered a part of a larger system and is also very likely made up of subparts which are themselves systems. This brings up a problem of terminology in identifying levels of systems.

Silvern handles this problem as follows:

> A SYSTEM may be analyzed into its parts. The major parts of a SYSTEM, also known as the major functions, are called SUBSYSTEMS. A SYSTEM must have two or more SUBSYSTEMS. If it has only one SUBSYSTEM, then that SUBSYSTEM is not a SUBSYSTEM but it is the SYSTEM itself. (36:125).

> The SUPERSYSTEM is a whole in which the major functions at the first level are SYSTEMS. Normally, the SUPERSYSTEM is conceptualized during the process of SYNTHESIS rather than ANALYSIS. It results from an awareness and a discovery that the SYSTEM being studied has some relationship with one or more other SYSTEMS and that this was unknown. Identifying the other SYSTEM or SYSTEMS, relating them and combining them into a new whole, called a SUPERSYSTEM, is the process of SYNTHESIS. (36:126).

> The SUPRASYSTEM is a whole in which the major functions at the first level are SUPERSYSTEMS. As in the case of the SUPERSYSTEM, normally it is the process of SYNTHESIS which produces the SUPRASYSTEM. The SUPRASYSTEM in formal education and training in the United States has not yet been conceptualized as far as is known. (36:126).

Analysis and Synthesis of Systems

A system is identified when a boundary is established within which everything is a part or element of the system. These elements may then be analyzed. Analysis requires the process of identifying, relating, separating, and limiting. When the system being analyzed consists of objects, actions and information, techniques of analysis are applied to the objects, actions, and information.

Silvern (36:i) defines analysis as:

> The process which is the breaking down of a whole into its parts showing the relationship of the parts to each other and to the whole itself. A known or exisiing whole SYSTEM, when broken down into its constituent parts or elements, meanwhile retaining a meaningful relation of the parts to each other and to the greater whole, has been "analyzed.

Analysis is the process by which an existing whole is examined. After the process of analysis it may be desirable to relate the parts identified in a new way. The relating of parts in a new way is the process of synthesis which is used to create a new whole.

Silvern (36:3) defines "synthesis" as:

> . . . the process of combining non-related elements into a meaningful relationship such that the new product is a whole SYSTEM. SYNTHESIS is widely used in engineering as a synonym for invention, innovation, creation, and design. Invention is essentially uncontaminated by an existing system and therefore produces an output as the result of the process of SYNTHESIS.

Factors to Consider in the Development and Testing of a System

The combination of analysis and synthesis can bring about the conceptualization of a new system or modified system. This is the first step in the process of developing a system which is illustrated in Figure 1. Once the new relationships have been conceptualized a prototype must be fabricated. This prototype of the new system then goes through the simulation process in order to see how it will function in the real life operation.

The box labeled "Simulate" in Figure 1 has three parts; "test prototype", "identify performance criteria", and "identify real life environment." The testing of the prototype requires two sources of information; the performance criteria (objectives) of the system, and the real life environment in which the system will operate. From the results of the simulation process the prototype will be debugged and, if necessary, sent back to "fabrication" and then "simulation" again.

When the prototype passes the simulation test, the new operational system is fabricated and maintained. There is a feedback from "maintain" to "fabricate" for keeping the system updated and operational. When the system ceases to be of sufficient value, it should be eliminated as shown by the last box in the model for developing a system.

The maintenance and/or elimination of a system is important. Sometimes systems are used or kept in use more out of tradition rather than because they perform a needed function. Banathy (3:12) explains that:

> A system receives its purpose, its input, its resources, and its constraints from its suprasystem. In order to maintain itself, a system has to produce an output which satisfies the suprasystem.

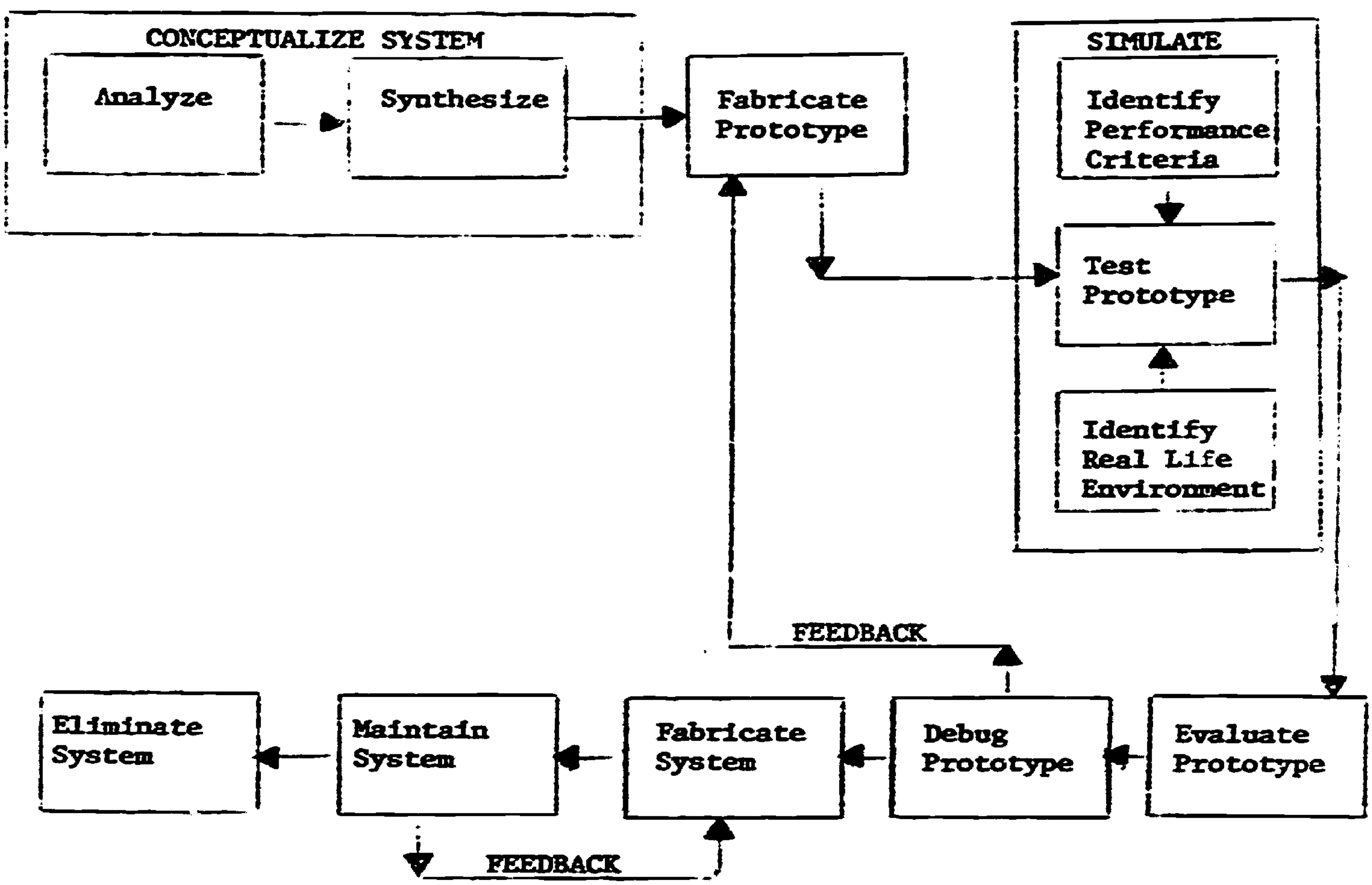

Figure 1. Flow-chart model describing the process of developing a system.

Silvern, L.C. Systems Engineering of Education I: Evolution of Systems Thinking in Education. Los Angeles: Education and Training Consultants Co., 1968, p. 113.

The key criterion for evaluating a system as suggested by Banathy is (3:13):

> . . . how closely the output of the system satisfies the purpose for which it exists.

Part II

What is Modeling?

Defining the Term "Model"

The term "model" is as widely used as the term "system" and more recently the two have been used in conjunction. However, the term "model" is probably not as frequently misinterpreted or used without a reasonable understanding of its meaning as the term "system." Focusing first on the term "model", Silvern(36:27) writes:

> . . . a model is defined as a conceptualization in the form of an equation, a physical device, a narrative or graphic analog representing a real-life situation. Consequently, the ideal is always a concept of real-life either as it is or as it should be, and the model has a degree of fidelity appropriate to the purpose for which it is created.

Ryan's definition of a model simply states that it is an abstraction of some aspect of the real world in an attempt to represent reality (31:27):

> A model is simply an abstraction of the real world in an attempt to represent reality. To build a model, one simply selects those elements from the system under analysis which one deems as being relevant to the problem. Very seldom, if ever, would such a model contain all the elements of the system being modeled. Complex models used with electronic computers may represent several aspects of the real world situation but to represent all aspects of most systems would be a prohibitive task.

Wallhaus (42:125-126) defines models in much the same way as Ryan and classifies them as follows:

1. Structural models, limited to depicting the elements of the system and the relationships (eg. graphical representation).
2. Functional models.
3. An Iconic model, 'looks like the object it represents.'
4. Analogue model, substitutes one property for another.

From these definitions it can be concluded that models are simply physical or abstract representations of some real object, situation, or activity, etc. Further, all models whether physical or abstract can be classified as structural, functional, iconic, or analogue. In addition, abstract models may represent the real-world in mathetmatical, graphic, or narrative form or any combination of these.

<u>Modeling A System</u>

To begin modeling a system or portion of a system that has been identified, one of the first concerns is to identify the purpose of the model -- what aspect of the real system is to be modeled. Wallhaus (42:128) says that:

> Since a model is a representation of a set of entities and the relationships between them it is necessary to define what set of components is to be included in a model.

Again, Wallhaus (42:127) states that:

> In order to properly design a model it is necessary to identify its purpose. Models are generally utilized in one of the following ways.
> (1) they may permit feasible and economical experimentation on real-world systems without incurring the costs, risks, and expenditures of time which may be required in actuality,

(2) they allow us to formulate, communicate, and discuss hypotheses,
(3) they bring about an understanding of the system variables and their relationships,
(4) they make it possible to forecast and project for planning and decision making,
(5) they allow control of the time scale. Real-world processes occur over long periods of time. Modeling can allow long time intervals to be collapsed, and
(6) they enable us to control and monitor real-world processes.

Another concern in constructing a model, especially a mathematical model, is how to represent or quantify and relate the variables. The data to feed the model is very important. For the model to operate properly the data must be of sufficient type, quantity and quality. Concerning this Kilbridge, et al, (22) points out that:

> . . . models without data are sterile. What is needed is not merely more data but the right data in the right form. To collect or record data meaningfully requires at least a working hypothesis as to how it will be used; without this, there is no rationale for deciding what data to collect, no principle for ordering the data, once gathered. To be useful, data must be kept over time so that it can be used for trends, time series, and comparisons.

To this Wallhaus (42:129) adds this word of caution:

> The model cannot be data driven, that is, entirely influenced by what data are available; but it is unrealistic to construct a model and then hope that the necessary data can be obtained.

Once the model is developed, the success or validation of a model must be in terms of the original purpose of the model. McKenney (28) states that:

> The criteria for success is: Does the model fulfill its purpose? . . . . The issue of "is the model true or not" may be dormant since the important question is: Will it allow reasonable estimates of an anticipatory nature. . . . Whether a model has predicted or not is often a function of what the prediction is to be used for.

Concerning validation, Wallhaus (12:136) concludes that:

> In summary, validation attempts to prove that the model is a reasonably true representation of reality within the context of its purpose. While a number of techniques for accomplishing this verification have been identified. . ., the state of the art is something less than satisfying.

Simulation is a means of validating a model. The Webster's Collegiate Dictionary has defined simulation as: "to assume the appearance of without reality."

A simulator would be a device and may be a model but simulation is a process, therefore, it should not be confused with the model itself.

Silvern (36:121-122) points out that processing data through a model using simulation can serve two different functions. First the model can be tested and debugged by using valid data. Also, a model that has been validated to represent real-life can be used to test new ideas or experimental data.

Some Advantages and Disadvantages of Models

Assuming that the model is a valid representation of some aspect(s) of the real world system, the question may be asked: What is the real utility of the model or the process of modeling? This would, of course, depend on the nature and use of the system being modeled. In general, Kraft and Lotta (23:28) cover not only the main advantages but also some principle disadvantages of using models as listed below. The following are the main advantages of using models in systems analysis:

1. Models provide a simplified abstraction of a complex real world problem.

2. Models provide a frame of reference for consideration of the problem.

3. Models sometimes suggest information gaps which before were not immediately apparent.

4. Models provide a "handle" to evaluate and study complex problems.

5. The construction or attempt to construct a model forces one to truly analyze as many of the real world attributes as possible. Sometimes this very process may provide insight which was otherwise camouflaged or unnoticed.

6. Models provide something which can be manipulated.

7. Models often provide the least expensive way to accomplish objectives.

Some limitations or disadvantages of using models, to mention a few, would be as follows:

1. Models are subject to the usual dangers encountered in dealing with abstractions. For example, the model may be greatly oversimplified and/or not a valid model of the desired object system.

2. The symbolic language used to represent a model may not lend itself to being stretched to encompass the model.

3. Some people have a tendency to become "hung-up" or infatuated with a model; and, as a result, their effectiveness in offering a solution to the problem becomes very limited.

Part III

Factors to Consider When Developing Systems Models for Management

The previous two parts of this chapter have attempted to define the common use of the terms "system" and "model". This part deals with considerations important to the manager when considering the use of systems models to organize and control various activities or functions.

Discussing management George (13:4) points out that:

> Every activity which we undertake involves an element that brings coordination or cohesiveness to the activity. Without this cohesiveness our acts would be ineffective stumbling, perhaps random and unproductive. This element that infuses plan and objective as well as cohesion to activities may be called management.

According to this definition, management ranges from coordinating very simple to very complex activities. This coordination may include receiving, sorting, translating, and directing information. Very simple management would be a low level of processing information and handling information, and there may be very little information involved. The more complex and the greater the number of activities that are involved under one manager, the more complex the management will be.

George (13:4) sums up a concise definition of management as follows:

> Management consists of getting thinss done through others; a manager is one who accomplishes objectives by directing the efforts of others.

Some management may take a great deal of technical knowledge, perception, understanding of world markets, understanding of finances, supply and demand, etc. Other management will be limited to a very narrow technical field or very simplistic types of operation. Since management is getting things done through others, it can be concluded that the development of systems models for use by managers irrespective of the management activity must reflect a concern for the capabilities of the persons involved with the system.

George (13:15) goes on to state that the total job of a manager is to:

> . . . create an environment conducive to the performance of acts of other individuals. (1) to achieve a collective goal (commonly called the firm's goal), and (2) to achieve one or more of the goals of the participating individuals.

Due to the complexity of modern day business, industry, schools, government, and other organizations, the systems approach to management has gained a good deal of attention in recent years. Banathy (4:13) offers a description of the systems approach to management when he states:

> The system approach appears to be the application of the systems view, or systems thinking, to human endeavors.

George (13:27) similarly writes:

> The systems approach is one in which the things to be managed and the tasks of management are viewed as a unit - as a set of elements so interrelated that they form an organic whole.

It should be noted that George clearly points out that the things to be managed and the tasks to be managed must be considered as a unit to identify the boundary of the system to be modeled.

Not only does the systems approach to management include the identifying and relating parts within the whole system, it is also concerned with the larger system, "supersystem" which indicates that management systems are open systems. Notice also that George and McGregor refer to an organic system. McGregor (26:40) states that:

> An industrial organization is an organic system. It is adaptive in the sense that it changes its nature as a result of changes and the external system around it.

McGregor (26:41) also emphasizes the human aspect of management and refers to the industrial organization as a socio-technical system. He explains this term as follows:

> . . . an industrial organization is a socio-technical system. It is not a mere assembly of buildings, manpower, money, machines and processes. The system consists in the organization of people around various technologies. This means among other things that human relations are not an optional feature of an organization - they are a built-in property. The system exists by virtue of the motivated behavior of people. Their relationships and behavior determine the inputs, the transformations and the outputs of the system.

From the previous discussion one could conclude that the systems approach to management involves communication and control of both equipment and activity by people. The complexity of such a system has brought about the use of modeling as a tool to identify, study and "manage" such systems. The complexity of the management systems and the use of the modeling technique is pointed out in the following rather lengthy quotation from Albers (1). He touches on several important factors that were identified in previous sections of this chapter as important to consider when identifying a system and developing a model of the same.

In his discussion on applications of systems concept to organization and management theory Albers states that:

> Business and other organization systems are controlled through decisions and information. The management process corresponds to the control process portrayed in the cybernetics model. (1 :78)
>
> An important advantage of models is that they can be used to gain better insights about the system being represented. Models can provide a basis for prediction if they adequately express the nature of the real system.
>
> Another advantage of models is that they can often be used to represent more than one kind of system. This idea was expressed on a grand scale by Professor Norbert Wiener's concept of cybernetics.* The basic elements of the cybernetics model correspond to the attributes of many kinds of systems, in particular systems that are exceedingly complex. (1:75)

*The term "cybernetics" introduced above in relation to systems and models has become a fairly common term in several disciplines. Because of the frequent use of the term related to a variety of settings, the origin of the term may help clarify its basic meaning. In 1948 Wiener wrote (43:11):

> . . . as far back as four years ago, the group of scientists about Dr. Rosenblueth and myself had already become aware of the essential unity of the set of problems centering about communication,

> Cybernetics is concerned with the communication and control problems necessary to achieve some purpose. Control is partly a problem of feedback which provides self-regulation through a comparison of the system's output with a predetermined standard. The input into the system may be modified if there is too much variation from the output norm.
>
> Control in the cybernetic model may also be expressed in terms of the theory of information. A system can be conceived as a mechanism for handling information (1:75).

With the development of electronic computers and large data banks of information, more complex management systems can be modeled and studied. These computers can process data for models representing several aspects of a complex system.

In talking about electronic computers and the systems concept Albers (1:76) states that:

> Elaborate models that simulate environmental and organizational realities can be used to test alternative planning strategies. The large variety of planning problems can be solved through resource allocation, inventory, queuing, and other kinds of mathematical models. Analogue models such as PERT have played an important part in planning and controlling highly complex projects. Business game models have been used extensively for purposes of executive development with a significant amount of success.

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*control, and statistical mechanics, whether in the machine or in living tissue. On the other hand we were seriously hampered by the lack of unity of the literature concerning these problems, and by the absence of any common terminology, or even of a single name for the field. After much consideration we have come to the conclusion that all the existing terminology has too heavy a bias to one side or another to serve the future development of the field as well as it should; and as happens so often to scientists, we have been forced to coin at least one artificial neo-Greek expression to fill the gap. We have decided to call the entire field of control and communication theory, whether in the machine or in the animal by the name Cybernetics, which we form from the Greek χυβερνήτης or "steersman."

Part IV

Example Systems Model Application

The application of the systems approach to management has yielded many example models from business, education, the military, etc. In reviewing specific models there is little to be learned since each was developed for a specific purpose and situation. Consequently, the purpose of this section is not to compare and contrast various systems models, but rather to simply show selected examples of systems model applications.

To begin with a very simplistic model would be the mathematical equation:

$$V = LWH$$

where

V = volume
L = length
W = width
H = height

This is a mathematical model representing the relationships of the volume of a rectangular container to the dimensions of the rectangular container. This model serves very satisfactorily when the dimensions are known and when it is desired to find the volume. Also, the equation can be transposed so that if volume is known and two dimensions are known, the third dimension can be found. Within its limited purpose this mathematical model is a very accurate representation of the system (a rectangular container). However, the model cannot be used to determine ratios of the sides to each other or to predict any other characteristics of the container as a system.

If the length needs to be twice the width and the height one-half of the width, then the equation must be modified to accurately represent the container.

The equation would then be:

$$V = H \times 2H \times 4H$$

where

V = volume $2H$ = width
H = height $4H$ = length

Further simpligying the mathematical model it becomes:

$$V = 8H^3$$

where

V = volume
H = height of the container

This mathematical model represents the volume of a rectangular container in terms of the height of a container having a definite relationship in the size of the sides. This equation, however, still does not represent the container in physical characteristics - size, shape, color, etc, or other aspects.

The mathematical model is also used to represent aspects of very complex systems. Management as previously described and defined in this report is much more complex than the relationships of volume to the dimensions of a rectangular container. Since some of us seem to think best or understand best when concepts are expressed quantatively in a model form, a management model can be expressed in mathematical form. As cited by George (13): this can be done:

> if we agree that managing consists of physical and conceptual acts which effect or yield a physical and conceptual environment; and if we further agree that these acts and these environments are collectively a function of group (corporate) and individual objectives, then, we could express managing as:

$$Mg = [(Ac + Ap) \longrightarrow (Ec + Ep)]\ f\ (Oi, Og)$$

where

Ac = conceptual acts
Ap = physical acts
Ec = conceptual environment
Ep = physical environment
Oi = individual objectives
Og = group (corporate) objectives

This mathematical representation of management relates the factors identified by George to each other and to the overall system of management. This mathematical equation, however, cannot be used in the same sense that the previous equation yielding the volume of the container. The reason being that the variables identified by George for the management model are not defined quantatively so that specific values can be used but rather this model is useful in presenting conceptual relationships. To assist the reader with the conceptual relationship of the elements making up the management model, George goes on to express the management model in the flow-chart model as shown in Figure 2.

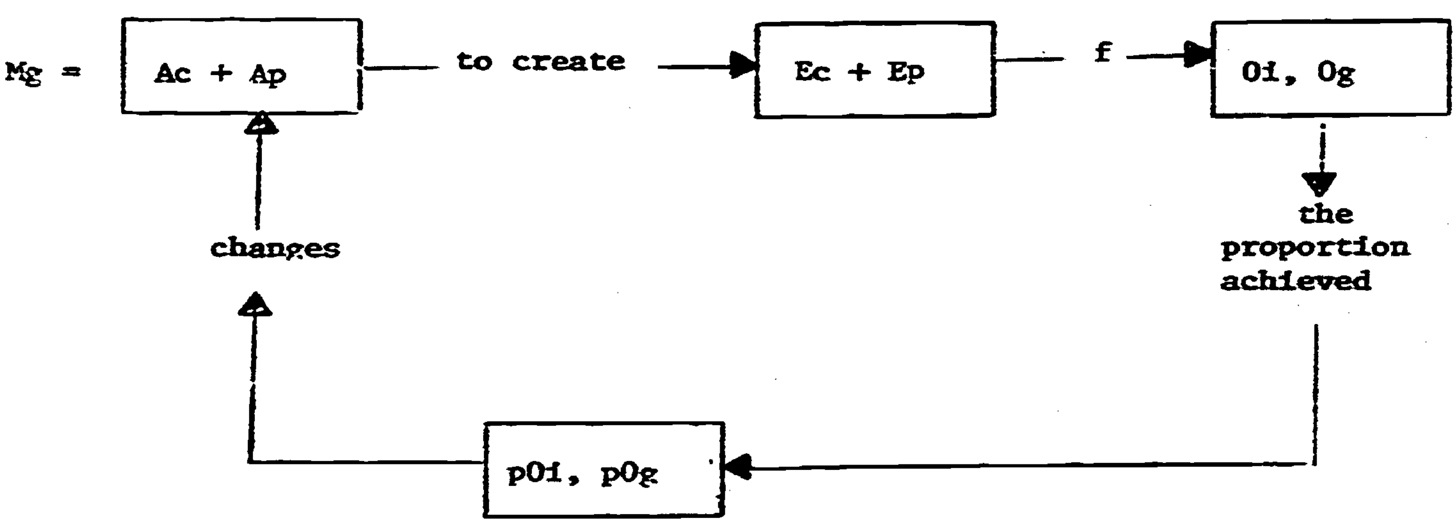


Figure 2. Management represented by simple flow-chart model.

This model points out some of the basic factors that go into the management model and their relationship. This model does not, however, show administration channels of authority or lines of responsibility time, resources, etc. Recall that when a system is modeled a specific aspect of the system is normally identified as a point of concern and that aspect only is modeled. The success of the model then depends on the degree that the model represents the aspect of the system being modeled. In this case, the concern was to relate the general factors of which management consists.

Figure 3 shows an example of a PERT Network utilized by the National Aeronautics and Space Administration to model those activities necessary to complete layout drawings for a specific project.

The term PERT refers to Program Evaluation and Review Technique -- which is essentially a management technique employing a graphic model as a means of relating activities. PERT, as most often described has been widely utilized in government, business and industry, and educational settings.

Basically, the technique consists of a series of events represented by circles which are joined by lines representing activities. The completion of a given activity represented by a line will result in the following event. Activities consume time and resources (man/hours and money) while events on the other hand consume no time or resources.

Use of PERT as a management technique necessitates the establishment of clear objectives which in time can be translated into events and major events (often called major milestone).

The technique utilized to its fullest allows the manager to assign a man/hour or man/day value to each activity through the use of the following symbols: a = optimistic time; b = pessimistic time; m = most likely time.

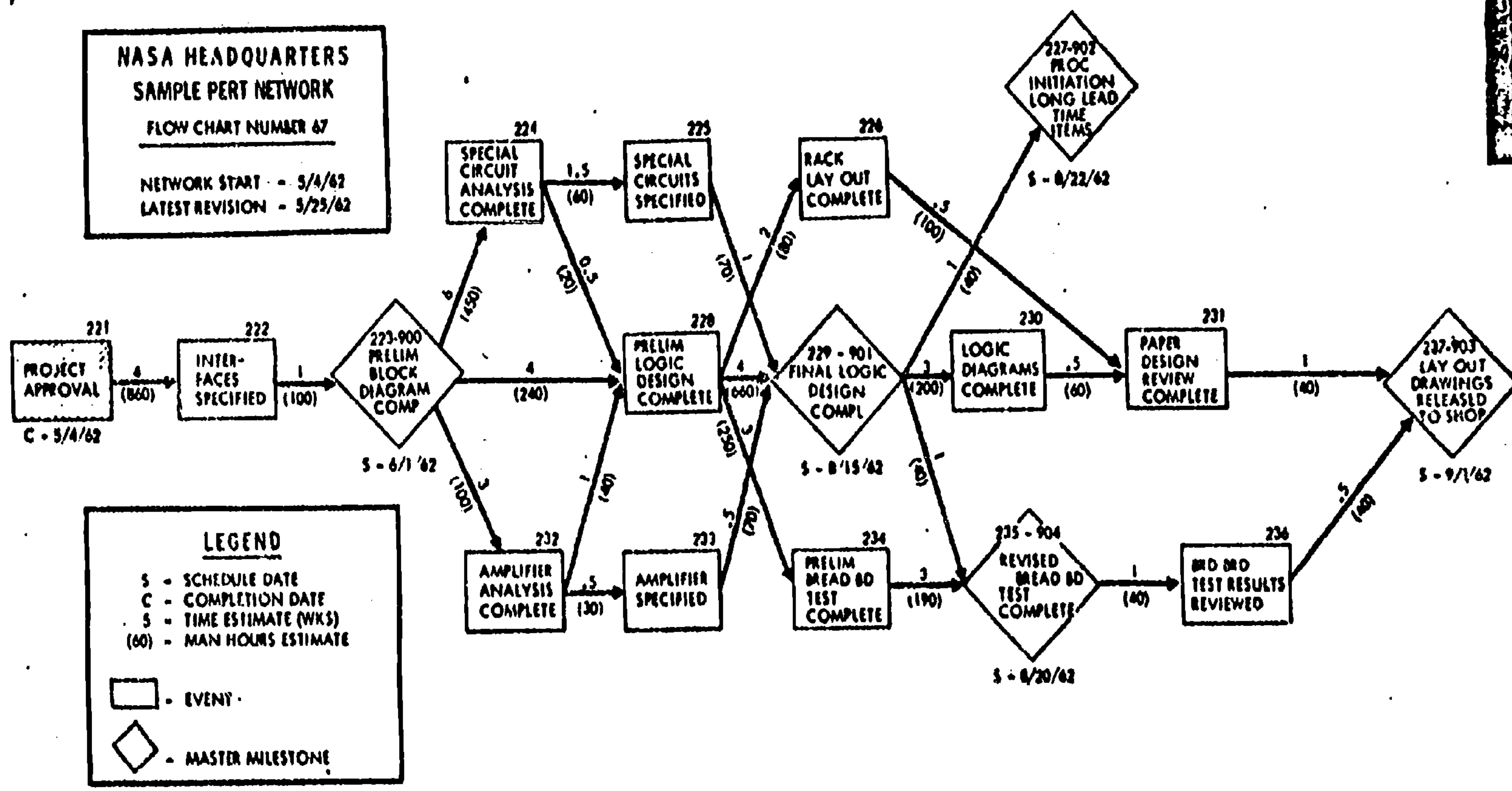


Figure 3. **Sample PERT Network As Used by NASA**

Using the formula:

$$te \text{ (average time)} = \frac{a + 4m + b}{6}$$

The manager can calculate the average time needed to complete an activity. Other formulas are then used to calculate the sequence of activites that will consume the greatest amount of time and thus determine the critical path. In general, because this path will consume the most time in man hours it will also have more important cost implications.

Having this information the manager can choose to alter various activites, assign more staff time to some, alter completion dates, etc., whatever he considers most expedient in achieving the objectives.

More recently the computer has been used as a tool to assist managers in completing the calculations necessary to effectively utilize the PERT technique on more complex projects.

As the systems get very large the PERT charts get large and complex. With the aid of the electronic computer a periodic evaluation of the entire project can be made very quickly. The computer can also be programmed to determine how resources should be shifted in order to keep activities in the critical paths on schedule. Figure 4 is an example of a computer print-out for the NASA PERT chart with some of the specific information that might be shown. By having a number of variables representing time and activity status fed into the computer, frequent computer evaluations and print-outs can be made to determine the overall status of the project.

NASA PERT
B

PAGE 1

DATE OF THIS REPORT IS 05-25-62

RUN 1 ENDING EVENT
BY SUCCESSOR EVENT NUMBER AND PREDECESSOR EVENT NUMBER
NETWORK NP PERT SAMPLE NETWORK FIRST RUN 05-09-62

EVENT PRE.	SUC.	ACTIVITY DESCRIPTION	ACTIV. TIME	DATE EXPECTED	DATE ALLOWED	DATE SCHD/ACT.	SLACK	RE-SOURCE	TIME REM.	ORG
0000-001	0000-221	PROJECT APPROVAL			04-14-62	A05-04-62	- 2.9			HOUS
0000-221	0000-222	DEFINING INTERFACES	4.0	06-01-62	05-12-62		- 2.9	800	1.0	PROJ
0000-322	0000-223	PREPARING PRELIMINARY BLOCK DIAGRAM	1.0	06-08-62	05-19-62		- 2.9	100	2.0	ELEC
0000-900	0000-224	PREPARING SPECIAL CIRCUIT ANALYSIS	6.0	07-20-62	06-30-62		- 2.9	150	8.0	ELEC
0000-224	0000-225	DESIGN SPECI'' CIRCUITS	1.5	07-31-62	07-25-62		- .9	60	9.5	ELEC
0000-228	0000-226	PREPARE RACK LAY OUT	2.0	08-07-62	08-22-62		2.1	80	10.5	ELEC
0000-701	0000-227	PREPARE LONG LEAD PURCHASE REQUESTS	1.0	08-28-62	08-22-62		- .8	40	13.5	PROC
0000-224	0000-228	INCORP SPLC CIRC ANAL IN PRELIM LOGIC DES	.5	07-24-62	07-04-62		- 3.9	20	8.5	ELEC
0000-232	0000-228	INCORP AMPLIFIER ANAL IN PRELIM LOGIC DES	1.0	07-06-62	07-04-62		- .4	40	6.0	ELEC
0000-400	0000-228	PREPARE PRELIMINARY LOGIC DESIGN	4.0	07-06-62	07-04-62		- .4	240	6.0	ELEC
0000-225	0000-229	INCORP SPLC CIRC DES IN FINAL LOGIC DES	1.0	08-07-62	08-01-62		- .9	70	10.5	ELEC
0000-220	0000-229	PREPARE FINAL LOGIC DESIGN	4.0	08-21-62	08-01-62		- 2.9	360	12.5	ELEC
0000-233	0000-229	INCORP AMPLIFIER DES IN FINAL LOGIC DES	.5	07-04-62	08-01-62		3.6	70	6.0	ELEC
0000-901	0000-230	PREPARE LOGIC DIAGRAMS	3.0	09-11-62	08-22-62		- 2.9	205	15.5	ELEC
0000-226	0000-231	REVIEW RACK LAY OUT	.5	08-10-62	08-25-62		2.1	100	11.0	ELEC
0000-230	0000-231	DESIGN REVIEW OF LOGIC DIAGRAMS	.5	09-14-62	08-25-62		- 2.9	60	16.0	ELEC
0000-400	0000-232	PREPARE AMPLIFIER ANALYSIS	3.0	06-29-62	06-27-62		- .4	100	5.0	ELEC
0000-232	0000-233	DESIGN AMPLIFIER	.5	07-03-62	07-28-62		3.6	30	5.5	ELEC
0000-220	0000-234	PRELIM BREADBOARD TESTING	3.0	08-14-62	08-01-62		- 1.9	250	11.5	ELEC
0000-234	0000-235	REVISED BREADBOARD TESTING	3.0	09-04-62	08-22-62		- 1.9	130	14.5	ELEC
0000-901	0000-235	INCORP FINAL LOGIC DESIGN IN BREADBOARD	1.0	08-28-62	08-22-62		- .9	40	13.5	ELEC
0000-404	0000-236	REVIEW BREADBOARD TEST RESULT	1.0	09-11-62	08-29-62		- 1.9	40	15.5	ELEC
0000-231	0000-237	INCORP DESIGN REVISIONS IN LAY OUT DWGS	1.0	09-21-62	09-01-62		- 2.9	40	17.0	ELEC
0000-236	0000-237	INCORP BREADBOARD REVISION IN LAY OUT DWGS	.5	09-14-62	09-01-62		- 1.9	40	16.0	ELEC
0000-223	0000-900	PRELIMINARY BLOCK DIAGRAMS COMPLETE	.0	06-08-62	05-19-62	06-01-62	- 2.9	0	2.0	ELEC
0000-229	0000-901	FINAL LOGIC DESIGN COMPLETE	.0	08-21-62	08-01-62	08-15-62	- 2.9	0	12.5	ELEC
0000-227	0000-902	PROCUR INITIATION - LONG LEAD ITEMS	.0	08-28-62	08-22-62	08-22-62	- .8	0	13.5	PROC
0000-237	0000-903	LAY OUT DRAWINGS RELEASED TO SHOP	.0	09-21-62	09-01-62	09-01-62	- 2.9	0	17.0	ELEC
0000-235	0000-904	REVISED BREADBOARD TEST COMPLETE	.0	09-04-62	08-22-62	08-20-62	- 1.9	0	14.5	ELEC

Figure 4. Sample of Computer Print-Out for NASA PERT Network

NASA PERT AND COMPANION

A PERT chart, then, functions effectively as a communication tool, as a logical expression of a project plan, and as a basis for project control. These functions yield the following advantages:

1. Planning (predict)
2. Reporting status
3. Delegate responsibility
4. Reduced complexity of large systems
5. Breaks down the uncertainty areas into smaller components

Basically, then, the PERT network is used to represent time, cost, and resource allocation. Usually, this method of modeling does not clearly represent such aspects of the system as critical decision points, alternative courses of action, and feedback for evaluation and redirecting of efforts, administrative relationships, material flow, etc. in the same manner that other types of flow-chart models can do.

Another modeling technique to represent some aspect of the system is the flow-chart model using the Logos language. The term Logos is derived from the expression "language for optimizing graphically ordered systems." (44:18). (For further explanation, see 44). Briefly, the Logos language is midway between a narrative description and a strictly symbolic representation of an idea. Basic applications of Logos rely on alpha characters forming groups of words or narratives which combined with Logos symbols result in a flow-chart as shown in Figure 5. The narrative expressions can be replaced by mathematical equations which are combined with the Logos symbols to yield a flow-chart as shown in Figure 6.

The Logos language can be used to communicate effectively with readers preferring words and also with others who prefer the more unambiguous terminology of mathematics. Figure 7 is an example of a flow-chart model

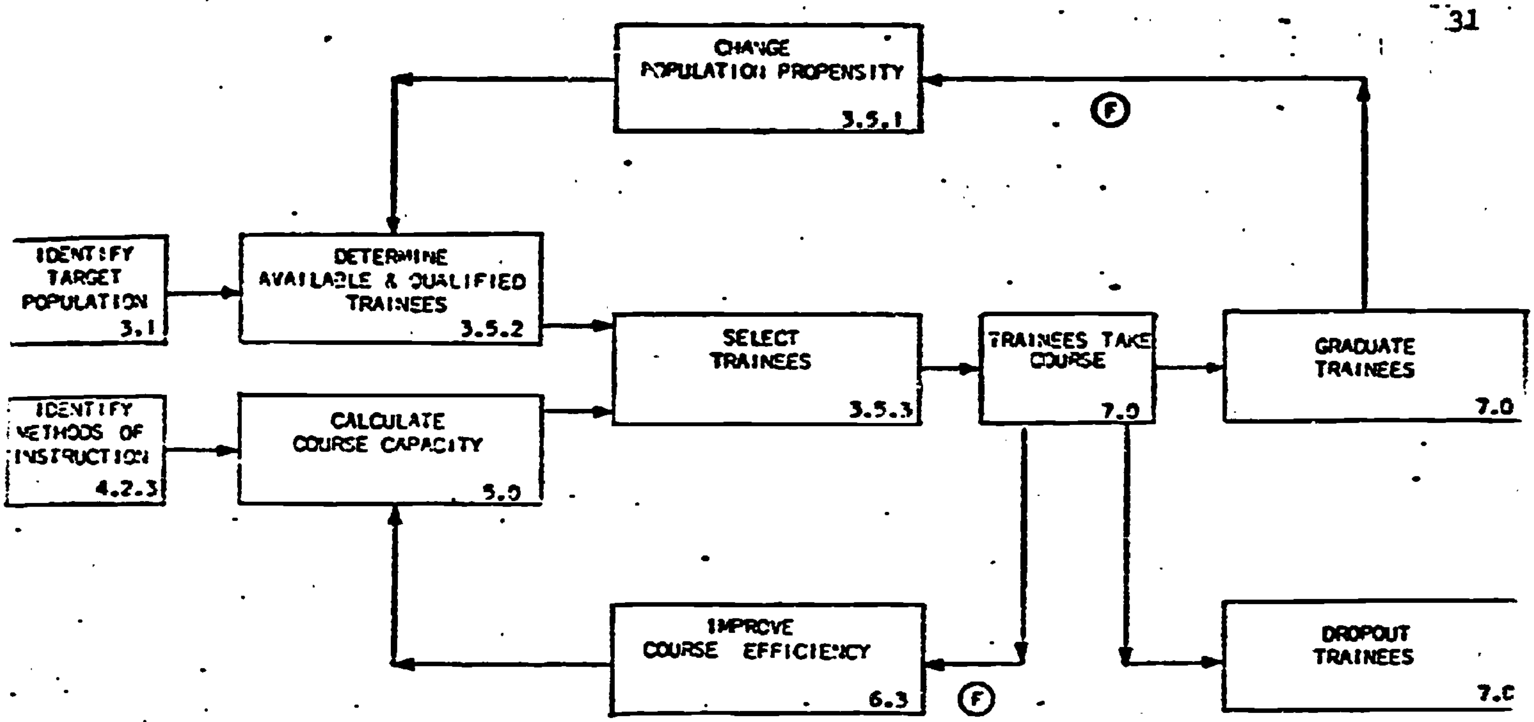


Figure 5. Flowchart Model of Automotive Mechanics Training System in Operation

Brooks, Carl N. "Training System Evaluation Using Mathematical Models," Educational Technology, June, 1969.

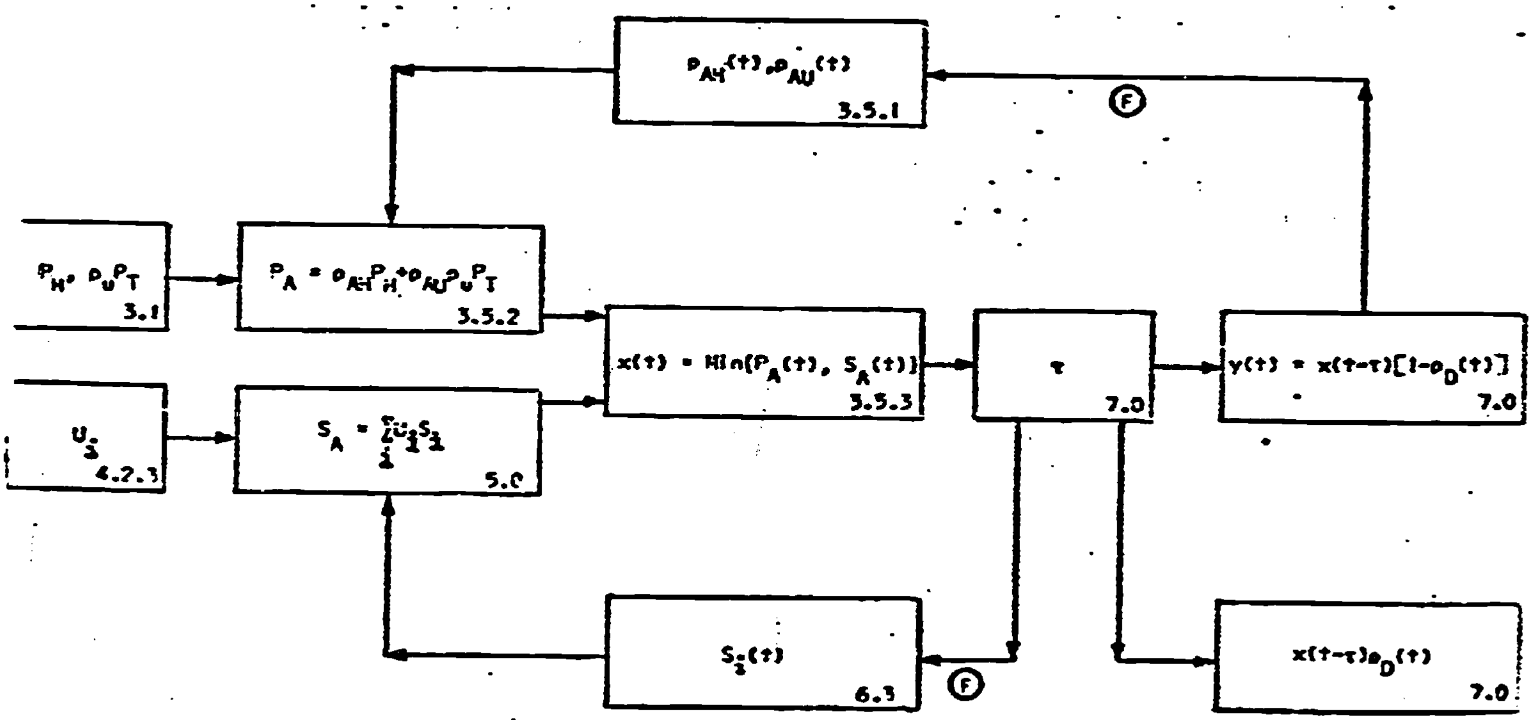


Figure 6. Mathematical Model of Automotive Mechanics Training System in Operation

Brooks, Carl N. "Training System Evaluation Using Mathematical Models," Educational Technology, June, 1969.

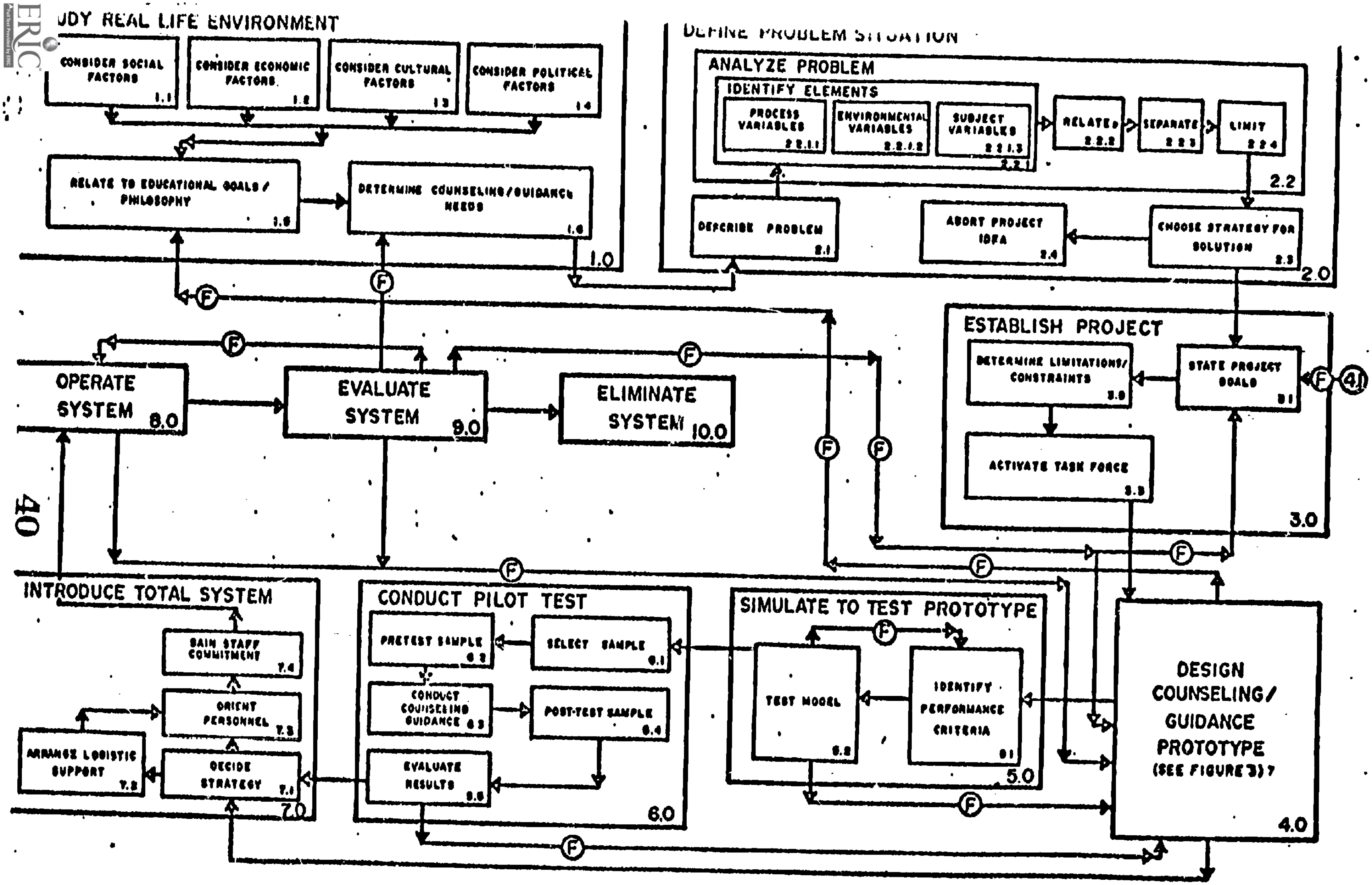


Figure 7   Counseling and Guidance Program Development System Model

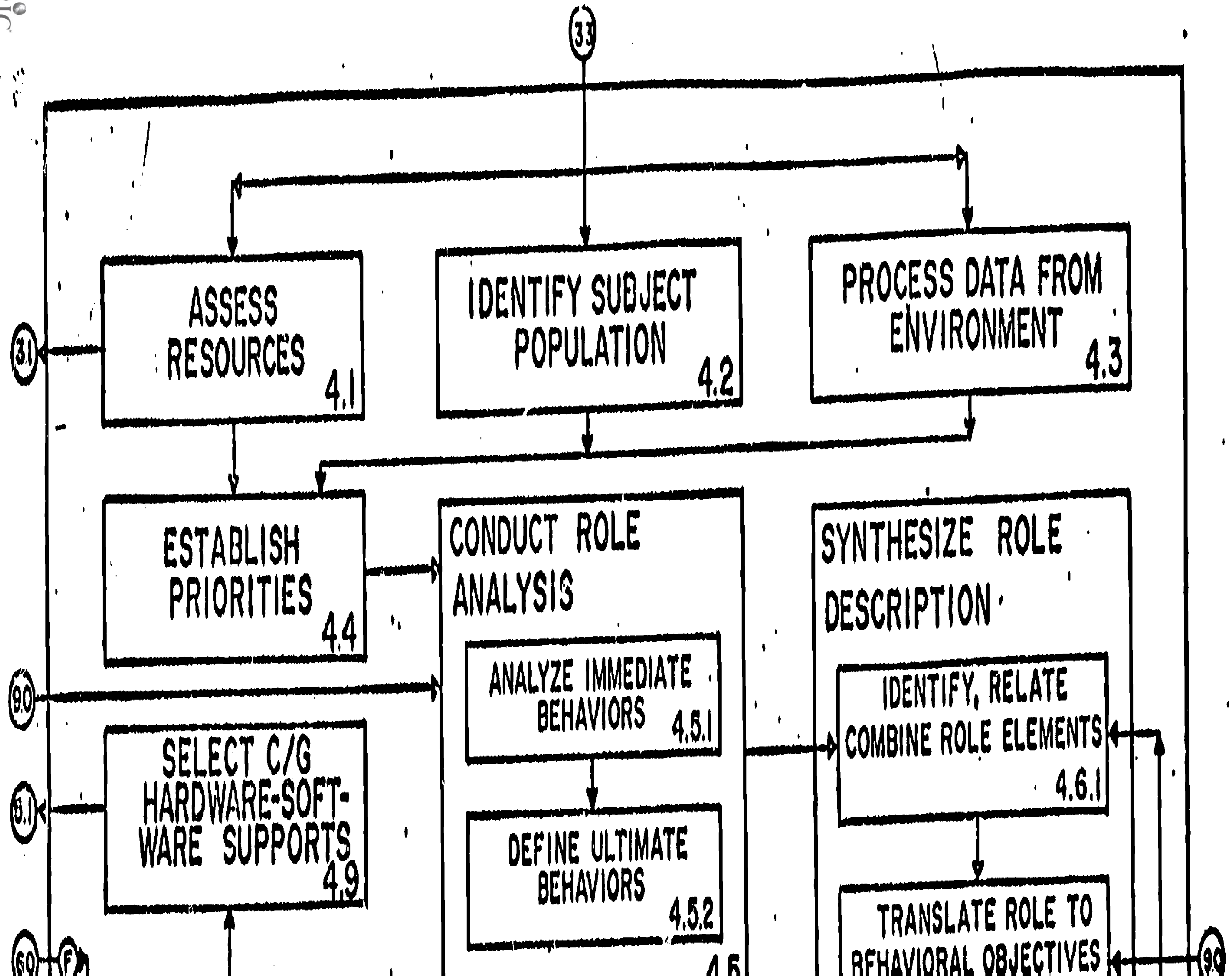
Hosford, R. E. and Ryan, T. A. "Application of Systems Design In the Development of Counseling and Guidance Programs," Unpublished mimeographed report) as part of readings for American Educational Research Association 1971 Presession Systems Research for Counseling and Educational Environments.

using the Logos language as developed by Hosford and Ryan (20) representing the development of counseling and guidance programs.

The boxes represent functions which in this case have a narrative description and also are coded with a numeric code. This model has several levels of specificity because the major boxes themselves have more detail represented by boxes inside them. The detail of a model can be increased by showing a breakdown of functions within the more major functions. Also, note that as the detail is increased the point numeric code also increases in digits.

Figure 8 shows additional detail of major section 4.0 in Figure 7. The signal path represented by a straight solid line having an arrowhead indicates the direction, origin and destination of information or material flow. It is not within the scope of this document to give all the detail of the language, but with this basic knowledge of the system it can be understood that this modeling technique lends itself to relating parts to each other and to the whole. As you examine the system model, you will notice that many of the boxes act as decision points in which a decision is made determining which alternative path the information or material will flow. The multiple arrows leaving a box indicate alternative courses of action depending on current circumstances and evaluation. Also, some of the signal paths are labeled with an "F" which indicate feedback. Feedback is based on some type of evaluation and information that goes back to modifying subsequent outputs from the box to which the feedback goes.

Briefly then, the flow-chart modeling technique using the Logos language readily lends itself to relating parts of a system to each other and to the system as a whole. This modeling technique makes it easy to increase


3.3
ASSESS RESOURCES 4.1
IDENTIFY SUBJECT POPULATION 4.2
PROCESS DATA FROM ENVIRONMENT 4.3
3.1
ESTABLISH PRIORITIES 4.4
CONDUCT ROLE ANALYSIS
ANALYZE IMMEDIATE BEHAVIORS 4.5.1
DEFINE ULTIMATE BEHAVIORS 4.5.2
SYNTHESIZE ROLE DESCRIPTION
IDENTIFY, RELATE COMBINE ROLE ELEMENTS 4.6.1
TRANSLATE ROLE TO BEHAVIORAL OBJECTIVES
9.0
SELECT C/G HARDWARE-SOFTWARE SUPPORTS 4.9
8.1
6.0
F

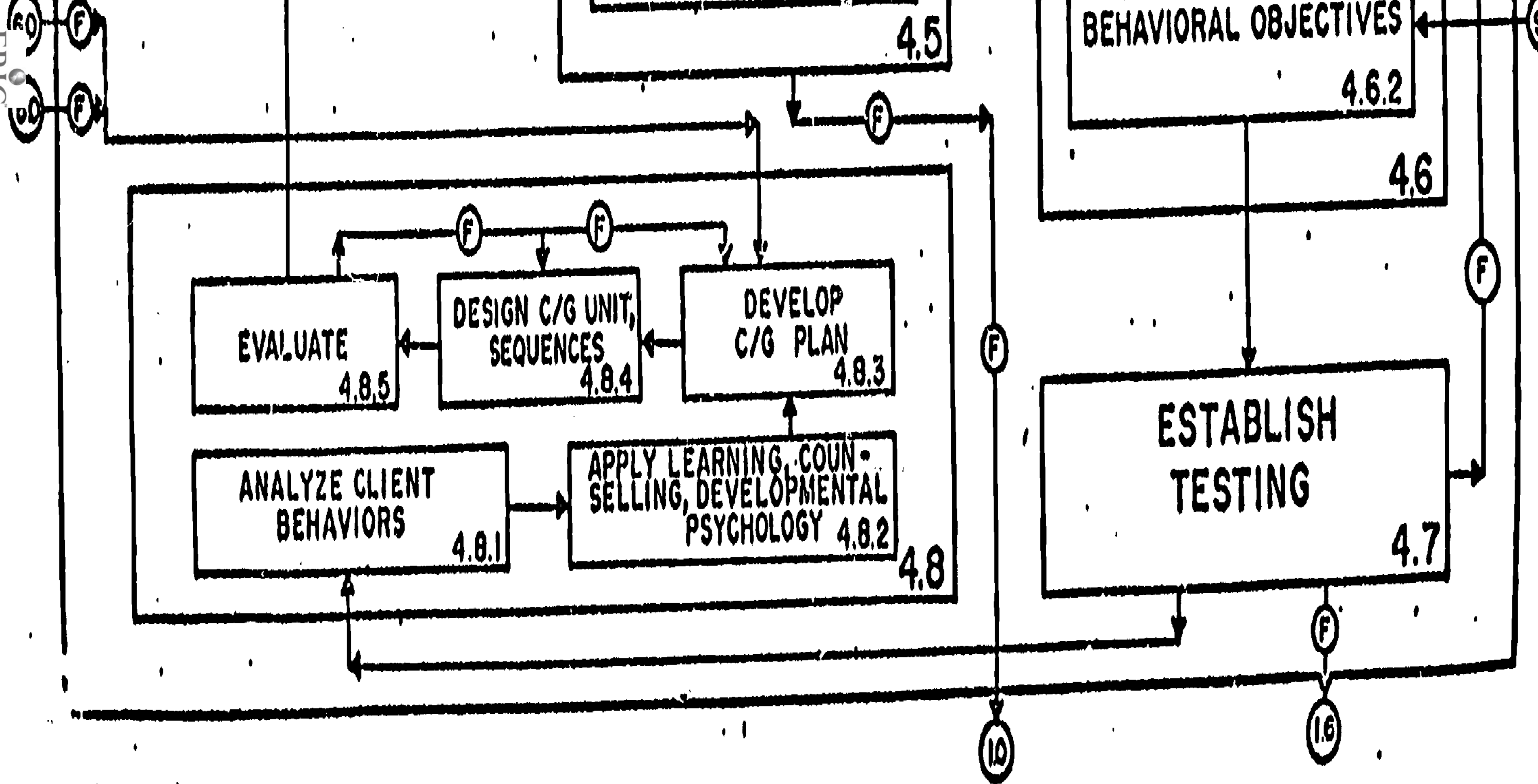


Figure 8. Design Counseling/Guidance Program Prototype

Hosford, R. E. and Ryan, T. A. "Application of Systems Design In the Development of Counseling and Guidance Programs," Unpublished mimeographed report) as part of readings for American Educational Research Association 1971 Presession Systems Research for Counseling and Educational Environments.

the level of specificity in the model by further identifying functions within the box to almost endless degree of specificity. Decision points are clearly shown along with alternative courses of action. This type of flow-chart model, however, does not lend itself as readily to the assignment of time, cost, and other resource allocation to individual components.

CHAPTER III

FINDINGS AND IMPLICATIONS

Literature reviewed in the preceding chapter of this report offered definitions of the term "system" and "model", as well as considerations important to the utilization of systems models as a management tool.

Summary of Findings

Based on the review of literature the following list of factors to consider when developing systems models has been prepared.

1. The use of systems can help accomplish the following tasks:
   a. Optimize outcomes
   b. Organize goals and objectives
   c. Identify missions and purposes
2. Some steps to be used in modeling a situation are as follows:
   a. Look at the situation
   b. Describe the problem in behavioral terms
   c. Identify terminal goals
   d. Determine what the constraints are
   e. Identify subgoals
   f. Establish priorities
   g. Insure that all activities lead to the terminal goal
3. Four steps in using the systems technique include the following:
   a. Analyze - separate and relate component parts
   b. Synthesize - put parts together, related in a new way to make a new whole

c. Model - represent the real world in graphic, narrative or mathematical, etc. form

d. Simulate - test or use under conditions similar to the real world

4. Four principles important with use of systems techniques are included here in no particular order or priority:

   a. System wholeness - the more wholeness a system has, the more efficient the system will be

   b. Systematization - the more strength there is in the relationship of elements, the more efficient the system will be

   c. Compatibility to environment

   d. Optimization - purpose of the system agreed to the objectives

5. The systems principal is not experimental; it is a method of selecting alternatives. Goals are very broad. From goals, one needs to relate, to restate, clarify, quantify, and define the goals to produce objectives. From goals, one goes to objectives, to output indicators, to criteria. As an example, a model called SPTO (Simulation, Population, Treatment, and Outcomes) identifies what is to be done, who is to do it, under what conditions, and what criteria will be used to measure.

6. The steps to be followed in modeling are as follows:

   a. Identify the problem in five words or less

   b. State the general goals

   c. Write the ideal objectives for performance, conditions, and standards

   d. Write the operational objectives for performance, conditions, and standards

   e. Check the quality of the objectives

Implications

The following findings and implications for the Illinois Occupational Curriculum Project are based on the previous review of literature and opinions offered by consultants.

1. The development of a model for the Illinois Occupational Curriculum Project should involve the identification of factors relating to the occupational curriculum whether within the institution or outside the institution and, in turn relating these factors to each other and to the curriculum system as a whole.
2. The development of a systems model for occupational curriculum development and evaluation will necessitate that a clear definition of purpose be prepared.
3. The Illinois Occupational Curriculum Project systems model should be developed to include the following characteristics: (1) organized and orderly; (2) comprised of objects, elements, components and relationships, among components and between components and the whole (3) function as a whole by virtue of interdependence of its parts; (4) synthesized in an environment to accomplish progress toward a goal; and (5) possessed of structure, function and development.
4. The Illinois Occupational Curriculum Project systems model should be constructed considering general principles of systems including: (1) The greater the degree of wholeness in the system, the more efficient the system; (2) the greater the degree of systematization, the more efficient the operation of the system; (3) the greater the degree of compatibility between system and environment, the more

effective the system; (4) the greater the degree of congruence between system synthesis and system purpose, the more effective the system.

5. The Illinois Occupational Curriculum Project systems model should consist of sufficient feedback loops for evaluation to monitor the direction of activities or re-evaluate alternatives so that direction may be altered if needed.

6. The Illinois Occupational Curriculum Project systems model should be developed through the process of anasynthesis which is the process of analysis, synthesis, modeling and simulation. Analysis of known systems and elements into their elements and the synthesis of these elements into new relations making new systems.

*7. The Illinois Occupational Curriculum Project systems model must receive its purpose, its inputs, its resources, and constraints from the larger, or supersystem. The real measure of success of the Illinois Occupational Curriculum Project systems model will be measured by the degree to which it satisfies the need existing in the larger system, that being the educational institution utilizing it.

*8. The Illinois Occupational Curriculum Project systems model should be a representation of selected factors affecting occupational curriculum within the real world system. The systems model cannot represent all of the aspects or factors within the real world system but to a reasonable degree it should represent the factors that need to be considered in developing and evaluating occupational curriculum.

*9. The Illinois Occupational Curriculum Project systems model must be designed and developed considering the data that is available and the data that is feasible to obtain. The model cannot be data driven (designed for readily available data) and yet the model cannot be developed demanding data that cannot be obtained.

10. A criterion for evaluating the Illinois Occupational Curriculum Project systems model should be the extent to which it represents the real system and its resultant usefulness to curriculum planners.

11. The Illinois Occupational Curriculum Project systems model will of necessity be complex because occupational education is a socio-technical system including technical information along with the human aspects. The Illinois Occupational Curriculum Project systems model must be developed considering the institution as a system, the subsystems within the institutions in which it will be utilized, and the individuals that will work with the system.

12. After careful identification of the components thought to be important to the system of occupational curriculum development and evaluation and the initial development of a system model for the same, field testing should be employed for the purpose of debugging and validating the Illinois Occupational Curriculum Project systems model.

13. The selection of a modeling technique should be made considering the purpose the model will serve.

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* To identify considerations related to these implications the Illinois Occupational Curriculum Project completed a study of present practices in decision making by curriculum planners in occupational education. (An Investigation of Decision Making Practices in Illinois Junior Colleges with Implications Toward A Systems Approach to Curriculum Development and Evaluating in Occupational Education).

CHAPTER IV

MODELING TECHNIQUE USED BY ILLINOIS OCCUPATIONAL CURRICULUM PROJECT

The previous chapters of this report presented a basic background of systems modeling and considerations important when utilizing systems models for management purpose. From these investigative activities specific findings and implications were drawn for the development of a systems model in occupational education for the Illinois Occupational Curriculum Project. This chapter of the report reviews the selection of the modeling technique and the development of the systems model by the project staff of the Illinois Occupational Curriculum Project.

As a result of investigative activities including: reviewing the literature concerning systems, modeling techniques, application of systems models to management, visiting with personnel in the field having expertise in the systems, and attending a systems modeling training session, it was decided that the flow chart modeling technique using Logos language would be used by the Illinois Occupational Curriculum Project.

Recalling the definition of a systems model, a model is a representation of the real system and the selection of the modeling technique for representing the system depends on the purpose and function of the model and the system it represents. It was felt that the flow chart modeling technique using Logos language combined with narrative guidelines and specific activity instructions would lend itself more readily to utilization by local school administrators.

This technique allows the system to be modeled at a very general level of specificity relating the major components and then expanding with greater specificity within components. As the major components are subdivided into the subsystems it is easy to expand the major components of the model to increasing detail and relating these components to each other and to the system as a whole. Also, using this flow chart modeling technique made it easy to show the relationships of activities, the decision points and the alternatives available at the decision points. The intitial concern of the Illinois Occupational Curriculum Project is more in being able to relate the parts to each other and to the whole showing the activities to be completed, their relative sequence, decision points, and alternatives. The use of the management technique such as PERT may be recommended as a part of implementing the systems model in a local school setting.

The project staff developed a flow chart model as the skeleton for the content of the overall system of occupational curriculum development and evaluation. Identifying the content parts or components of the system served as the focus of two other areas of investigation carried on by the Illinois Occupational Curriculum Project. These investigations are reported in the following project reports. "An Investigation of Curriculum Development and Evaluation Models with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education." Unpublished Illinois Occupational Curriculum Project report, Joliet Junior College, Joliet, Illinois: May, 1971; and, "An Investigation of Decision-Making Practices in Illinois Junior Colleges with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education." Unpublished Illinois Occupational Curriculum Project report, Joliet Junior College, Joliet, Illinois: May, 1971.

These studies served as a basis for identifying and relating the parts to each other and to the whole system. As previously mentioned, the flow chart model began at a low level of specificity showing only a few major components of the system. These components were gradually subdivided increasing the level of specificity of the flow chart model showing more detailed components. (A copy of one of the initial drafts of the Illinois Occupational Curriculum Project flow chart model is contained in Appendix A). The flow chart modeling technique appeared to also lend itself to flexibility of use by administrators. The administrator would be free to select alternatives according to his own situation and, if it was felt necessary, he could even exclude sections of the model.

As this flow chart model became increasingly complex, it appeared that the format most helpful to administrators would be to identify key questions that would be asked at major decision points in the flow chart model. Based on these key questions, procedures and activities were carefully spelled out that would give an administrator assistance in obtaining objective answers to the key question identified. To assist in executing these specific activities sample materials and correspondence were developed to accompany these suggested activities. In using this type of format the administrator has the option of following the materials in a very systematic procedure or if time and manpower does not permit the execution of all suggested activities, the administrator may go to any particular section of the model and obtain assistance in making decisions.

Copies of the guidelines and activities developed by the Illinois Occupational Curriculum Project are available upon request as well as an updated copy of the graphic flow chart model. These documents have not been appended to this report due to their size and developmental state.

BIBLIOGRAPHY

1. Albers, Henry H. "Organizational Systems: The Decisional and Informational Processes," Principles of Management - A Modern Approach. New York: John Wiley & Sons, Inc., 1969.

2. Allport, G. W. "Open System In Personality Theory," Journal of Abnormal and Social Psychology. 1960, 61, 301-311.

3. Arnold, Joseph. Columbus, Ohio: The Center for Vocational-Technical Education, The Ohio State University. Consultation at Joliet Junior College.

4. Banathy, Bela D. "Systems for Education," Instructional Systems. Palo Alto: Fearon Publishers, 1968.

5. Blocker, Clyde E., et al. The Two-Year College: A Social Synthesis. Englewood Cliffs, New Jersey: Prentice-Hall, 1965.

6. Bloom, B. S. Taxonomy of Educational Objectives - Handbook I: Cognitive Domain. New York: David McKay Co., 1956.

7. Boulding, K. A. "General Systems Theory: The Skeleton of Science", General Systems. 1956, 1, 17.

8. Braden, Paul. School of Occupational and Adult Education, College of Education, Oklahoma State University, Stillwater, Oklahoma, 74074. Project consultant.

9. Cook, Desmond L. 216 Ramseyer Hall, 29 W. Woodruff Avenue, Columbus, Ohio, 43210. Project consultant.

10. Cook, Desmond L. "Better Project Planning and Control Through the Use of System Analysis and Management Techniques". Columbus: Educational Program Management Center, College of Education, The Ohio State University, November, 1967. (Mimeographed).

11. Drucker, Peter F. The Age of Discontinuity. New York: Harper and Row, 1969.

12. Forrester, Jay W. "Industrial Dynamics - After the First Decade", Organization Concepts and Analysis, (Ed. William G. Scott). Belmont, California: Dickenson Publishing Company, Inc. 1968.

13. George, Claude S. (Jr.). Management for Business and Industry. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.

14. Gross, Betram M. "The Coming General Systems Model of Social Systems." Human Relations, 20 - 4, November, 1967, 357-74.

15. Hall, A. D. & Fagen, R. E. "Definition of a System," In W. Buckley (Ed.), Modern Systems Research for the Behavioral Scientist. Chicago: Adline Publishing Company., 1968.

16. Hartley, Harry J. Educational Planning-Programming-Budgeting: A Systems Approach. Englewood Cliffs, New Jersey: Prentice-Hall, 1968.

17. Havighurst, Robert J. "Social Change and the Community College", The NCA Quarterly, 41 - 3, Winter, 1967, 241-48.

18. Heinich, Robert. Instructional Systems Technology Division, Indiana University, Bloomington, Indiana. Project consultant.

19. Heinich, R. "A System of Instructional Management", unpublished paper; November, 1962, as reported in Silvern, L.C. Systems Engineering of Education I: Evolution of Systems Thinking in Education. Los Angeles: Education and Training Consultants Co., 1968, p. 4.

20. Hosford, R. E. and Ryan, T. A. "Application of Systems Design in the Development of Counseling and Guidance Programs", (unpublished mimeographed report) as part of readings for American Educational Research Association 1971 Presession Systems Research for Counseling and Educational Environments.

21. Katz, Daniel and Kahn, Robert L. The Social Psychology of Organizations. New York: John Wiley and Sons, 1966.

22. Kilbridge, Maurice, Robert P. O'Block, and Paul V. Teplitz. "A Conceptual Framework for Urban Planning Models," Management Science. Vol. 15, No. 6, February, 1969.

23. Kraft, H. P. and Latta, Raymond F. "Systems Engineering Techniques: Embarrassment or Opportunity for Today's Educators?" Educational Technology, September, 1969, p. 26.

24. Kuo-Cheng Wu. Ancient Chinese Political Theories, Shanghai: The Commercial Press, Ltd., 1928, pp. 40-41, as reported in George, Claude S. (Jr.). "The Managerial System", Management for Business and Industry. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970, p. 26.

25. Lawrence, Paul R. and Lorsch, Jay W. Organization and Environment: Managing Differentiation and Integration. Boston: Harvard, 1967.

26. McGregor, Douglas. "The Manager's View of the Organization", The Professional Manager, (Ed. Caroline McGregor and Warren G. Bennis.) McGraw-Hill Book Company, 1967.

27. McKee, Robert L. and Ripley, Kathryn Jane. "The Documentation of Steps to Establish A Technical College and the Evaluation of 'PERT' As A Planning Tool for Educators, Phase I" Bailey's Crossroads, Virginia: Northern Virginia Technical College, March 31, 1966.

28. McKenney, James L. "Critique of 'Verification of Computer Simulation Models'", Management Science. Vol. 14, No. 2, Oct., 1967.

29. Miller, . J. and Rice, A. J. Systems of Organization: The Control of Task and Sentient Boundaries. London: Tavistock, 1967.

30. National Aeronautics and Space Administration, Pert and Comparison Cost System, NPC 101, October 30, 1962, published by the Director of Management Reports, National Aeronautics and Space Administration, Washington 25, D. C.

31. Ryan, T. Antoinette. "Systems Techniques for Programs of Counseling and Counselor Education", Educational Technology. June, 1969, p. 8.

32. Roueche, John E. and Boggs, John R. Junior College Institutional Research: The State of the Art. Washington: American Association of Junior Colleges, 1968.

33. Seiler, John A. Systems Analysis In Organizational Behavior. Homewood, Illinois: Irwin-Dorsey, 1967.

34. Sharkansky, Ira. Public Administration: Policy Making in Government Agencies. Chicago: Markham, 1970.

35. Silvern, Leonard C. President of Education and Training Consultants Co., 12121 Wilshire Boulevard, Los Angeles, California, 90025. Project consultant.

36. Silvern, L. C. Systems Engineering of Education I: Evolution of Systems Thinking in Education. Los Angeles: Education and Training Consultants Co., 1968.

37. Stern, Jacob. University of Illinois, 343 Educational Building, Urbana, Illinois, 61801. Consultation at Joliet Junior College.

38. Stowe, Richard. Audio-Visual Center, Indiana University, Bloomington, Indiana, 47401. Project consultant.

39. Terreberry, Shirley. "The Evolution of Organizational Environments." Administrative Science Quarterly. 12-4, March, 1968, 590-613.

40. Von Bertalanffy, L. "General Systems Theory", General Systems. 1956, 1, 1.

41. Von Bertalanffy, L. "General Systems Theory", General Systems. 1962, 7, 1-12.

42. Wallhaus, R. A. "Modeling for Higher Education Administration and Management", Management Information Systems In Higher Education: The State of the Art, (Ed. Charles B. Johnson and William G. Katzenmeyer). Durham, North Carolina: Duke University Press, 1969.

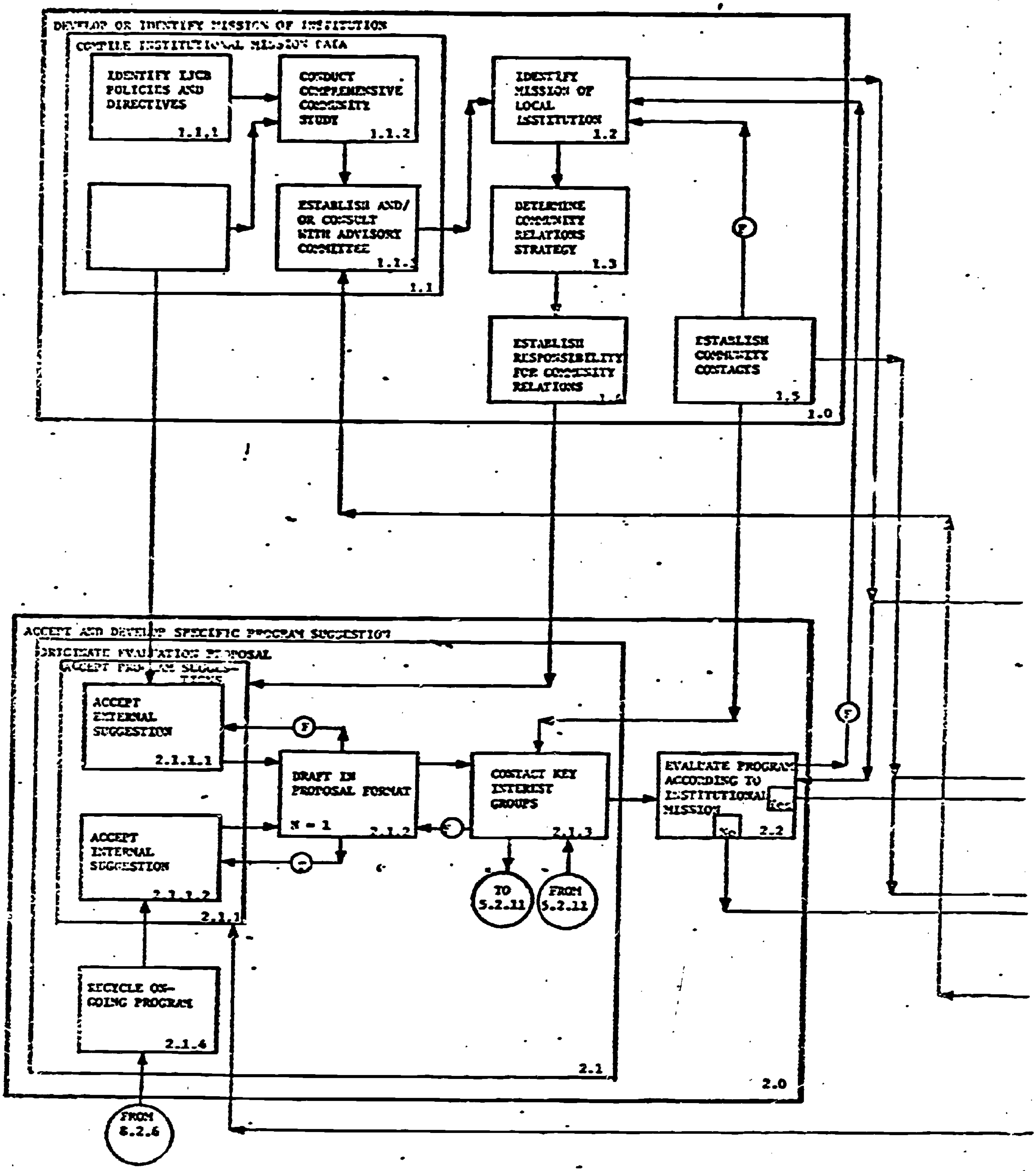
43. Wiener, Norbert. Cybernetics or Control and Communication in the Animal and the Machine. Cambridge, Massachusetts: The Massachusetts Institute of Technology Press, 1948, p. 11.

44. Silvern, L.C. "Logos: A System Language for Flowchart Modeling", Educational Technology. June, 1969.

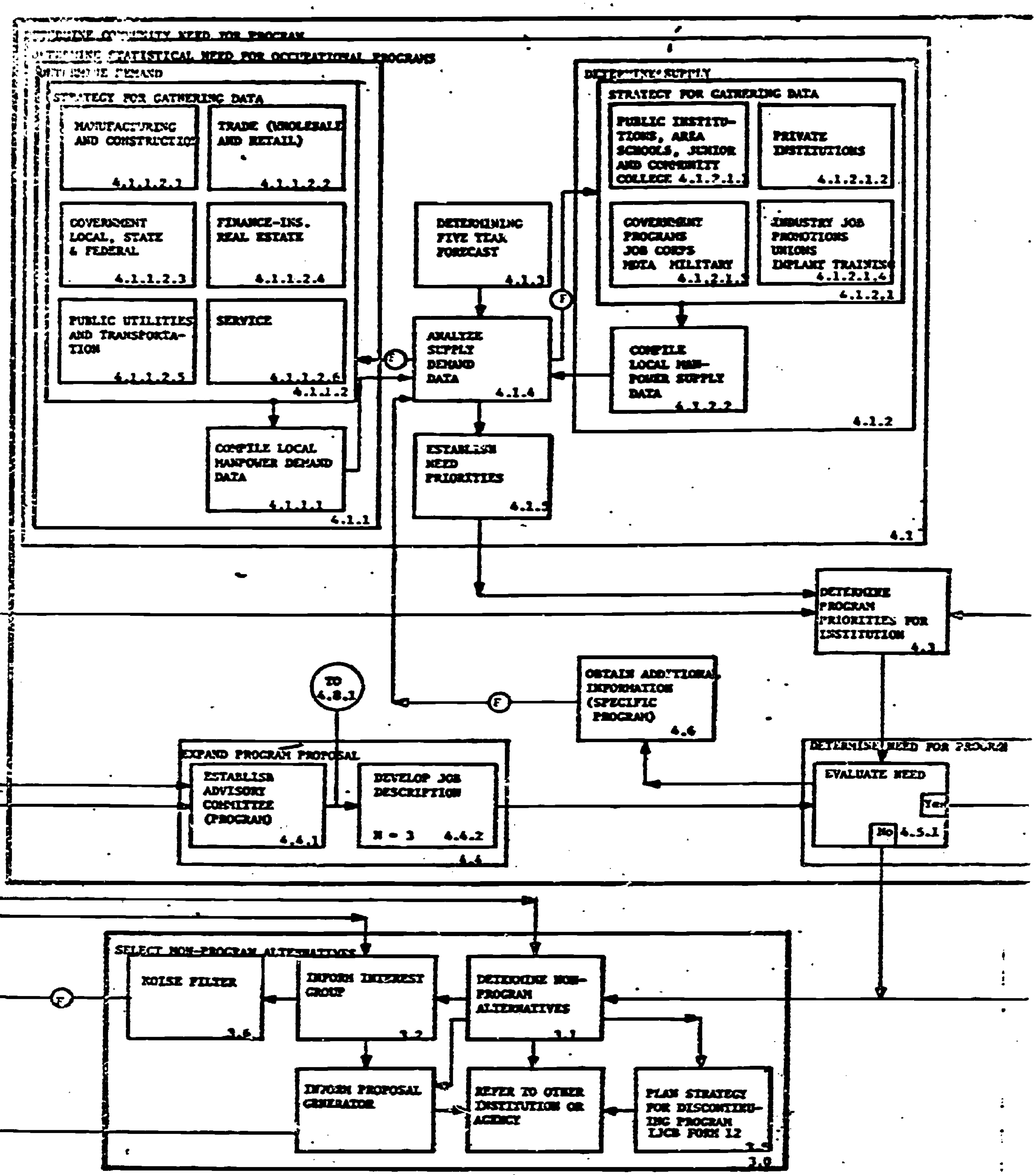
APPENDIX A

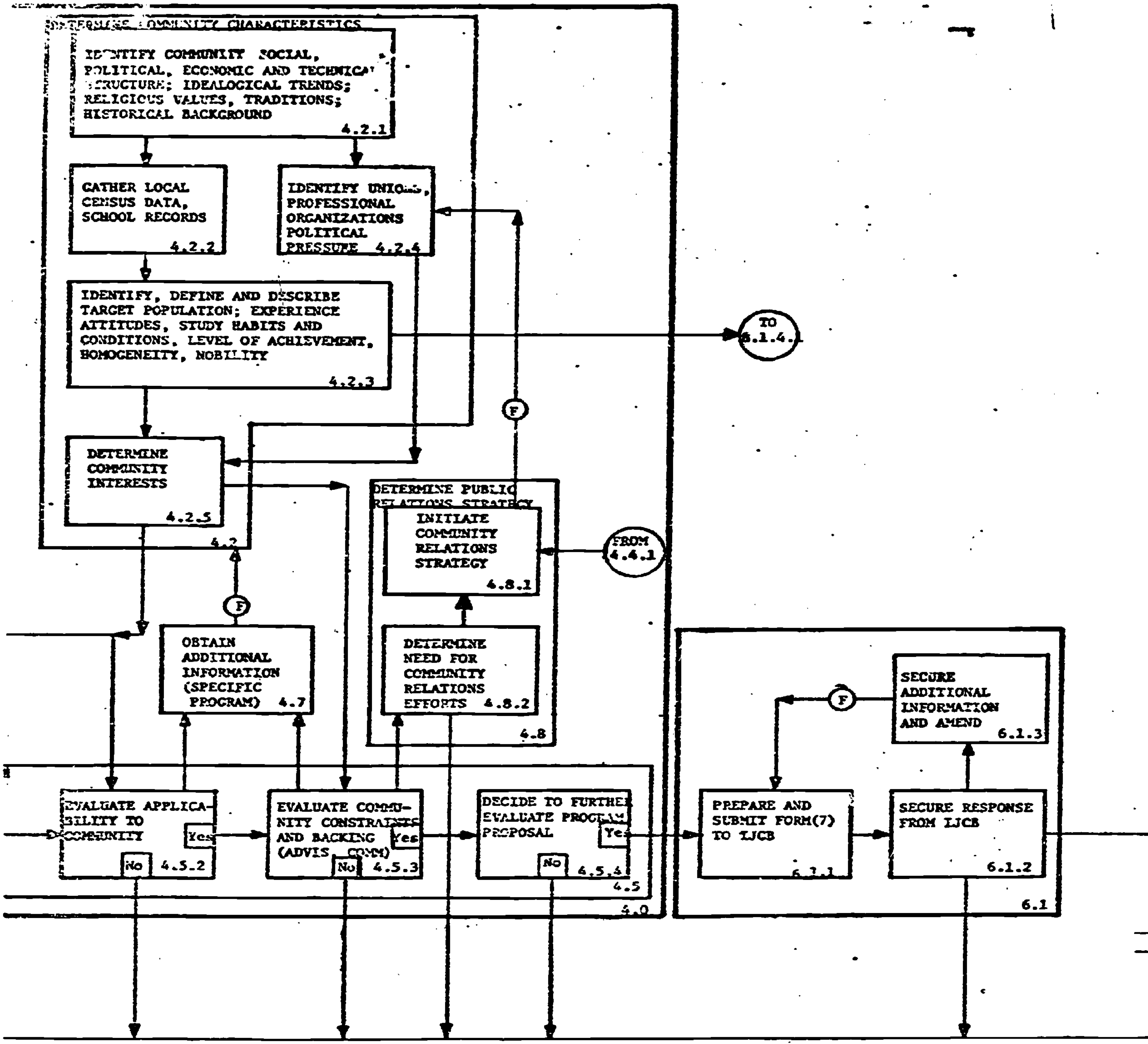
Initial Draft of Flow Chart Model for Occupational Curriculum Identification Development, Implementation and Evaluation

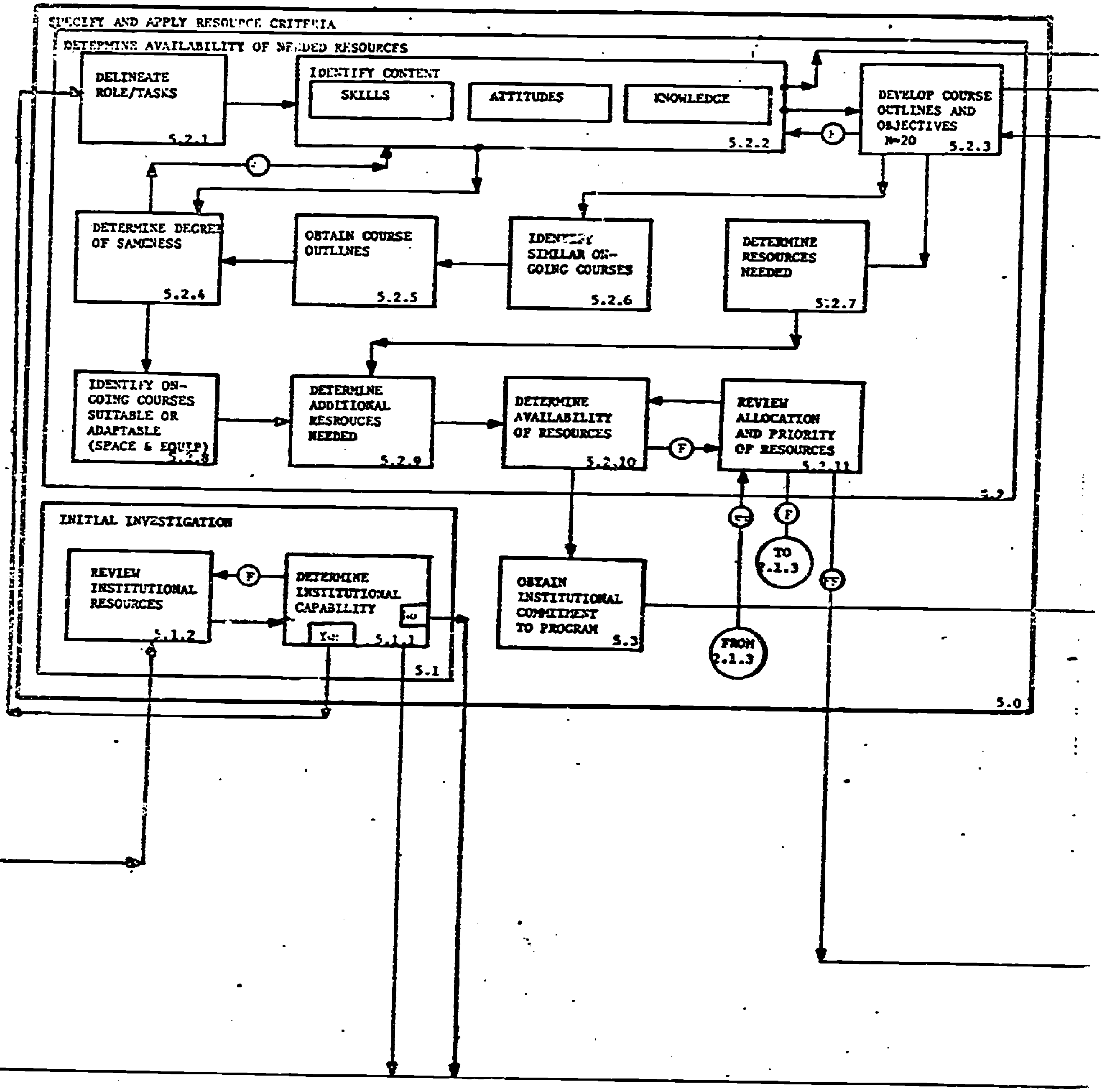
Developed by the
Illinois Occupational Curriculum Project

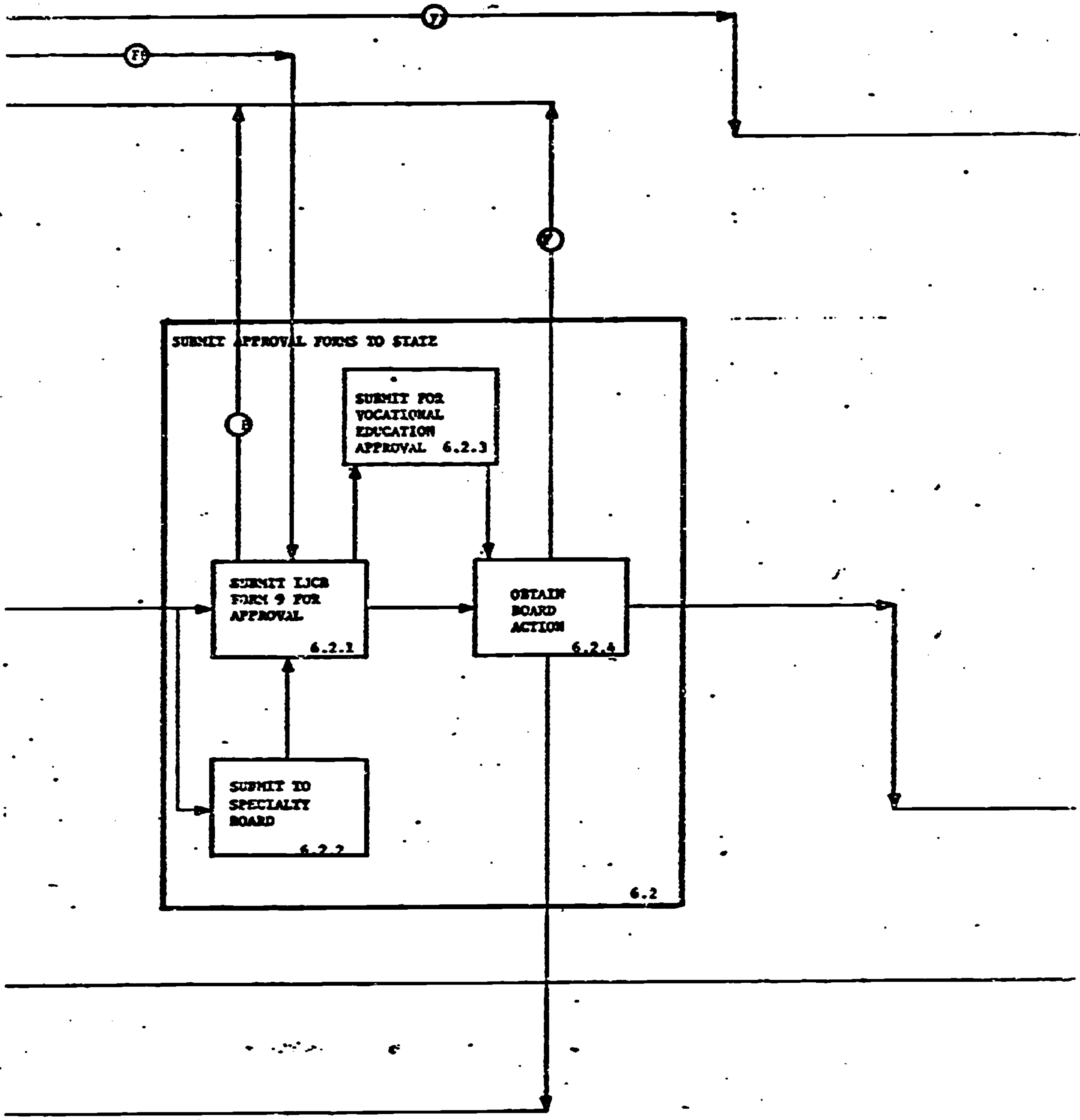


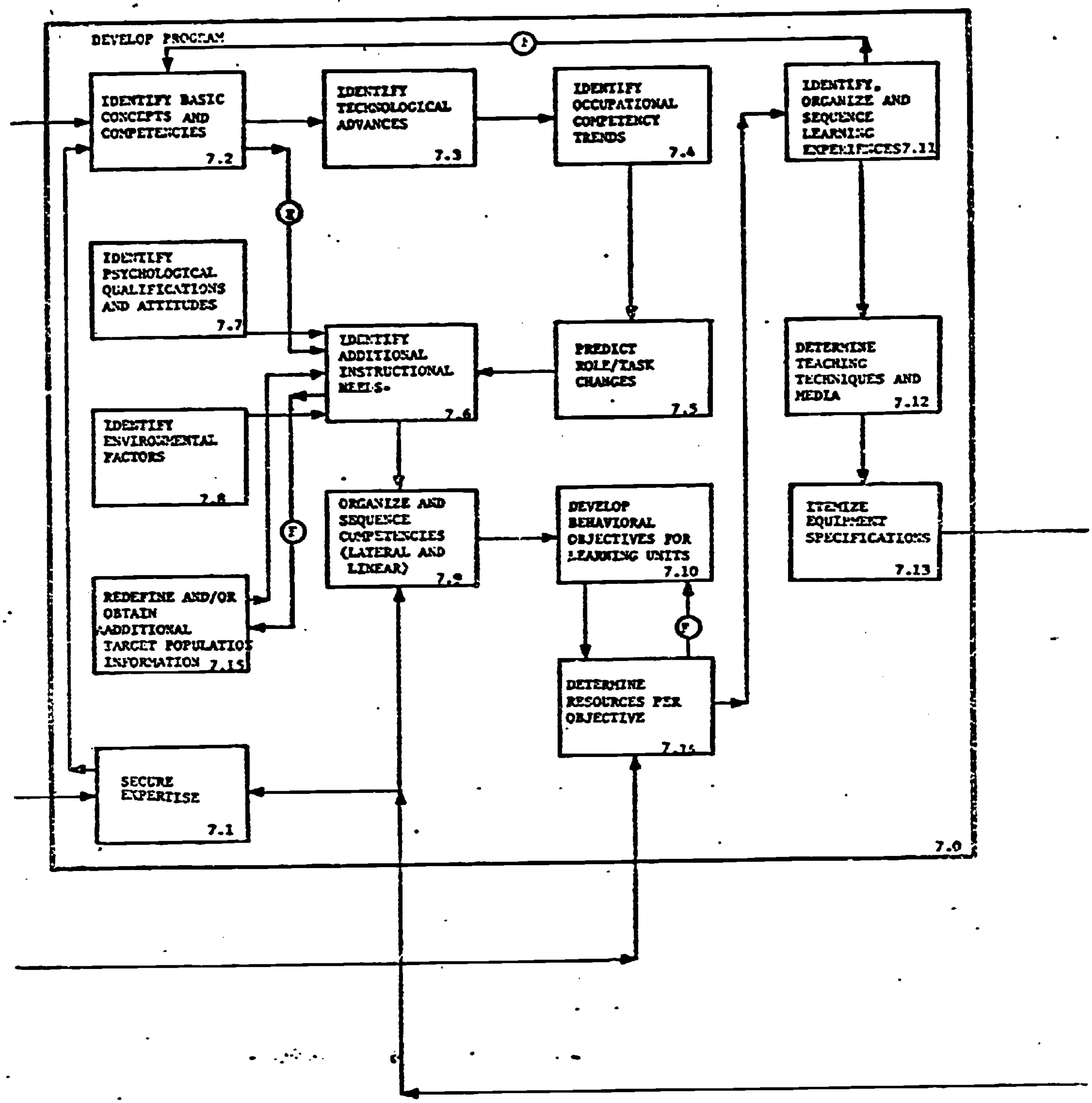
IDENTIFY LJCB POLICIES AND DIRECTIVES 1.1.1
CONDUCT COMPREHENSIVE COMMUNITY STUDY 1.1.2
ESTABLISH AND/ OR CONSULT WITH ADVISORY COMMITTEE
1.1
IDENTIFY MISSION OF LOCAL INSTITUTION 1.2
DETERMINE COMMUNITY RELATIONS STRATEGY 1.3
ESTABLISH RESPONSIBILITY FOR COMMUNITY RELATIONS
ESTABLISH COMMUNITY CONTACTS 1.5
1.0
ACCEPT EXTERNAL SUGGESTION 2.1.1.1
ACCEPT INTERNAL SUGGESTION
DRAFT IN PROPOSAL FORMAT
CONTACT KEY INTEREST GROUPS
TO 5.2.11
FROM 5.2.11
EVALUATE PROGRAM ACCORDING TO INSTITUTIONAL MISSION 2.2
2.1.1
RECYCLE ON-GOING PROGRAM 2.1.4
2.1
2.0
FROM 8.2.6

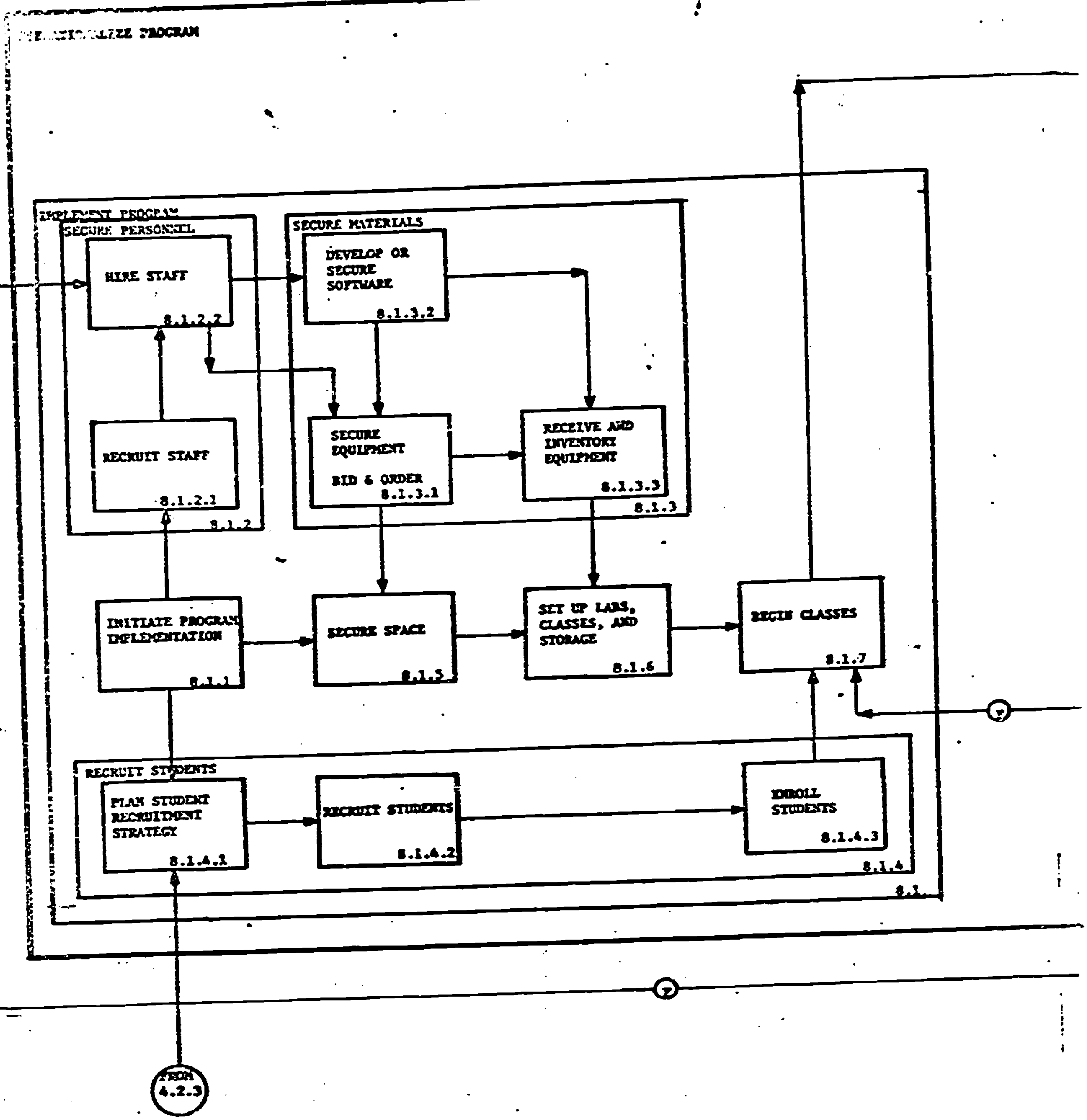

EXPAND PROGRAM PROPOSAL
ESTABLISH ADVISORY COMMITTEE (PROGRAM) 4.4.1
DEVELOP JOB DESCRIPTION N = 3 4.4.2
4.4
STRATEGY FOR GATHERING DATA
MANUFACTURING AND CONSTRUCTION 4.1.1.2.1
TRADE (WHOLESALE AND RETAIL) 4.1.1.2.2
GOVERNMENT LOCAL, STATE & FEDERAL 4.1.1.2.3
FINANCE-INS. REAL ESTATE 4.1.1.2.4
PUBLIC UTILITIES AND TRANSPORTATION 4.1.1.2.5
SERVICE 4.1.1.2.6
4.1.1.2
COMPILE LOCAL MANPOWER DEMAND DATA 4.1.1.1
4.1.1
DETERMINING FIVE YEAR FORECAST 4.1.3
ANALYZE SUPPLY DEMAND DATA 4.1.4
ESTABLISH NEED PRIORITIES 4.1.5
STRATEGY FOR GATHERING DATA
PUBLIC INSTITUTIONS, AREA SCHOOLS, JUNIOR AND COMMUNITY COLLEGE 4.1.2.1.1
PRIVATE INSTITUTIONS 4.1.2.1.2
GOVERNMENT PROGRAMS JOB CORPS MDTA MILITARY 4.1.2.1.3
INDUSTRY JOB PROMOTIONS UNIONS INPLANT TRAINING 4.1.2.1.4
4.1.2.1
COMPILE LOCAL MAN-POWER SUPPLY DATA 4.1.2.2
4.1.2
4.1
DETERMINE PROGRAM PRIORITIES FOR INSTITUTION 4.3
TO 4.8.1
OBTAIN ADDITIONAL INFORMATION (SPECIFIC PROGRAM) 4.6
EVALUATE NEED
Yes
No
4.5.1
SELECT NON-PROGRAM ALTERNATIVES
NOISE FILTER 3.6
INFORM INTEREST GROUP 3.2
DETERMINE NON-PROGRAM ALTERNATIVES 3.1
INFORM PROPOSAL GENERATOR
REFER TO OTHER INSTITUTION OR AGENCY
PLAN STRATEGY FOR DISCONTINUING PROGRAM LJCB FORM 12
3.0
F

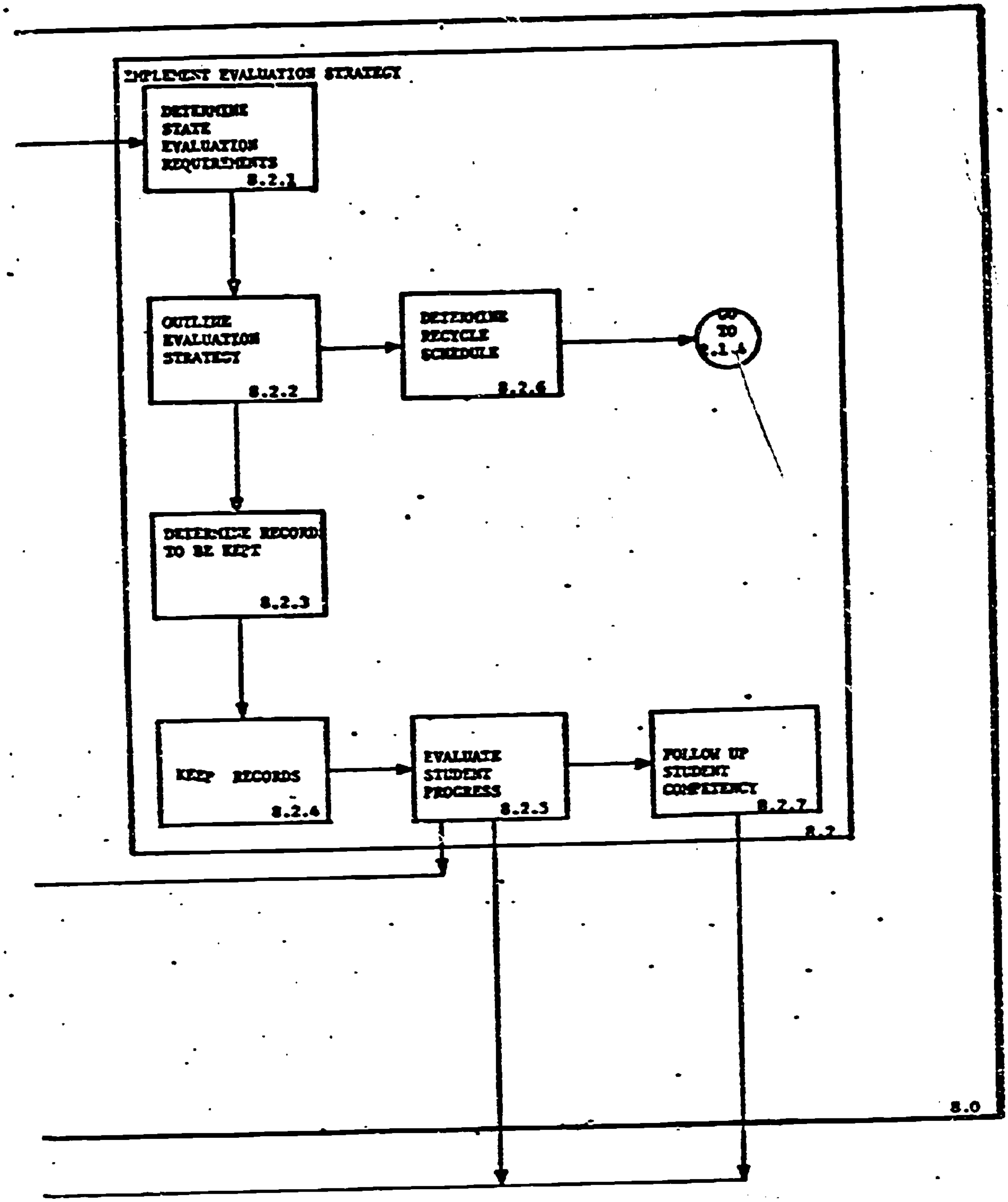

DETERMINE COMMUNITY CHARACTERISTICS
IDENTIFY COMMUNITY SOCIAL, POLITICAL, ECONOMIC AND TECHNICAL STRUCTURE; IDEALOGICAL TRENDS; RELIGIOUS VALUES, TRADITIONS; HISTORICAL BACKGROUND 4.2.1
GATHER LOCAL CENSUS DATA, SCHOOL RECORDS 4.2.2
IDENTIFY UNIONS, PROFESSIONAL ORGANIZATIONS POLITICAL PRESSURE 4.2.4
IDENTIFY, DEFINE AND DESCRIBE TARGET POPULATION; EXPERIENCE ATTITUDES, STUDY HABITS AND CONDITIONS, LEVEL OF ACHIEVEMENT, HOMOGENEITY, MOBILITY 4.2.3
TO 6.1.4.1
F
DETERMINE COMMUNITY INTERESTS 4.2.5
4.2
DETERMINE PUBLIC RELATIONS STRATEGY
INITIATE COMMUNITY RELATIONS STRATEGY 4.8.1
FROM 4.4.1
F
OBTAIN ADDITIONAL INFORMATION (SPECIFIC PROGRAM) 4.7
DETERMINE NEED FOR COMMUNITY RELATIONS EFFORTS 4.8.2
4.8
SECURE ADDITIONAL INFORMATION AND AMEND 6.1.3
F
EVALUATE APPLICABILITY TO COMMUNITY Yes No 4.5.2
EVALUATE COMMUNITY CONSTRAINTS AND BACKING (ADVIS. COMM) Yes No 4.5.3
DECIDE TO FURTHER EVALUATE PROGRAM PROPOSAL Yes No 4.5.4
4.5
4.0
PREPARE AND SUBMIT FORM(7) TO LJCB 6.1.1
SECURE RESPONSE FROM LJCB 6.1.2
6.1


SPECIFY AND APPLY RESOURCE CRITERIA
DETERMINE AVAILABILITY OF NEEDED RESOURCES
DELINEATE ROLE/TASKS 5.2.1
IDENTIFY CONTENT
SKILLS
ATTITUDES
KNOWLEDGE
5.2.2
DEVELOP COURSE OUTLINES AND OBJECTIVES N=20 5.2.3
DETERMINE DEGREE OF SAMENESS 5.2.4
OBTAIN COURSE OUTLINES 5.2.5
IDENTIFY SIMILAR ON-GOING COURSES 5.2.6
DETERMINE RESOURCES NEEDED 5.2.7
IDENTIFY ON-GOING COURSES SUITABLE OR ADAPTABLE (SPACE & EQUIP) 5.2.8
DETERMINE ADDITIONAL RESROUCES NEEDED 5.2.9
DETERMINE AVAILABILITY OF RESOURCES 5.2.10
REVIEW ALLOCATION AND PRIORITY OF RESOURCES 5.2.11
5.2
INITIAL INVESTIGATION
REVIEW INSTITUTIONAL RESOURCES 5.1.2
DETERMINE INSTITUTIONAL CAPABILITY 5.1.1
5.1
OBTAIN INSTITUTIONAL COMMITMENT TO PROGRAM 5.3
TO 2.1.3
FROM 2.1.3
5.0


SUBMIT APPROVAL FORMS TO STATE
SUBMIT FOR VOCATIONAL EDUCATION APPROVAL 6.2.3
SUBMIT LJCB FORM 9 FOR APPROVAL 6.2.1
OBTAIN BOARD ACTION 6.2.4
SUBMIT TO SPECIALTY BOARD 6.2.2
6.2


DEVELOP PROGRAM
IDENTIFY BASIC CONCEPTS AND COMPETENCIES 7.2
IDENTIFY TECHNOLOGICAL ADVANCES 7.3
IDENTIFY OCCUPATIONAL COMPETENCY TRENDS 7.4
IDENTIFY, ORGANIZE AND SEQUENCE LEARNING EXPERIENCES 7.11
IDENTIFY PSYCHOLOGICAL QUALIFICATIONS AND ATTITUDES 7.7
IDENTIFY ADDITIONAL INSTRUCTIONAL NEEDS 7.6
PREDICT ROLE/TASK CHANGES 7.5
DETERMINE TEACHING TECHNIQUES AND MEDIA 7.12
IDENTIFY ENVIRONMENTAL FACTORS 7.8
ORGANIZE AND SEQUENCE COMPETENCIES (LATERAL AND LINEAR) 7.9
DEVELOP BEHAVIORAL OBJECTIVES FOR LEARNING UNITS 7.10
ITEMIZE EQUIPMENT SPECIFICATIONS 7.13
REDEFINE AND/OR OBTAIN ADDITIONAL TARGET POPULATION INFORMATION 7.15
DETERMINE RESOURCES PER OBJECTIVE 7.14
SECURE EXPERTISE 7.1
7.0
F
F
F
F


INSTITUTIONALIZE PROGRAM
IMPLEMENT PROGRAM
SECURE PERSONNEL
HIRE STAFF 8.1.2.2
RECRUIT STAFF 8.1.2.1
8.1.2
SECURE MATERIALS
DEVELOP OR SECURE SOFTWARE 8.1.3.2
SECURE EQUIPMENT BID & ORDER 8.1.3.1
RECEIVE AND INVENTORY EQUIPMENT 8.1.3.3
8.1.3
INITIATE PROGRAM IMPLEMENTATION 8.1.1
SECURE SPACE 8.1.5
SET UP LABS, CLASSES, AND STORAGE 8.1.6
BEGIN CLASSES 8.1.7
RECRUIT STUDENTS
PLAN STUDENT RECRUITMENT STRATEGY 8.1.4.1
RECRUIT STUDENTS 8.1.4.2
ENROLL STUDENTS 8.1.4.3
8.1.4
8.1
FROM 4.2.3


IMPLEMENT EVALUATION STRATEGY
DETERMINE STATE EVALUATION REQUIREMENTS
8.2.1
OUTLINE EVALUATION STRATEGY
8.2.2
DETERMINE RECYCLE SCHEDULE
8.2.6
GO TO 2.1.4
DETERMINE RECORDS TO BE KEPT
8.2.3
KEEP RECORDS
8.2.4
EVALUATE STUDENT PROGRESS
8.2.5
FOLLOW UP STUDENT COMPETENCY
8.2.7
8.2
8.0

BIBLIOGRAPHY OF ILLINOIS OCCUPATIONAL CURRICULUM PROJECT DOCUMENTS

1. "Proposal for Phase I of A Research and Development Project in Occupational Education: The Development of Process Models for Decision-Making in Curriculum Development and Evaluation." IOCP, Joliet Junior College, Joliet, Illinois: February 1, 1970.

2. "Proposal for Phase II of A Research and Development Project in Occupational Education: The Development of Process Models for Decision-Making in Curriculum Development and Evaluation." IOCP, Joliet Junior College, Joliet, Illinois: May 29, 1970.

3. "Proposal for Phase III of A Research and Development Project in Occupational Education: The Development of Systems Models for Decision-Making in Occupational Curriculum Development and Evaluation." IOCP, Joliet Junior College, Joliet, Illinois: April 23, 1971.

4. "Phase I Report of A Research and Development Project in Occupational Education: The Development of Process Models for Decision-Making in Curriculum Development and Evaluation." Unpublished report by IOCP, Joliet Junior College, Joliet, Illinois: October, 1970.

5. "Phase II Report of A Research and Development Project in Occupational Education: The Development of Systems Models for Decision-Making in Occupational Curriculum Development and Evaluation." Unpublished report by IOCP, Joliet Junior College, Joliet, Illinois: May, 1971.

6. "An Investigation of Curriculum Development and Evaluation Models with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education." Unpublished IOCP report, Joliet Junior College, Joliet, Illinois: May, 1971.

7. "An Investigation of Decision-Making Practices in Illinois Junior Colleges with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education." Unpublished IOCP report, Joliet Junior College, Joliet, Illinois: May, 1971.

8. "An Investigation of Systems Designs and Management Techniques with Implications Toward A Systems Approach to Curriculum Development and Evaluation in Occupational Education." Unpublished IOCP report, Joliet Junior College, Joliet, Illinois: May, 1971.

9. "Guidelines for Occupational Program Identification, Development, Implementation, and Evaluation." (One unpublished IOCP report) Joliet Junior College, Joliet, Illinois. June, 1971.

10. "Activity Manuals for Occupational Program Identification, Development, Implementation and Evaluation." (Four unpublished IOCP reports), Joliet Junior College, Joliet, Illinois: June, 1971.