DOCUMENT RESUME

ED 115 850 CE 005 688

TITLE Computer Assisted Planning for Education, A Prototype. The Management Information System for Occupational Education. Journal of Research and Development in Education. v7 n2, Winter 1974.

INSTITUTION Georgia Univ., Athens. Coll. of Education.

NOTE 169p.; For related documents, see ED 062 553; ED 068 646-647; ED 072 225; ED 072 228; ED 072 303-304; CE 005 687-727

AVAILABLE FROM Business Manager, College of Education, G-3 Aderhold Building, University of Georgia, Athens, Georgia 30602 ($2.00)

EDRS PRICE MF-$0.76 Plus Postage. HC Not Available from EDRS.

DESCRIPTORS Computers; Data Collection; *Demonstration Projects; *Electronic Data Processing; *Management Information Systems; Periodicals; *Program Descriptions; Program Evaluation; State Programs; *Vocational Education

IDENTIFIERS *Management Information System Occupational Educa; MISOE

ABSTRACT

The journal describes the Management Information System for Occupational Education (MISOE), designed to provide computerized information support capability for State level occupational education planning. An introductory chapter presents a guide for reading the publication. The second chapter describes basic components and terminology and outlines the conceptual structure of inputs, process, product, and impact. Chapter 3 briefly outlines the important information types of the census data systems which provide minimum information for statewide management of occupational education. The sample data systems which provide information necessary for policy development are presented in chapter 4. The economics of public investment in education and MISOE cost analysis systems are discussed in chapter 5. Chapter 6 describes interactive computing systems and the flexibility of MISOE data files. Interacting with MISOE data, operations, and output indices is the subject of chapter 7. Planning for occupational education using MISOE is dealt with in chapter 8. Educational policy and system dynamics are described in chapter 9. The final chapter offers assessments of MISOE from the professional perspectives of a State manager of occupational education, an educational researcher, and an economist. A two-page reference list and brief notes about the 10 contributors conclude the journal. (Author/MS)

Journal of Research and Development in Education

Volume 7 • Number 2 • Winter, 1974 • Athens, Georgia

Computer Assisted Planning for Education a prototype

The management information system for occupational education

EDITORIAL POLICY

The *Journal of Research and Development in Education* is published five times per year. Each issue is devoted to a central theme. The Editorial Board selects the theme for each issue. Criteria for theme selection are relevancy, breadth of interest, and availability of scholarly collaboration on a broad geographical basis.

The Editorial Board invites theme suggestions from scholars, researchers and developers as well as professional organizations in education.

Unsolicited manuscripts must be accompanied by postage-paid return envelope.

Address the Editor at College of Education, G-3 Aderhold Building, University of Georgia, Athens, Georgia 30602.

SUBSCRIPTIONS AND CHANGE OF ADDRESS

The *Journal of Research and Development in Education* is a non-profit publication published five times per year. No. 1 of each issue begins in the Fall. Subscription rate in the U.S. is $7.00 annually ($8.00 elsewhere to cover postage and handling). Single and back issue copies if available are $2.00 each ($2.25 elsewhere). Single copy orders must be prepaid. Direct all subscription correspondence to *Journal of Research and Development in Education*, Business Manager, College of Education, G-3 Aderhold Building, University of Georgia, Athens, Georgia 30602. Annual subscriptions are automatically renewed unless cancelled by subscriber.

EDPRESS

VOL. 7, NO. 2, WINTER, 1974

Second-class postage paid at Atlanta, Georgia.

TABLE OF CONTENTS

Our readers will note this issue is somewhat longer than usual but it was necessary in order to present the whole story of MISOE. It was possible for us to present the whole story only because of the cooperation of the Massachusetts Department of Education who shared the additional cost involved.

PREFACE

The single purpose of this publication is to provide a basis for judgement on the part of the reader about a recent development designed to support the policy making management function for occupational education at the state level. This development is called the Management Information System for Occupational Education (MISOE). Although MISOE has been developed for occupational education, it could serve as a prototype for all public education and has implications for the development of social policy beyond education. It is hoped that this publication will provide a necessary basis for a judgement about the usefulness of MISOE by a wide range of readers, from legislators to concerned lay citizens.

It is recommended that the reader immediately skip to Chapter 1, which describes the nature of the development offered for evaluation. For the reader who is persuaded that MISOE is sufficently valuable to warrant an examination for the purpose of evaluation, Chapter 1 also provides a guide to the publication which is designed to help arrive at a knowledge-based judgement with a minimum investment of precious time. If the reader's evaluation is positive, we would like to insist upon his returning to read the following paragraphs of acknowledgement.

The development of MISOE has occupied approximately three years of the Principal Investigator's life and could not have been accomplished without the specific contribution of the following people:

Charles Buzzell, Associate Commissioner, Division of Occupational Education, Massachusetts Department of Education, has provided support, inspiration and (above all) "beat the Philistines back", thus allowing MISOE to become. The management leadership demonstrated by Charles Buzzell should serve as a role model for development, research and progress in government. It is not easy to provide support for a development whose implications are hardly understood by a substantial number of one's colleagues and, at the same time, a development that challenges the current practices of other colleagues.

Elizabeth Weinberger, Research Associate, MISOE staff, whose logic, persistence and insight are responsible for a substantial part of MISOE. Miss Weinberger wrote Chapter 7, and contributed mightily to the substance of Chapter 4.

John Creager, Division Director, Division of Educational Statistics, American Council on Education has provided MISOE with valuable assistance during this development. Dr. Creager is a first rate social scientist who is more responsible for the development of MISOE Sample Data Systems than anyone. His genius is reflected throughout this entire publication.

Martin Breslow, Research Associate, MISOE staff conceptualized the interactive

computing system for MISOE and played a major role in developing the MISOE Census Data System. The range of accomplishments described by these two functions speaks to the insightfulness of Mr. Breslow. Chapters 3 and 6 represent his contributions to MISOE in this publication.

William Kyros, Research Associate, MISOE staff developed TERMOBS for MISOE. We consider TERMOBS an important development for occupational education, and Bill Kyros is probably the only person in the world who has been able to make sense out of performance objectives for instructional management at the state level.

Gerald Downey, Assistant Professor, Lowell Technological Institute, single handedly developed the cost analysis system for MISOE. As a part of this function, Dr. Downey helped develop the CDS Reporting System, and wrote Chapter 5 of this publication.

Michael Garet, (part-time MISOE staff member and graduate student Systems Dynamic Department, Sloan School of Management, Massachusetts Institute of Technology, minoring in education and social policy at Harvard University) is responsible for adopting dynamic simulation to MISOE. He alone has developed the model of Chapter 9, and, in addition earlier models for MISOE. Dynamic simulation is very much a part of the total conception of MISOE and Michael Garet is responsible for the development of the fit of this vital process into MISOE.

Finally, without our secretarial staff, we would simply not be able to communicate our development to anyone. They are Mrs. Anne Bowes and Mrs. Majorie Alongi. On behalf of the entire MISOE staff, I publicly acknowledge our debt to these women.

William G. Conroy, Jr.
Guest Editor
Principal Investigator
Management Information System for Occupational Education

CHAPTER 1
A STATEMENT OF INTRODUCTION

William G. Conroy, Jr.

This chapter is intended to accomplish three separate goals:

1. to offer a statement of purpose for MISOE;
2. to suggest implications of MISOE for managers of public education and society at large; and
3. to present a guide for efficient reading of this publication.

A Statement of MISOE Purpose

The purpose of MISOE is to provide a computerized, information support capability for those charged with the responsibility of planning for occupational education at the state level. MISOE has been purposefully designed to support the planning process by allowing man easy access to information and operations to analyze information such that experience can influence the process of policy formulation. MISOE has been developed upon the fundamental assumption that a capability for man to analytically interact with experience will contribute to a better understanding of the future consequences of current policy. To accomplish this goal, MISOE has adopted "state of the art" computer technology to equip the manager with a capability to enter into an interactive dialogue with information and simultaneously provide analytical tools to examine this experience in light of future goals.

MISOE conceives of resouce allocation as the fundamental state level planning function for occupational education, i.e., assigning funds to specific alternatives which are designed to cause desired outcomes to occur. Planning in occupational education includes describing program characteristics, stipulating the range and number of students to be served and stating the desired outcomes for individuals who experience these planned programs and society as a whole. These plans include a statement of social and private costs, and an explicit estimation of the economic benefits for society and the so-called target students.

The planning or policy-making, management function supported by MISOE includes the following three levels.

1. *The Overall Social Agencies Level* Planning at this level is typically done by the legislature, and determines the optimal mix of education with other social services necessary to achieve desirable societal goals.
2. *The Overall-Education Level* – Planning at this level is usually done by the Chief State School Officer and his staff, and seeks to stipulate the optimal mix of occupational and nonoccupational education necessary to attain specified societal goals.
3. *The Within Occupational Education Level* – Planning at this level is most frequently done by a division or bureau at the state department of education and decides the specific occupations for which students are to be prepared, the occupational capabilities within occupational programs with which students are to be prepared, and the program characteristics which seem most likely to help students achieve learning objectives of occupational education programs.

MISOE assumes that the degree to which the state management level permits local government to initiate plans at any of these levels is discretionary to the legislature. Although MISOE is helpful for planning at the local level, its primary purpose is to support statewide policy formulation for occupational education. Simply because MISOE is designed to support statewide planning, it does not follow that it disregards the local educational planning function, even though it clearly distinguishes between these governmental levels. A reasonable description of the distribution of planning responsibility for education between state and local governments assumed by MISOE in development is that local planning occurs with a statewide framework. MISOE has been developed to help policy-making managers at the state level specify that framework or structure for occupational education, within the democratic tradition.

MISOE conceives of occupational education as an alternative means for achieving desirable and specified societal goals. Further, the only reason society supports the practice of occupational education is because of its perceived, positive contribution to the attainment of these goals. MISOE has been developed to provide policy-making managers at all levels (hereafter, managers) with an information system designed to help them understand relationships between occupational education and the society it serves in a way that supports planning for the future at the state level.

MISOE supports the principle that policies for education must be made on the basis of future benefits, and that the future time frame which constitutes this basis for public education is several generations. Whether the political structure which controls public education in America can tolerate futurism as a foundation for planning is not at all certain, nor is it certain that middle managers of public education are particularly concerned with taking society's future into account as they "innovate change."

MISOE Implications for Managers and Society

It is obviously difficult to speculate about the influence of a development yet to be implemented. It seems more sensible to suggest a perspective or "something to think about" while forming an evaluation of MISOE, and that is "What are the likely consequences of MISOE on both the policy-maker and the policy-making function?"

The goal of MISOE is to provide management with a better understanding of the future consequences of current policy through numerical and interactive analysis of experience. As this publication will describe, MISOE allows management to browse and analyze a wide ranging data description of past successes and failures in a way that is at the same time responsive to an enormous variety of policy hypotheses and predictive of future consequences. As an interactive, computing capability, MISOE provides management with immediate response to complex questions. This response is likely to cause new understandings and insights, generating more questions. Continued interaction between management and MISOE could be described as a developing chain of knowledge which suggests causal relationships among parts of man's world. Some of these interactively developed understandings will question previously held beliefs, while many "facts" will be confirmed. Usually, the development of a policy-relevant understanding will result from a fairly substantial dialogue with the MISOE interactive computing system.

It should be pointed out that MISOE has been designed such that few technical skills are required to browse and analyze the data files, however, some numerical analysis skills are required to interpret numerically described experience. Given this brief description of the process of "thinking with machine", it seems reasonable to hope that those attempting to determine the usefulness of MISOE will develop a position on its likely consequences for the policy-making manager, whether he be a Legislator, a teacher, a Chief State School Officer, a member of a State Board of Education, a student, a citizen or an Associate Commissioner for Occupational Education.

One way of thinking about ranges of responses to this question is to attempt to fix a position on a continuum which could be described by the following extreme points:

1. Management should rely on a research staff to browse and analyze experience for policy development, probably developing recommendations within a range of alternative constraints; or
2. Policy making management should define its function to include the development of new understandings through direct, interactive and analytical dialogue with experience.

It is obviously not possible to develop a definitive position until there has been considerable experience on the part of policy-making managers with interactive, computer systems. Unfortunately, the past performance of computers in providing numerical analysis of experience as a support for policy formulation has been dismal. Usually computers have been used to answer one or two question, typically formulated by policy-makers, but answered by researchers from one or several disciplines. Researchers access computers through a data processing team. The computer is used to process and analyze a mountain of information against these one or two questions. The result of this experience is typically a final report, which can either be accepted or rejected. If the final report provides new understandings requiring more information, another study must be undertaken. On the other hand, MISOE offers a capability for managers to enter into a direct interaction with experience (structured by the logic of multi-disciplines) in the process of arriving at new understandings for the purpose of policy formulation. One could argue that policy-making managers who delegate to subordinates the task of probing and analyzing experience are in fact "giving away" the fundamental policy-making task, even though different skills than typically possessed by the average policy-maker are required for utilization of MISOE.

It is reasonable to speculate about the implications of MISOE on society as part of the process of evaluating its usefulness. Again, it might be helpful to frame a response along a continuum defined by the following two poles:

1. In the hands of a fascist and closed administration it could facilitate a centralization of policy making for public education; or
2. In the hands of a democratic and open administration it can provide a basis for contributing to the improvement of the quality of life.

Although it is not an unreasonable conclusion that freedom is frequently the function of governmental ignorance, it seems not unreasonable to hope that knowledge can contribute to improving the lot of man during his brief tenure on earth, without necessarily causing political revolution.

A Guide to Understanding MISOE Through this Publication

This publication is designed to serve a wide range of educational policy-makers including: legislatures; state department of education personnel; superintendents: principals and teachers; school boards; and concerned citizens. It is difficult to accomplish this goal with one publication. However, the following few paragraphs are designed to provide the reader with a guide so that he can get to the "heart of the matter" with a reasonable time investment. Then, if he is sufficiently interested in learning details of the MISOE structure, he can "dig more deeply" into selected sections of this publication. All this is not to discourage the reader from carefully wading through the entire volume, as such an exercise will provide maximum understanding.

One word of caution. The single purpose of this publication is to provide a basis for judgement of a development for educational management. It is possible to evaluate this development with absolutely no information at all, simply on the basis of an immediate response to a vaguely understood stimulus. Such an activity is of no value to providing a basis for advising others. On the other hand, a reader can become hopelessly buried in the details of this publication, and base his judgement on something other than the essence of the potential of MISOE to serve society. The following guide should help the reader strike a balance between these extremes.

Chapter 2 is a description of a certain basic components of MISOE that are necessary to understand its scope. It is described as a necessary dictionary experience (evil) and should be "carefully skimmed" by all readers.

Chapters 3, 4, 5, and 6 describe in some detail (nontechnical) important components of MISOE which are overviewed in Chapter 2. These chapters will be of considerable interest to readers who are moving toward a positive evaluation of MISOE and who want to learn of its structure. However, the uncommitted, probing and casual reader wants to arrive at such a positive evaluation (or not) before investing his valuable time with an indepth analysis; he should "quickly skim" these chapters. The "uncommitted skimmer" should attempt to seek a broad understanding of the information types of MISOE as he races through Chapters 3, 4, and 5, as well as a "feel" for the computer terminal and file structure described in Chapter 6.

Chapter 7 should be read about as carefully as Chapter 2. Its purpose is to provide a reader with an understanding of the process of entering into an interactive dialogue with a computer. It is purposefully conversational and hopefully enlightening. It is a necessary prerequisite to Chapter 8.

Chapter 8 is designed to offer the reader an experience in policy formulation with MISOE. It speaks for itself and is the basis upon which a judgement about MISOE should be made. Unfortunately, the reader is constrained by the logic of the example. In real MISOE he could probe along any branching chain his logic dictated, within the boundaries of the MISOE data structure. All the data presented in Chapter 8 are manufactured for the purpose of this example, as are all the data anywhere in this publication.

Chapter 9 describes and offers an example of understanding and interpreting experience through a modelling process. The process described is called *dynamic simulation*, and is also supported by an interactive computer capability.

When man as a determiner of social policy interacts with MISOE as described in Chapter 8, he could be described as operating from a model or conception of the world at large. His dialogue with experience extends his understandings about this world. His conceptual model of the world is constrained by the number of elements he can "juggle" in his mind at one time. Frequently the development of social policy involves "juggling" more elements at one time than man can accommodate. Dynamic simulation offers a computer assisted methodology to deal with and develop understandings about complex social issues. Unlike other techniques (mathematical programming), its fundamental purpose is not to specify optimum and simplified solutions to complex problems, but rather to contribute to a development of understandings on the part of human managers about the fundamental nature of relationships between elements relevant to a particular social policy in formulation.

Dynamic simulation can be particularly useful in making explicit those elements to be acted upon by a policy in future time and communicating understandings about alternative outcomes from various policy decisions. It is most useful at the Over Social Agency Level. Dynamic simulation has been incorporated into MISOE as a supportive process for policy making, when combined with the interactive information system which constitutes the basis of MISOE. Chapter 9 should be read by those who are at least moving toward a positive evaluation of MISOE as a result of completing Chapter 8.

Chapter 10 offers an assessment of MISOE by a state-level manager for occupational education, an economist, and an educational researcher, and they are: Dr. Charles Buzzell, Associate Commissioner for the Division of Occupational Education, Massachusetts; Dr. Jacob Kaufman, Professor, Department of Economics, Pennsylvania State University and David V. Tiedeman, Professor, Northern Illinois University. This assessment has not been written as an indepth analysis of MISOE. Its purpose is to provide a suggested framework for evaluating MISOE from three separate points of view. It is designed to help the reader reflect upon the usefulness of MISOE. It should provide an interesting reference point against which a reader can judge his evaluation.

CHAPTER 2
A FEW GENERAL DEFINITIONS AND DISTINCTIONS

William G. Conroy, Jr. and William Kyros

There seems to be a tendency among human beings working together over a long period of time to develop a language for communicating among themselves. One would expect the scope of the language to be positively related to the size and resourcefulness of the group members, and the length of time they worked together. Another predictor of language size might be the function of the group. The development of computerized information systems must rank as one of the most powerful function predictors of jargon productivity, and MISOE's overall performance on this criterion is formidable.

Typically, members of such in-groups have infrequent contact with the world at large, and they become unaware that their private set of symbols do not communicate beyond the group. Incredibly, it is not unusual for such group members to develop negative evaluations toward non-group members who cannot understand their esoteric language, and non-group members are often dismissed as an inferior batch of human beings, somehow unable to understand and appreciate beauty and truth. This seems particularly true of professional groups, and certainly workers in the field of educational development and research are not second class professionals in terms of this particular standard.

It would probably be possible for us to describe MISOE in a way that is totally incomprehensible to anyone but the MISOE staff. As a matter of bitter historical fact, the MISOE staff is guilty of having done this on a number of unforgettable occasions, and have paid a high price for each blunder. One of the causal factors of these communication failures by developers seems to be the intriguing complexity of the development process. The resolution of the enormous problems at hand always seems crucial, and there simply never appears to be time to pull together a description of progress. In fact, to the so-called development purist such activities are viewed as counterproductive, public relations forays. This is a particularly fascinating dilemma for MISOE, since its fundamental purpose is to develop an easy access, interactive computer system which involves complex technology and systems for use by the educational manager, a group typically not distinguished by its track record in applications of developments by social scientists or systems analysts.

To accomplish the single goal of this publication, i.e., to communicate an understanding of MISOE as a management support process such that a judgment of its usefulness can be made by the reader, it is necessary to stipulate a small part of the MISOE vocabulary, but this exposition will be limited to the essential minimum required to understand MISOE structure. A maximum effort is being made to keep "MISOE-eze" to a minimum, i.e., we are attempting to communicate in the common vernacular. The purpose of this short chapter is to set forth a few definitions and distinctions which are absolutely necessary to an understanding and evaluation of MISOE.

A Conceptual Structure

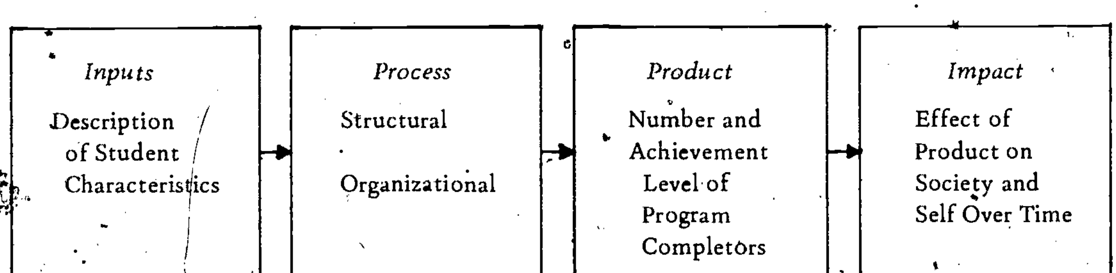
A conceptual structure is nothing more than a plan for describing and classifying the parts of a whole and the relationships among those parts. Typically, such structures are a compromise between the complexity of the whole and the need for a definable structure. Occupational education is a complex whole, managed by a wide range of individuals, from the United States Congress to the local school board, with state boards of education, state administrators, teachers' unions, advisory groups and others wedged in between. These factors suggest the need for a conceptual structure for occupational education which is both comprehensive and uncomplicated if it is to be useful as a basis for an information system designed to support management.

The four boxes in Figure 1 are offered as a visual description of the conceptual structure of occupational education upon which MISOE is based.

The conceptual structure presented in Figure 1 describes occupational education as a four element whole, in which students (input) experience a planned process. The product of occupational education includes the number of

FIGURE 1

A CONCEPTUAL STRUCTURE FOR OCCUPATIONAL EDUCATION



completors, and the capabilities of these completors which were fostered by the intervention of the educational process. The impact element of the conceptual structure is defined by:

1. The impact of the product of the educational program on society over time; and
2. The relationship between the educational process experienced by the student and his subsequent life-style.

These stark descriptors are not intended to dehumanize their objects, but rather to provide clear distinctions among parts of a totality. Regrettably, such labeling seems to accomplish both objectives simultaneously.

Arbitrarily, MISOE's conceptual description of occupational education defines expenditures as a part of the process element within the model, and assigns so-called contextual elements to input space. The contextual components include the non-school world of the student. MISOE assumes that students are, in part, defined by these factors, and that they exert an interactive influence during the student's tenure within an educational program. MISOE contents itself with measuring the effect of these influences upon the student by its comprehensive battery of measures that describe the student at point of entry into the program.

Descriptive Information

The information types of MISOE have been classified by the input, process, product and impact conceptual structure (IPPI) and are briefly described at this point.

Input Information describes the characteristics of the student at entry point into the program. This information is developed from the so-called input battery and includes a description of students' abilities, achievement, personality, values and his out-of-school environment (home, family, peer relations, etc.).

Process Information describes components of the planned educational process. This information is wide ranging, and includes such program descriptors as length, characteristics of the staff, the nature of the school organization, etc. Process variables can be thought of as a basis for hypotheses formulation to explain differences in product or impact. All process variables result from a management plan or policy, and process information describes the results of these plans as program elements. Expenditure information describes process elements in terms of dollars.

Product Information is constituted by three separate parts:

1. Simply whether the student is a completor or a non-completor;
2. A description of general educational development, and
3. A detailed statement of the occupational capabilities achieved by each completor within specific programs.

Occupational capabilities are described by objectives which are called TERMOBS by MISOE, that is terminal objectives. MISOE product information includes a comprehensive measure of general educational development to provide a basis to estimate those capabilities of completors which are not directly related to specific occupations, like reading ability or knowledge of social studies. These measures provide a basis for comparing students who have sacrificed non-occupational learning experiences to those who have not specialized in a specific program designed to develop competence within named occupations. TERMOBS represent a major development effort of the MISOE staff and will be described in some detail later in this chapter.

Impact Information attempts to describe the experience of program completors during post-program life. The impact information includes a description of both occupational and nonoccupational behavior, including measures of productivity, career patterns, voting behavior and community service.

Analytical Information

Analytical information describes relationships among the IPPI elements. Their fundamental purpose is to provide a basis for assuming causation of one IPPI element upon another, namely process on product and product on impact. In both cases such information includes controls for the human variability of students as they interact with process and the consequences of these differences in terms of product and impact. The description of the major analytical information types of MISOE assumes controls for individual differences.

Process Product Information describes relationships between sets of educational process elements and the resulting product, as described by the product measures, i.e., number of completors, general educational development or TERMOBS. *Process product information* seeks to describe systematic relationships between a level of productivity and the initiation and maintenance of a certain process mix, i.e., the interacting elements within an educational program. For example, is a faculty with an average age of 46, an average verbal IQ of 104, an average of 5 years experience in the specific occupation being offered before entering teaching and an average of 12 years teaching experience more likely to be associated with programs that produce more competent tradesmen and technicians than a faculty that is younger, on the average, but with less industrial experience before entering teaching?

MISOE's process battery represents a wide range of process elements, from fairly static characteristics like faculty age and program length to constructs like staff planfulness, moonlighting and inbreeding. In general, the process battery includes major characteristics of educational programs necessary for planning, like staff characteristics and program length, as well as a variety of constructs which are both within the reach of management control and have a high probability of accounting for product and impact differences.

Cost Effective Information is a way of relating expenditures in occupational education to product. It is a very uncomplicated analytical information type, but one which should be of some usefulness to management. In MISOE there are a limited variety of productivity descriptions:

1. *Number of completors.* Some programs are more productive than others in that they produce more completors at a fixed cost.
2. *Number of TERMOBS achieved per completor.* Some occupational education programs are more productive because they produce more students who have achieved more TERMOBS, on the average, than another program, at a fixed cost.
3. *Quality scores averaged over completors.* Some occupational education programs are more productive because they produce students who have achieved higher scores on TERMOBS than students from another program, at a fixed cost.
4. *General Educational Development.* Some programs are more productive because they produce students with higher scores on measures of general educational development than others, at fixed costs.

Cost effectiveness information must control for input variability and is always framed to reflect a balance among productivity alternatives. In spite of these controls, there seems to be a negative attitude toward the appropriateness of such information for the management of a human service like public occupational education, as it seems to smack of an "assembly line mentality." Nonetheless, educational management must frequently decide between process mixes, and one of the criteria frequently used is cost effectiveness. For example, given a fixed amount of capital, what is the optimum mix of staff and materials to graduate fifty automechanics from a secondary program each year for the next ten years? Cost effective information in MISOE is designed to provide a clear description of the relationships in occupational education between cost and productivity.

Cost Impact Information (cost benefit) describes relationships between the cost of occupational educational programs and the resulting benefits to society or specified individuals. It is an essential tool for selecting alternatives at several levels:

1. Between public education and other alternatives like health, national defense and environmental control;
2. For determining the mix between occupational and nonoccupational education; and
3. For deciding among occupational education programs; for example, should society increase the number of automechanics or reduce the number of computer programmers.

Although the development of cost benefit ratios involves the use of econometrics and an understanding of several economic principles (none very difficult), the management implications of cost benefit ratios are straightforward. Goals (benefits) are specified and quantified in dollars, while the costs of alternative programs to achieve these goals are calculated, and thus cost benefit ratios are formulated. For example, if a goal of education is to produce completors who pay maximum taxes, a societal benefit, a cost benefit analysis would rank order educational program alternatives in terms of the favorableness of their cost benefit ratios, with benefits the summation of total taxes paid over a prescribed number of years, and costs the total public expenditure for the educational program. The higher the evaluation of the ratio, the better the investment, in terms of that benefit, i.e. benefits over costs.

Cost Impact Information provides an equivalent of a system of market principals for investment in social agencies, and represents a crucial information type of MISOE. As a matter of fact, cost impact information is conceived as the single most important information type for the management of occupational education at the state level, as it is this information that provides the basis of social investment in extra cost occupational education programs. In fact, so-called marginal thinking, extra costs to extra benefits, forms the basis for investment in public education as it competes with other social agencies for limited dollars to impact upon societal goals. A current criticism of public education is based on a form of cost impact logic, and that is public education is not contributing to equalizing opportunities in terms of economic benefits, consistent with its promise, while other forms of intervention to accomplish this goal of economic equality have been suggested (Jencks, 1972). The economics of MISOE are discussed in more detail in Chapter 5.

MISOE Data Systems

MISOE has two major data systems: The MISOE Census Data System (CDS) and the MISOE Sample Data Systems (SDS). The basic distinction between these systems is that the Census Data System includes basic descriptive information about major components of all occupational educational programs, while the Sample Data Systems are detailed descriptions of a limited number of occupational education programs in a prescribed number of schools. These separate data systems are described in some detail in the next two chapters, but several basic distinctions of each system will be set forth at this time, as a part of this overview sketch of the major components of MISOE.

CDS is comprised of that information management requires of each occupational education program to meet its basic accountability responsibilities. This information includes enrollments within occupational education programs, by grade, level (secondary, postsecondary, adult), school type (comprehensive, regional vocational-technical, etc.), by geographic region, and by certain student characteristics (sex, race, handicapped, etc.). In addition, CDS describes annual expenditures by school, occupational education program, as well as information about staff characteristics and space utilization by occupational education program. CDS is considerably more complex than it appears, since it provides for integrated reporting of basic information for occupational and nonoccupational education in a way that allows for comparisons by these gross data among programs.

Another important feature of CDS is the way in which it connects information together. Essentially, CDS is a cross-sectional data system, with the school or program as a unit of analysis. Enormous development pains have been taken such that census information is maximumly crossed. For example, the reporting forms provide for crossing a description of enrollments by grade and occupational education program. Frequently, census type information systems are designed such that management is limited by aggregation alternatives. It is not unlikely to find statewide census information systems from which management can either discover total enrollments in occupational education over all grades, or the total secondary enrollment by grade. Such data systems cannot cross information by occupational program and by grade. MISOE CDS was carefully designed to avoid such limitations.

CDS also describes completors by TERMOBS achieved within occupational education programs. This is conceived as an enormously useful management tool. TERMOBS are discussed in some detail in this chapter, and the description of completors by TERMOBS within occupational education programs is described in Chapter 3.

SDS is divided into two subsystems, described as SDS(1) and SDS(2). SDS(2) includes only the secondary sector of occupational education, and is limited to the nineteen high enrollment programs (accounting for about eighty per cent of the enrollment within Massachusetts at the secondary level). SDS(1) includes a number of additional occupational education programs to those of SDS(2), as well as students from the postsecondary and adult levels. Also included in SDS(1) is a sample of students at the secondary level who are not enrolled in occupational education. The purpose of including a nonoccupational education cohort is to provide a basis for comparison to the extra cost occupational education programs in terms of both products and impact.

SDS(2) information includes a description of input, process, product and impact, while SDS(1) is limited to the input battery, the impact battery, minimum product-data, i.e., completion/noncompletion, a measure of general educational development at the secondary and community college levels and expenditure information. Put another way, process information and TERMOB test data are not included in SDS(1). Essentially, this means that process-product and cost effectiveness analysis are possible for SDS(2), while cost impact analysis is available for both SDS(2) and SDS(1).

Chapter 6 describes how Census and Sample Data Systems are connected together for interactive use by management. An important part of MISOE development has been the creation of a technical capability to connect all data files together for interactive file browsing. This is a result of a complex system of classifying and identifying data. There is no attempt to swerve into a technical discussion at this point, but it somehow seems reasonable to at least acknowledge the development effort of the MISOE staff.

USOE Codes

A preliminary discussion of USOE Codes (Vocational Education and Occupations, *U.S. Government Printing Office*, 1969) is necessary background to a description of TERMOBS. USOE Codes provide a numerical classification system for occupational education programs. USOE Codes have two numbers to the left of the decimal and up to eight numbers to the right. The numbers to the left of the decimal specify broad occupational areas, for example, health occupations, office occupations, trade and industrial occupations. As one moves to the right from the decimal number, more occupational specificity is obtained. For example, 14.000000 is the USOE Code for all office occupations. 14.0102 describes Bookkeepers.

USOE Codes provide occupational descriptors for occupational education programs, and are a basis for describing students enrolled in programs. Frequently, students are enrolled in programs which can be described by more than one USOE Code, and completors often attain a configuration of entry level occupational capabilities in more than one occupational area, as described by USOE Codes. Obviously, USOE Codes provide an important identification component of the MISOE information system.

TERMOBS (describes below) are conceived as descriptors of occupational capabilities, and MISOE provides a mechanism such that completors of occupational education programs can be described by the configuration of occupational capabilities achieved within occupational areas as described by USOE Codes. The reporting process is explained in a little more detail in the following chapter, but the important understanding at this point is that MISOE provides a structure for each local educational agency (LEA) to describe its completors in terms of the occupational capabilities (TERMOBS) which represent the configuration of entry level occupational capabilities deemed appropriate by that institution. Classification of occupational education completors on a CDS basis by USOE Codes and TERMOBS provides a basis for detailed analysis between occupational skills attained and career history. In addition, such information provides a clear set of instructional goals for educational managers.

One final point needs to be made about USOE Codes, before a brief description of TERMOBS is presented, which is that although they provide coded occupational descriptors for instructional programs of occupational education, these occupational descriptors are often different than specific job titles. Usually a USOE Code includes a variety of specific job titles, for example the USOE Code 17.3601 describes Millwork and Cabinet Occupations, which can include the following specific job titles: Cabinetmaker Foreman: Cabinetmaker; Refrigerator Cabinetmaker; Cabinetmaker Apprentice; Molding Sander; Multiple-Drum Sander; Stroke-Belt-Sander Operator, etc.

Vocational Education and Occupations, (USGPO. 1969), provides a basis for crossing USOE Codes and job titles of the *Dictionary of Occupational Titles*. MISOE provides a basis for describing a completor of an occupational education program in terms of specific capabilities. within an occupational area designated by a USOE Code or Codes. This information is basic to relating occupational education to the world of work by specific occupations, while not constraining open systems for occupational education. These distinctions are important to users of MISOE, particularly for program planning purposes.

TERMOBS

TERMOBS are performace objectives which are purposefully comprehensive, that is to say they describe substantial occupational capabilities. They have been designed to provide a description of the performances which describe occupational competence within one or several occupations. TERMOBS include the three components of the classical performance objective: *The conditions* or the equipment, machinery and supplies that are required for the execution of the performance; *the performance* or a statement of what the completor is expected to be able to do; and *the extent* or the criteria against which the performance is to be evaluated. It is important to understand that TERMOBS are limited to describing the occupational competency of completors of USOE coded occupational programs, and are not to be confused with so-called enabling objectives which describe the results of a learning task. Each USOE coded occupation is described by about sixty separate TERMOBS, which are sufficient to specify the occupational capabilities of completors. TERMOBS are limited to the psychomotor oriented outcomes of occupational education and do not treat affective goals at all.

Figure 2 presents a typical TERMOB describing the format of the TERMOB and provides a basis for understanding their use in MISOE.

The conditions, performance and extent of each TERMOB are flexibly organized, so that each school can stipulate the particular combination of conditions, performances and extents that seem appropriate for their students. The performances are coded so that 2.01 always describes a general statement of performance and the resulting product or service. Specific procedures associated with the general statement of performance are coded from 2.02 to 3.00 and are numbered sequentially to relate each procedural step to a corresponding extent. Although the steps (procedures or operations) are listed in the order in which they are to be performed, it is possible for the faculty of a local school to alter the performance sequence by the

FIGURE 2

A TYPICAL MISOE TERMOB

/ / / / /

System/School ID

Program	Electronics	Division	03	Circuit Testing
USOE Code No(s)				
		Unit	02	Amplifiers
		TERMOB No.		13-025
		No. of Completors		

1.00 CONDITION

( ) 1.01 Single-State Common Emitter Voltage Amplifier With Bias Stabilization
( ) 1.02 Schematic Diagram
( ) 1.03 List of Formulas, Tables, Graphs, Etc.
( ) 1.04 Basic Electronics Took Kit (Appendix 1)
( ) 1.05 Oscilloscope
( ) 1.06 VTVM
( ) 1.07 VOM (Conventional/Digital)
( ) 1.08 Power Supply
( ) 1.09 Signal Generators
( ) 1.10 Frequency Counter

2.00 PERFORMANCE

General Statement of Performance and Resulting Outcome
( ) 2.01 *Test a Single-Stage, Common Emitter Voltage Amplifier with Bias Stabilization* to Determine Circuit Characteristics Employing the Following Operations:

( ) 2.02 Select Proper Test Equipment
( ) 2.03 Check and Zero as Necessary All Test Equipment Used
( ) 2.04 Determine Voltage Gain
( ) 2.05 Determint Input/Output Impedance
( ) 2.06 Determine High/Low Frequency Cutoffs
( ) 2.07 Determine Power Gain
( ) 2:08 Determine Frequency Response Curve

3.00 EXTENT

General Statement of Extent and Extent of Resulting Outcome
( ) 3.01 Following Proper Procedures and Safety Precautions to Approval of a Board of Expert Raters. To Be Completed Within Two Hours With Each Step Judged As Satisfactory or Unsatisfactory

( ) 3.02 Of Sufficient Sensitivity and Characteristics To Produce Significant Values
( ) 3.03 In Accordance With Manufacturer's Procedures
( ) 3.04 Theoretical Value ± 20%
( ) 3.05 Theoretical Value ± 20%
( ) 3.06 Theoretical Value ± 20%
( ) 3.07 Theoretical Value ± 20%
( ) 3.08 Theoretical Value ± 20%

reporting process. Further, the reporting process of TERMOBS allows for LEAs to specify additional conditions or extents, accept or reject TERMOBS altogether, or specify TERMOBS not included in the MISOE file.

In summary, TERMOBS represent a process for reporting the occupational capabilities of program completors which does not restrict the range of program objectives, but is flexible and open, without sacrificing specificity. In MISOE-CDS, each occupational department in each school describes enrollment by TERMOBS, within USOE Codes. No testing of students against locally opted standards is included in the MISOE-CDS design. In SDS, however, students are tested against these criteria (criteria referenced testing), and quality scores are developed on a one to five scale, with a score of less than two a failure. This publication will not stipulate TERMOB data in detail, except to say that it includes a form of item analysis which rank orders TERMOBS by their level of difficulty as determined by the comparative performance of students. The MISOE staff proudly feels that TERMOBS represent an important development, in that they provide a basis for evaluating occupational education programs in terms of achievement, without forcing constant standards across programs.

The following are the occupational areas for which TERMOBS have been developed:

1. Distributive Occupations
2. Practical Nursing
3. Occupational Child Care
4. Accounting and Computing
5. Business and Data Processing
6. Filing, Office Machines and General Office Clerical
7. Stenographic, Secretarial Occupations
8. Automotive Body and Fender
9. Automotive Mechanics
10. Drafting
11. Woodworking
12. Electrical
13. Electronics
14. Plumbing and Pipefitting
15. Graphic Arts
16. Machine Shop
17. Metalworking
18. Cosmetology
19. Quantity Foods

Each of the occupational areas stipulated above represents a wide variety of specific occupations.

Conclusion

The basic distinctions and definitions stipulated in this chapter provide a necessary and sufficient background for an overall understanding of the structure of MISOE information systems. However, in order to use the indices and be able to work through the example of Chapter 8, it would be helpful to have more information about the Census and Sample Data Systems, the MISOE cost systems, and at least some idea of how the data within the MISOE file system is structured. It is suggested that the casual reader at least skim the next four chapters, before studying Chapters 7 and 8 in detail.

CHAPTER 3
MISOE CENSUS DATA SYSTEMS

Martin Breslow

The purpose of this chapter is to describe the important information types of the MISOE census data systems (MISOE-CDS). MISOE-CDS is comprised of information describing a few characteristics of each institution offering occupational education. The few characteristics include the minimum information required for the statewide management of occupational education, e.g., enrollments, expenditures, etc. This descriptive information provides the basis for communicating the statewide scope of occupational education in terms of these fundamental, few characteristics.

MISOE-CDS has been carefully designed to offer a census level description of a fluid and dynamic process of public occupational education. It is not unusual to find census data systems widely regarded as simple-minded classification schemes which are not capable of describing the complexities of practice. MISOE-CDS was painfully designed to accommodate wide variations in reporting occupational education practice in terms of these few characteristics. The structure of MISOE-CDS is designed to encourage variation, and not to penalize innovation with an over-structured reporting system. This is an important development, given a desire to initiate and maintain an information base for statewide planning in occupational education which is based on accurate information.

Occupational education is part of total education, and a census data system should allow comparisons between occupational and nonoccupational education in terms of these few characteristics which constitute the census data system. MISOE-CDS has been designed such that it is integrated with the existing data system for total education, thus providing a single reporting package to local school districts.

Although MISOE-CDS was difficult to develop, it is relatively uncomplicated to describe and should provide no difficulty to either the casual or careful reader. This chapter briefly outlines the important information types of MISOE-CDS as follows:

1. expenditures;
2. enrollments:
3. TERMOBS;
4. staff: and
5. instructional area.

The process for developing expenditures by occupational education programs from CDS information is described in Chapter 5. It is important to understand that the MISOE census data system has been purposefully designed to allow maximum flexibility and interactive analysis. Chapter 6 details the connections between MISOE census and sample data systems for interactive analysis, and both Chapters 5 and 6 indicate how MISOE-CDS expenditure information is used as a basis for estimating costs in the sample data systems.

A final introductory note to this chapter is to restate (Chapter 2) that MISOE-CDS was developed to maximize a cross-connection of data on the reporting forms. This is essential to provide range for interactive analysis with the MISOE census data system. Frequently, statewide census information systems are little more than a series of individual and unconnected reports grown from a variety of laws affecting public education. As a result, such "mandated information" census information systems are not organized as a part of a total management information system, vital to statewide planning for education, and are often regarded as a burdensome administrative chore, totally unrelated to the imaginative function of educational management.

Expenditure Data

Cost information is a vital descriptive characteristic for the statewide management of occupational education. Accordingly, MISOE-CDS provides cost information at the LEA, the school and the individual occupational education program level. MISOE-CDS cost data is not limited to a total cost for a program, but is available by a wide variety of descriptors within the total cost function, for example, staff, instructional materials, etc.

Cost data at the school level allows the comparison of the per pupil expenditures for occupational and nonoccupational education by level (secondary, post-secondary and adult) and by school type (self contained and comprehensive school). The cost associated with the nonoccupational education program of students enrolled in occupational education is an available cost information type within MISOE-CDS. Put another way, the cost of educating an occupational student can be divided into academic and occupational education components. These comparisons are important since one alternative to spending money in occupational education is spending money on nonoccupational education. This information is especially significant for the management for self-contained occupational education schools.

Management also needs to know how occupational education costs vary by school type. CDS school types include the following distinctions:

1. *Comprehensive Secondary Schools* — Schools in which students are enrolled in both occupational and nonoccupational education.
2. *Self-Contained Secondary Schools* — Schools in which all students are enrolled in occupational education.
3. *Academic Secondary Schools* — Schools in which no students are enrolled in occupational education.
4. *Two-Year Colleges*
5. *Other Institutions*

Secondary schools can be classified as regional and nonregional, while all schools can be classified as public or private. Cost data can be classified by USOE codes, across schools and regions. Expenditures by federal, state and local governments are also separately identifiable by program, school and LEA. Since dropouts and transfer-outs increase the average cost of program completors, CDS provides a basis for estimating cost per completor and cost per dropout for each program. Considerable detail on the MISOE cost analysis system is provided in Chapter 5. Consequently, this discription of the expenditure information in CDS is abbreviated.

Enrollment Data

The statewide management function for occupational education needs to know the real enrollment of students in LEAs, schools and individual occupational education programs within schools. Reporting enrollments at the LEA and school level is a relatively straightforward matter. MISOE-CDS describes enrollments by LEA, by grade and sex for each school and for occupational and nonoccupational education. Individual school enrollments in nonoccupational and occupational education are available by grade, race and sex. In addition, MISOE-CDS provides a description of the number of completors of occupational and nonoccupational education by level (secondary, post-secondary and adult), race and sex. Thus, the statewide management function can determine the proportion of completors by level and type of education.

Describing enrollments for occupational programs in a way that reflects real life variation is a more complex matter than merely describing enrollment above the individual program level. In some programs students are being prepared for single occupations. In others, they may be learning occupational skills for several occupations at the same time. In still other instances, students may be receiving training for several occupations in the early phases of a program, but specialize in a specific occupation toward the end of the program.

In order to be able to stipulate each of these variations, CDS provides for describing enrollments by USOE codes within each grade. Students in a program who are in the same grade and who are being prepared for an occupation described by the same USOE code or codes are considered to be enrolled in the same "student group". The enrollment in each student group is available by race and sex, as well as student type (disadvantaged and handicapped).

At the end of the school year the number of students in each group who are:

1. continuing or graduating;
2. repeating; or
3. transferring or dropping out are described.

Thus, CDS provides the state-level management function with a complete picture of the flow of students through the occupational education process, and at the same time provides a detailed description of enrollments within occupational education programs by USOE codes.

Terminal Objectives

USOE codes describe broad occupational areas. In order to provide more useful information for the state-level management function in stipulating the specific occupations for which students are being prepared, CDS provides a process for specifying the configuration of TERMOBS (see Chapter 2) attained by each student group, within each occupational education program, for each school. Students in the final grade of an occupational education program are grouped together based on the TERMOBS they have attained within student groups, previously described. Thus, if students within a single school are being prepared for the same group of occupations but with different sets of TERMOBS, then more than one group of completors exist for reporting purposes.

Each student group represents a unique combination of USOE codes and TERMOBS. These student groups are a data refinement of the student groups previously described, which included only a description of students by the broad occupational areas for which they were being prepared. This grouping is available only for the final grade.

Enrollment is reported for each of these final grade student groups by race, sex and student type. With this data, MISOE-CDS provides the state-level management function with the capability of determining the specific occupations for which students are being prepared within each program. Furthermore, the state-level management function can generate summary statistics describing the frequency with which specific TERMOBS are offered over programs, as well as a description of the numbers of students prepared with unique TERMOB combinations within occupational education programs, as described by USOE codes.

The MISOE Sample Data Systems will provide a ranking for TERMOBS based on the performance of students over time. Through this form of item analysis, TERMOBS can be classified as not difficult, difficult, or very difficult. TERMOBS in the Census Data System will be referenced with this descriptor, and thus programs can be compared in terms of the difficulty level of TERMOBS offered. Such information might be useful as a basis for explaining dropout rates, for example.

Staff Information

The description of the numbers and certain characteristics of faculty and administrators for occupational education is useful to the state management function. MISOE-CDS provides a description of the occupational education faculty in a way that they can be classified by student groups, i.e., grade, USOE codes and TERMOBS (for completors). The faculty can also be cross-classified by city or town, LEA or school, as well as by race or sex. Administrators and nonoccupational faculty are classified by city or town, LEA and school. Thus, the manager can easily determine the proportion of the state-wide educational staff involved in preparing students for occupational education in general, for specific occupations, by grade within occupations, or specified combinations of USOE codes.

In addition to providing the description of the numbers of staff in a way that they can be aggregated by a variety of dimensions within occupational education, MISOE-CDS includes information which describes the salary, degree status and work experience of the faculty for occupational education. This information is coded and connected such that it can be summarized and/or compared across grades and USOE codes within occupational education. For example, management at the state level can determine (interactively) if the faculty differs significantly by age, teaching experience or salary across occupational education programs.

Instructional Area

An important educational resource is the instructional area, i.e., the classroom, the lab or the shop within the particular school. This resource is relatively fixed and high cost, and it is particularly important that it be used efficiently. It is therefore desireable that the state-level management function have information describing the way in which occupational education instructional areas are used throughout the school year. Instructional space in occupational education is also important for allocating certain educational costs to specific occupational education programs. Thus, an important part of the MISOE-CDS information system is a description of the instructional areas used for occupational education.

MISOE-CDS information provides a description of the amount of space that is actually in use by time of day and by specific occupational education area (USOE code(s)). This information includes both floor space area and work stations. Instructional space is also rated in terms of its suitability as an instructional station for specific occupational areas.

With this information, the state-wide management function can maintain a running inventory of available space for expanding occupational education programs, not only as a total, but for specific occupations in specified geographic locations. For example, management can determine (interactively) the number of available learning stations for preparing automechanics in cities, during (1) the regular school year, and (2) during the summer months.

Conclusion

MISOE-CDS information is not complex in terms of the variety of major information types provided (expenditure, enrollment, staff and instructional area), and therefore should present no difficulty to the reader. The complexity of MISOE-CDS is caused by the range of observation units (every program) and the resulting data landslide, as well as the necessity of connecting and crossing this information for interactive analysis. Chapter 7 describes the user indices of MISOE-CDS data files for interactive analysis.

The next chapter describes MISOE Sample Data Systems, which constitute the major information bases for policy formulation. However, the process of policy development usually involves a need to know certain dimensions of the state of the real world, and therefore knowledge of the information components of MISOE-CDS is important. The advantage of crossing MISOE-CDS and SDS files during interactive policy formulation should be made obvious by the example presented in Chapter 8.

CHAPTER 4
MISOE SAMPLE DATA SYSTEMS

John A. Creager, Elizabeth Weinberger,
and William G. Conroy, Jr.

The sample data systems of MISOE provide management with most of the information necessary for policy development in occupational education. Information of the sample data systems provides the basis for assuming causation relationships between process and product, as well as describing the relationship between differential levels of achievement by students and the resulting impact on both society and the individual student. Since it is necessary for management to have a reasonably firm understanding of the basis for policy formulation as supported by the MISOE information systems, a fairly thorough description of the sample data systems will be presented in this chapter.

The text of this chapter assumes an understanding of Chapter 2, and will not repeat any of the definitions and distinctions offered in that part of this publication. This chapter is divided into four parts, and they are:

1. A description of the sample and research design of the MISOE sample data systems, including a specification of the size of the sample;
2. A comprehensive outline of the variables in each of the IPPI components of MISOE, as well as the rationale for their selection;
3. A brief statement about the MISOE security safeguard system which is designed to protect the privacy of subjects in the sample data systems; and
4. Examples of generated variables (Gen Vars), an important part of understanding the scope and power of MISOE sample data systems.

The MISOE sample data systems are not considered an exhaustive list of potentially significant variables within the IPPI elements. Nowhere is this more evident than within the process component. However, it was necessary to attain closure, such that initiation of the first cohort could be achieved. The sample data systems described below are thought of by the MISOE staff as first generation MISOE, with the obvious expectation that those who follow this pioneering effort will improve upon the first generation range of variables. Nonetheless, the MISOE sample data systems are offered as a reasonable information basis for policy formulation in occupational education at the state level.

As managers explore the experience of occupational education as described by the sample data systems from the perspective of current policy needs for future programs, it is hoped that new understandings will be launched which will make demands for different information in future MISOE generations. In the meantime, the MISOE sample data systems described within this chapter set boundaries of alternatives for policy development with MISOE. The sample data systems constitute a major part of the range of symbols which are available for computer assisted policy making in occupational education.

Sample and Research Design of the Sample Data Systems

Occupational education is not just a production line for gadgets per unit of time, but a complex process of human development with wide ranging social consequences. The sample data systems are designed to provide a rich information base necessary to understand the likely consequences of policy alternatives for complex human beings. To keep a system of data collection, storage, analysis and retrieval manageable under logistic and cost constraints, the information describing the characteristics of occupational education programs, the students served, the capabilities achieved and the social impacts of the students over future time is developed on a sample, rather than a census basis. It is for this reason that sample data systems have been so named.

The sampling design for MISOE sampling data systems (MISOE-SDS) was developed to attain a probability sample for occupational education within a state which is of sufficient size to permit scientifically viable samples of students, teachers and administrators within and among occupational programs, as well as for a comparison group of students who did not receive occupational education. Further, the sample has to be sufficiently flexible to allow analysis to be targeted upon specific levels, e.g., secondary, postsecondary and adult, or for programs within levels, for example, automechanics or data processing.

A two-stage sampling design has been adopted. At the first stage, schools are taken as the primary sampling unit and are stratified disproportionately into twelve strata. Each strata is defined by type of school and community size, as shown in Figure 1.

With comprehensive schools defined as schools which include students enrolled in both occupational and nonoccupational education and self contained secondary schools including only students enrolled in occupational education, schools were selected in each strata by recourse to a published table of random numbers. A varying sampling ratio from six to 100 per cent was used, depending upon the distribution of schools in the population in each strata. It was decided that each strata should be large enough to allow representation of all the occupational education programs at all levels. However, to accomplish this a collapse of strata was necessary as shown in Figure 2 for small enrollment programs at the secondary level and all adult and postsecondary level occupational education programs.

FIGURE 1
MISOE-SDS STRATA

Comprehensive Schools	*Self Contained Vocational-Technical Schools*
Cities and Towns (1) 75,000 or Greater	(2) 75,000 or Greater
(3) Three Largest Cities in Massachusetts	(4) Three Largest Cities in Massachusetts
Cities and Towns Between (5) 10,000 and 75,000	(6) Cities and Towns Between 100 and 75,000
(7) Towns of Less Than 10,000	(8) Towns of Less Than 10,000
(9) Regions	(10) Regions
Cell 11 3 Community Colleges	*Cell 12* 3 County Agricultural Schools

FIGURE 2
STRATA COLLAPSE FOR SMALL ENROLLMENT PROGRAMS.

	Comprehensive Schools	Self Contained Vocational-Technical Schools
Cities and Towns of 75,000 or more		
Cities and Towns of less than 75,000 including regions)		

Before moving on to the second stage of sampling, it is important to understand relationships between the occupational education programs in the sample data systems, the strata design of the sample data systems, and the information differences between the sample data systems, i.e., SDS(1) and SDS(2). These programs are as follows:

1. SDS(1) includes occupational education programs at the secondary level which have small enrollment; occupational education programs at the postsecondary and adult levels; and a nonoccupational education comparison group at the secondary and community college levels. These programs are as follows:

SECONDARY

Agriculture Production
Ornamental Agriculture
Auto Body
Cosmetology
Commercial Art
Plumbing and Pipefitting
Care and Guidance of Children
Consumer Homemaking
Metalworking

POSTSECONDARY

Community College	*Non-Community College*
Associate Nurse	Dental Assistant
Office Education	Practical Nurse
Electronic Technology	
Electrical Mechanical Technology	

ADULT

Supplemental	*Preparatory*
Office Education	Office Education
Fire and Safety Technology	Distributive Education
	Apprentice
Fireman Training	Carpentry
Police Science Technology	Plumbing and Pipefitting
Quantity Foods	Metallurgy

2. SDS(2) includes only occupational education programs at the secondary level and all IPPI information types. These occupational programs are:

SDS(2) Programs

1. Distributive Education
2. Office Education Programs
3. Automotive Mechanics Programs
4. Millwork and Carpentry Programs
5. Electronics Programs
6. Electrical Programs
7. Drafting Programs
8. Machine Shop Programs
9. Graphic Arts Programs
10. Quantity Foods Programs

From an information perspective, SDS(1) occupational programs at the secondary level do not include process and TERMOB information. No process information is gathered for the non-occupational education comparison group. However, the input and impact battery for these groups is exactly like that of SDS(2), and expenditure information and the estimation of general educational development is included in the data file. Postsecondary, community college programs include the same data types as secondary SDS(1) programs, while students of postsecondary, non-community college programs and adult programs are measured by a special input battery, and there is no measure of general educational development included. It should be noted that some programs occur at different levels, for example office education and quantity foods. In total, there are forty schools in the MISOE sample data systems in all strata, and all information for all levels and programs is gathered within these schools. There are about 15,000 students in all sample data systems, with approximately 6,500 in SDS(2) and 8,500 in SDS(1).

The first stage sampling weights to be applied to sample data in estimating population parameters are simply inverse sampling ratios. These, however, vary by program and level, because not all schools in a stratum offer all programs at all levels.

The second state of sampling is to be accomplished within the schools selected by the first stage. All administrators and teachers associated with the SDS(1) and SDS(2) programs in a sampled school are expected to participate in MISOE. For the sampling of administrators and teachers, the second stage weights are expected to be very close to unity. Entry level students in each relevant program are sampled at varying ratios, with weights equal to the inverse of the sampling ratio. The pattern of sampling ratios is constrained by the total amount of testing that can be arranged at reasonable costs for all schools and programs. It turns out that 100 per cent sampling is possible for students entering a program within a school up to an enrollment of about thirty students. Beyond that level, the sampling ratios drop off accordingly. It should be noted that most analysis will be based on aggregates across sampled schools and then across strata so that the samples on which particular analyses are based will be of sufficiently large size to ensure reasonable precision in aggregate estimates of population characteristics. However, with fixed logistic and cost constraints, MISOE has opted to trade off some precision in order to obtain its richly varied information base.

The weights actually applied to student data for computing aggregate estimates and for conducting analyses relevant to the population will be the product of the first stage and second stage weights. Given the probability sampling design, these weights produce statistically unbiased estimates of aggregate population characteristics. Such inferential statistics will, however, be subject to considerable amounts of sampling error.

Because MISOE has decided upon two-stage sampling with disproportionate stratification, the typical formulae for the standard errors of commonly used statistics, e.g., the standard error of a mean or percentage, are not applicable. The appropriate formulae are known for some aggregate statistics, but require special and costly computer software development to make them available in a systematic way to the interactive user of the system. The user will not be overly concerned by these technical considerations, nor should he be so distracted. Rather, he may be expected to focus interest on substantive interaction with the data base to generate, develop and test policy-oriented questions. Nevertheless, MISOE plans, as a part of its own administrative and quality control responsibilities, to compute estimates of precision in its aggregate statistics for some extreme and typical cases. MISOE recognizes its scientific responsibility to report such information in the appropriate technical journals.

It should be noted that if higher precision is desired, it can only be attained at cohort replacement time and under either or both of two conditions:

1. More funds are available to permit testing and processing data for larger samples; or
2. Sufficient analysis has been accomplished to indicate which factors now measured in the data base are unpredictive of educational quality and impact or are redundant and can be eliminated from the data base.

The sampling and weighting considerations just described are subject to certain adjustments for logistic problems that inevitably arise in a program of this magnitude. Allowance has been made in MISOE development for detection and treatment of such problems. Much more important is the fact that additional weighting factors are required for replicated impact measurement. This arises because the students are no longer under the jurisdiction of the school and must be contacted by mail. Because respoonse to mail surveys is not a random process, the additional weighting factors must do double duty; adjust aggregate counts for the amount of nonresponses, and correct for the bias due to nonresponse. Fortunately, MISOE will have extensive input, process, and product information in terms of which respondents and nonrespondents can be compared. Given this information, weights can be developed based either on actuarial tables defined by such variables contrasting the two groups, or on regression estimates of the probability of response, given the characteristics of individuals in the mailout group. The weights are functions of reciprocals of such estimated probabilities and are applied to the records of the respondents. For inter-element analysis, the impact response weights can be multiplied by the two-stage sampling weights to derive the appropriate weight for representing the original cohort populations.

One of the features of the MISOE sample data systems is that the information retrieved by the manager will have been weighted in such a manner that it is applicable as estimates for the populations of students and programs in which he is interested, rather than only for the samples. This is accomplished by a system of posting the appropriate weights to the data files at data entry time.

The *research design* of the MISOE sample data systems is longitudinal. This means that sample cohorts of students entering the educational programs noted in the previous section are followed over time through the educational process, to becoming an educational product, and finally entering the social, economic and cultural life of American society and making their impact upon that society over time. Thus, MISOE sample data systems obtain extensive data on the input characteristics of students, as well as on such measurable aspects of the educational process as teacher and administrator characteristics, physical environments and instructional strategies. Then, MISOE measures the quality of the product with a unique combination of traditional and criterion-referenced measurement techniques. Finally, MISOE sample data systems obtain extensive data at subsequent points in time (1 year, 5 years, 10 years after program completion) describing on-the-job performance and the many aspects of the former student's life as a citizen. Such impact information also describes the return to society of its investment in the student.

The major advantage of a longitudinal research design is the connectability of the data over time for each student in the sample cohort, such that the complex and real-life process is mirrored by the data system. Thus analysis is not confined to within input, process, product, or impact, but can also be carried out across these elements, to describe the crucial relationships required for policy determination.

An important feature of a longitudinal research design is that is allows analysis to account for individual differences. For example, students can be differentiated by a variety of input characteristics, and studied as they move through education and into society. These groupings can be developed as a result of a differential impact or achievement. For example, a manager might be interested in discovering if the cost of training for students who are of average intelligence but come from homes supportive of education is very different than students of average intelligence from homes not supportive of education.

The major disadvantage of a longitudinal design is the time required to obtain complete data across all elements for a sample cohort. This design requires certain risks to be taken in regard to continuing support commitments. Fortunately, one does not have to wait until all the data are in to perform relevant analysis. Moreover, the apparent high costs of a longitudinal design are offset by the benefits of connectability as noted above.

For instructive purposes, a brief comparison with a longitudinal research design to two other design alternatives is now offered. These two research designs are called cross-sectional and assessment.

In the cross-sectional design, the four elements (input, process, product and impact) would be separately measured, each with a different sample cohort having passed through the system at different times. Not only is there no real connectability across elements, but one must make some dubious assumptions to the effect that there are no temporal changes in the culture that might effect different cohorts educated at different times, that one cohort is equivalent to another in input characteristists, and that all cohorts have experienced the same educational process. Also, if all four elements were measured on different cohorts at the same time, it would be very costly and very difficult (logistically) to obtain the rich variety of information on any of the four elements that is possible under a longitudinal design. Moreover, it should be recalled that some large and expensive studies have been severely criticized for trying to make causal inferences from a cross-sectional data base.

The assessment design is primarily concerned with ascertaining what progress students have made toward the attainment of selected educational objectives. Thus, "census-like" data are obtained on samples of such groups, usually focused on what MISOE calls product data. Assessment is typically not designed to evaluate the effectiveness of the educational process, but usually seeks to estimate educational attainments of groups of people. Therefore, in MISOE terminology, it gathers and summarizes product data with only a few demographic characteristics (like age and grade level) to define a few subgroups of interest. Its data are not connectable.

Like MISOE product data, assessment tends to use criterion-referenced measurement of defined educational objectives. As diagnostically useful as they are, assessment data are highly restricted in their ability to aid management in policy and decision making purposes. The longitudinal design includes the positive values of both cross-sectional and assessment designs, but provides a basis for differential analysis, using the individual student as a unit of analysis. A longitudinal research design reflects stages of growth for individual and complex human beings through life as a student and on into citizenship. Non-longitudinal research designs are severely limiting for interactive analysis and make it virtually impossible to do any analysis across elements. The policy-making example of Chapter 8 should make clear the advantages of a longitudinal research design in supporting an interactive information system designed to support policy formulation.

Selection and Specification of IPPI Variables

Considerable detail is provided in describing the selection process of the input and process batteries, as a way of indicating the care with which MISOE has been constructed. Less attention is paid to product variables, as they have already been described. Impact is measured by two instruments, and therefore does not require the same breadth of coverage as input and process. A reader is advised to skim this section of the publication until after he has had an opportunity to become involved in the simulated, policy-making experience of Chapter 8, unless he has a particular interest in the scope of the MISOE sample data systems. This chapter does provide a statement of the range of information available to interactively support policy formulation and is therefore a useful reference.

Input Batteries Because of the wide range of ages included in the MISOE-SDS(1) and SDS(2) samples and because the adult education programs differ in duration and content from secondary and postsecondary community college-level programs, two MISOE input batteries were assembled. MISOE Input Battery I is to be administered to SDS(1) and SDS(2) students at the secondary and postsecondary community college level. Input Battery II is to be administered to SDS(1) students at the adult and postsecondary, noncommunity college level. The individual instruments that comprise the batteries are described in a later section.

Several complex factors were involved in the selection of any given commercial instrument for inclusion in either of the MISOE test batteries. One of the major concerns was that each battery include a comprehensive sample of those measurable student characteristics or behaviors which, on the basis of prior research findings or our current hypotheses, appeared most likely to be related to product and/or impact data. Thus, each instrument included in either of the MISOE input test batteries was evaluated in terms of its likely value as a predictor of student outcome or behavior.

A second related consideration involved in the selection of input instruments was that each of the input batteries include a comprehensive measure of diverse student behaviors and characteristics. Thus, it was decided that each of the input batteries should include cognitive and noncognitive measures, verbal and nonverbal measures, measures of ability, achievement, personality, values and attitudes, background information, including factors such as socio-economic status, educational and occupational aspirations, relationships with family and peers, etc.

A third consideration for every instrument included in the MISOE input test batteries was the psychometric properties of the instrument, particularly reliability and validity. Only those instruments which we adjudged to be psychometrically sound on the basis of information provided in the test manuals and the independent reviewers in O. K. Buros' *Mental Measurement Yearbooks* were included in the batteries.

A fourth consideration was whether a given instrument conformed to the specific needs of the MISOE research paradigm. For example, we had originally intended to include one of the commercially available interest inventories in one or both of our input batteries. One of our requirements for an interest inventory, in addition to the previously stated considerations, was that it be equally directed toward the interests of occupational education and nonoccupational education students. After carefully reviewing each of the well known commercially available inventories that met all of our other requirements, it was decided that none of them conformed to this specific need. We instead constructed out own Occupational Aspirations Inventory and included it as an item in our Pupil Inventories. (The Pupil Inventories will be discussed in detail at a later point in this chapter.) The Pupil Inventories themselves were constructed in-house because of our specific requirements. The rationale for our selection of the instruments or commercially available parts of these instruments included in Input Batteries I and II, respectively, is detailed in the following section of this chapter.

A fifth consideration, in addition to those already mentioned, involved the amount of time required to administer a given instrument. In order to keep total battery administration time to a minimum, all other things being equal, the least time-consuming instrument was chosen. Testing time for Input Battery I is five, one-half school days, while testing time for Input Battery II is five hours.

The rationale behind selection of commercial instruments included in Input Battery I is as follows:

I. The Cognitive Measures

As previously mentioned, MISOE is concerned with obtaining a wide range of cognitive measures in Input Battery I.

A. The Iowa Tests of Educational Development (ITED)

One of our major requirements for an achievement battery was that it could be used as a measurement of general educational development in a pretest, posttest type design. The measure of general educational development is to be administered as part of Input Battery I to SDS(1) and SDS(2) students at the very beginning of their enrollment in an occupational or nonoccupational education program. These same students are to be retested on this same measure of general educational development at the end of their respective programs. Comparisons can then be made between the change scores of various student groups, for example, occupational vs. nonoccupational education students, on the measure of general educational development. One of our major considerations in selection for a G.E.D. measure was that the change score on this measure reflect primarily curriculum effects given similar student types. However, since the instrument used to assess general educational development is to be administered on a statewide basis, it was essential that the instrument which was selected cover a wider range of knowledge than that which would be likely to be encompassed by any given curriculum. After reviewing each of the major commercially available achievement batteries, we narrowed the field down to the two instruments which appeared to best meet the majority of our requirements. These were:

1. The Stanford Achievement Tests High School Battery, and
2. The Iowa Tests of Educational Development, High School Battery

On the basis of the fact that the Iowa had been used extensively for many years, whereas, the Stanford battery was relatively new, and because the Stanford Achievement Tests are keyed to grade norms, we decided to select the Iowa Tests of Educational Development as our achievement battery.

In addition, the ITED yields a composite score derived from the Reading

Total, Language Arts Total and Mathematic scores which was suspected to correlate highly with a traditional IQ measure. MISOE wanted to include an IQ measure in Input Battery I as it was felt that the IQ score offers a powerful predictive tool. The MISOE staff is aware of the many legitimate criticisms of the IQ when used as a sole measure of aptitude; however, it was felt that these criticisms were not as applicable to a test battery which also used the Culture Fair Intelligence Test as a measure of general ability.

B. The Differential Aptitude Test (DAT)

Our primary criteria for multi-aptitude battery was that the aptitudes measured not be highly correlated with measures yielded by the Iowa Tests of Educational Development (i.e., that it contribute a unique valid variance) and that it provide measures of aptitudes which were most likely to be related to product or impact data (i.e., its predictive value.) We narrowed our choices down to the two instruments which appeared to best meet our criteria, these being: 1) The General Aptitude Test Battery (GATB), and 2) The Differential Aptitude Tests (DAT). A careful study of these instruments revealed that the DAT would be preferable to the GATB in terms of the unique valid variance provided if used in conjunction with the ITED. Based upon this finding, as well as a hunch that the DAT would be more appropriate for administration to the diverse MISOE sample, it was selected as the multi-aptitude battery instrument.

After examining the DAT, it was decided to include only selected scales in Input Battery I for two reasons; Firstly, some of the aptitudes measured by the DAT appeared to be very similar to scales included in the ITED. Indeed, the combined Verbal Reasoning and Numerical Ability score of the DAT was found to correlate highly (.80's) with the composite score of Form X-35 of the ITED. Secondly, in order to keep total test administration time to a minimum, while still including a wide range of measures, it was necessary to be very selective.

Thus, the first two scales of the DAT which were eliminated were Verbal Reasoning and Numerical Ability. The DAT Language Usage Scales were also eliminated from Input Battery I because of their similarity to related ITED Scales. It was also decided that the Abstract Reasoning Scale need not be included because it would not add much unique valid variance above that provided by the DAT Space Relations score (r=.63) and the Culture Fair IQ score.

It should be noted that we decided to truncate the DAT rather than the ITED for several reasons. Firstly, the DAT is constructed so that separate scales can be fairly easily administered; this it not true of the single booklet ITED. Secondly, MISOE uses the ITED in a pretest posttest design and this argued for keeping the instruments intact in order to obtain the maximum number of change scores.

C. The Culture Fair Intelligence Test – Scale 2

The decision to include the Culture Fair Intelligence Test in the input batteries was based on several factors. Firstly, since the input batteries were to be administered to a statewide sample of Massachusetts students of varied cultural and socioeconomic background, it was felt that an ability measure which is relatively unsubject to cultural and socioeconomic biases as is claimed in the Culture Fair Manual could be a valuable addition to the battery. Secondly, it was felt that a Culture Fair (i.e., language-free) test might be a better predictor of the outcome behaviors of the less verbally oriented students than ability or achievement measures which are highly dependent upon command of the English language. Inasmuch as the primary focus of the MISOE sample is the occupational education student, and since it can be hypothesized that many of the students who choose the occupational education curriculum are less verbally oriented than students who choose the traditional academic curriculum, it was felt that a nonlanguage ability test might be a more effective predictive tool for this sample of students.

After we had made the decision to include the Culture Fair, it was necessary to decide which of the two higher level scales to use and for whom. According to the manual, Scale 2 is designed, for children 8-14 years old and for unsettled (non-college) adults. Scale 3 is designed to discriminate among higher ranges of intelligence from high school age through adulthood. In order to maximize analysis flexibility and because of the logistics of the testing process it was preferred to use one scale for students at all levels in our sample. After carefully examining Scale 3 the staff decided that it would probably prove to be too difficult for the majority of our sample; Scale 2, on the other hand, seemed to present the appropriate level of difficulty for the majority of our sample, but ran the risk of "topping out" with the four-year college bound students and/or the community college students, for whom we were less apprehensive than the bright four-year college bound students because we did not expect that the community college students would be significantly different than the majority of the secondary level students. Consequently, Scale 2 was administered to several members of the MISOE staff who obtained high, but not perfect scores. It was decided to use Scale 2 for all students in the sample.

II. The Noncognitive Measures

The noncognitive measures included in Input Battery I and the rationale behind their selection are as follows:

A. The Junior-Senior High School Personality Questionnaire

In the area of personality measurement the choices were narrowed to the three following instruments which appeared most consistent with MISOE requirements: 1) The California Personality Inventory (CPI); 2) The 16 Personality Factor Test (16PF); 3) The High School Personality Questionnaire (HSPQ), essentially a high school level form of the 16 PF. The CPI was highly praised by reviewers in Buros (1965) for the empirical method by which it was developed. The 16 PF and HSPQ did not appear to be as psychometrically sound as the CPI, but offered other advantages. Firstly, it was felt that the language used in the CPI might be too sophisticated for some of the students in our sample. Secondly, the CPI would contribute least in terms of unique valid variance to the battery. Therefore, it was decided to eliminate the CPI from consideration.

Once again, because of the logistics of the testing situation and the desire to maximize analysis flexibility, it was hoped MISOE could use only one personality measure for students at all levels in our sample. It was felt that some of the language in 16 PF might be a problem for certain students. The language employed in the HSPQ did not present this problem. After careful examination of the HSPQ questions it was decided that they would be appropriate for students at all levels and therefore it was decided to use the HSPQ as personality measure.

B. The Survey of Personal Values and the Survey of Interpersonal Values

The decision to include the two Values Surveys in the input battery was based primarily upon a judgement that the values purportedly measured by these Surveys (e.g., leadership, goal orientation, practical mindedness) might prove to be of significant value. The criterion validity data provided in the survey manuals also presented interesting research possibilities. The Values Surveys also met all of our other criteria.

C. The Survey of Study Habits and Attitudes (SSHA)

The SSHA purportedly measures study habits, motivation for studying and certain attitudes towards scholastic activities which are important in the classroom. The decision to include this instrument in Input Battery I was based upon the assumption that the attitudes measured might prove to be significantly related to scholastic achievement and that this instrument might therefore contribute to the predictive value of the battery.

The SSHA is available in two forms, a high school form and a college form. After reviewing both forms it was decided that the high school form could be used for students at all levels in our sample, whereas the college form contained language that might be too sophisticated for some students. We therefore decided to use the high school form.

III. Inhouse Instruments Developed for Input Battery I

As previously mentioned, MISOE developed its own instruments in those instances in which commercially or otherwise available instruments did not meet staff specifications.

A. The Cover Sheet

The necessity for the Cover Sheet which identifies name, address and birthdate was created by the decision to employ a security link system for MISOE data. The main purpose of the Cover Sheet is to enable the link agency to assign a permanent identification (PID) number to a given person's data.*

B. The Student Master Identification Form (SMIF)

The Student Master Identification Form contains information about those basic and personal student characteristics which could be used to classify students for research purposes. This form is also used to identify the unique program in which a given student is enrolled, and, for occupational education students, the student's grade and USOE code configuration.

*See Security Safeguard System later on in this chapter.

C. The Massachusetts Pupil Inventory

Early on in the developmental stage of the input batteries it had been decided than an attempt would be made to assess those contextual variables (i.e., variables describing those experiences or conditions in a student's life which are exterior to the current school experience) that appeared most likely to be related to pupil outcome behaviors. Some of the contextual variables sought were: peer group influence; relationship with parents; socioeconomic and educational background data, etc. In addition, it was hoped that the pupil inventory could contain the following additional information that was not obtainable from our other instruments; educational aspirations of pupils, peers and parents; pupil occupational aspirations and pupil self concept.

None of the previously available pupil inventories that were examined combined all of the infromation that we sought. We therefore decided to construct our own pupil inventory using questions from previously available questionnaires, as well as items developed inhouse.

Items from previously available questionnaries were used whenever possible because it was felt that this would increase the reliability of our instrument and reduce the necessity for conducting large-scale reliability studies. The pupil inventory was field tested in various stages of development on approximately 500 secondary level students of varying levels of ability. Some of these students were given the inventory in very small groups and interacted with the developer on these questions which presented problems. The other students were told to comment in the margins whenever they had a problem with a question. All of the questionnaries were carefully examined; the final copy reflects all necessary changes in content, structure or language of the questions as revealed by the field-testing process.

The Rationale Behind Selection of Commercial Instruments included in Input Battery II is described below:[1]

I. The Cognitive Measures

A. The Culture Fair Intelligence Test

The same rationale for selecting this test for Input Battery I applies to its inclusion in Input Battery II.

B. The Differential Aptitude Tests (Form L)

Two additional scales of the DAT in addition to those included in Input Battery I were added to Input Battery II. These are: 1) Verbal Reasoning, and 2) Numerical Ability. These scales were added to Input Battery II for the following reasons: Firstly, the absence of the ITED in Input Battery II necessitated the addition to Input Battery I of measures of the very basic verbal and numerical skills obtained in Input Battery I from the ITED. Secondly, the combined verbal reasoning plus numerical ability scores yielded by the DAT provides a measure of general scholastic aptitude or intelligence.

[1] Input Battery II is basically a truncated version of Input Battery I. Therefore, the rationale for the selection of most of the instruments included in Input Battery II has already been discussed in the previous section.

It was felt that this score, like the composite score yielded by the ITED might be a powerful predictor of student outcome behaviors.

II. The Noncognitive Measures

Because the total testing time allotted to Input Battery II is much less than that allotted to Input Battery I, it was decided that the number of noncognitive measures included in Input Battery II be quite limited. It was decided that the two Values Surveys included in Input Battery I should represent the noncognitive measures in the second Input Battery for two reasons. Firstly, these two instruments appeared to be the most appropriate noncognitive measures available in Input Battery I for the adults in our sample. (Whenever possible we wanted to use the same instruments in both batteries to maximize analysis flexibility). Secondly, it was felt that the variables measured by these Value Surveys had the greatest potential predictive value in terms of student outcome behaviors. The rationale behind their inclusion in Input Battery I also applies to their inclusion in Input Battery II.

III. Inhouse Instruments Developed for Input Battery I

The Cover Sheet, Student Master Identification Form and an adult level version of the pupil inventory (The Massachusetts Adult Level Pupil Inventory) were included in Input Battery II for the same reasons that they were included in Input Battery I. It should be noted that the MALPI was field tested in the same manner as the MPI, with a sample of approximately 100 adult level students.

A Look at the Instruments

This section will detail the scores or variables generated by each of the instruments included in each of the Input Batteries. The psychometric properties of the commercially available instruments will not be discussed as this information is readily available from the test manuals as well as other independent sources. It should be noted at this point that the decision was made to include only raw scores in the input section of the MISOE data entry system.

Input Battery I

A. *The Iowa Tests of Educational Development, Form X-5.*

The 13 ITED scores to be entered in the input section of the MISOE data system for all students, except adults and noncommunity college, post-secondary students are:

1. Reading Comprehension Score
2. Vocabulary Score
3. Reading Total Score (derived from scores 1 and 2)
4. Language Usage Score
5. Spelling Score
6. Language Arts Total Score (derived from scores 4 and 5)
7. Mathematics Score
8. Composite Score (derived from scores 3, 6 and 7)
9. Social Studies Background Score
10. Social Studies Total Score (derived from scores 1 and 9)
11. Science Background Score

12. Science Total Score (derived from scores 1 and 11)
13. Use of Sources Score

B. *The Differential Aptitude Tests, Form L*

The 3 DAT scores included in Input Battery I are:

1. Mechanical Reasoning Score
2. Spatial Relations Score
3. Clerical Speed and Accuracy

C. *The Culture Fair Intelligence Test, Scale 2, Form A*

The 5 scores yielded by this test are:

1. Series Score
2. Classification Score
3. Matrices Score
4. Conditions (Topology) Score
5. Total Score (to be converted into IQ score)

D. *The Junior-Senior High School Personality Questionnaire, Form A*

The popular terms for the 14 primary scores to be included in the input data system for Input Battery I students are:

1. Factor A Score (Reserved vs. Warmhearted)
2. Factor B Score (Dull vs. Bright)
3. Factor C Score (Affected by feelings vs. Emotionally stable)
4. Factor D Score (Undemonstrative vs. Excitable)
5. Factor E Score (Obedient vs. Assertive)
6. Factor F Score (Sober vs. Enthusiastic)
7. Factor G Score (Disregards rules vs. Conscientious)
8. Factor H Score (Shy vs. Adventurous)
9. Factor I Score (Tough-minded vs. Tender-minded)
10. Factor J Score (Zestful vs. Circumspect Individualism)
11. Factor O Score (Self-assured vs. Apprehensive)
12. Factor Q_2 Score (Socially group dependent vs. Self sufficient)
13. Factor Q_3 Score (Uncontrolled vs. Controlled)
14. Factor Q_4 Score (Relaxed vs. Tense)

E. *The Survey of Interpersonal Values*

The 6 values scores yielded by this instrument and their definitions as offered in the manual are:

1. Value for *Support* Score: Being treated with understanding, receiving encouragement from other people, being treated with kindness and consideration.
2. Value for *Conformity* Score: Doing what is socially correct, following regulations closely, doing what is accepted and proper, being a conformist.
3. Value for *Recognition* Score: Being looked up to and admired, being considered important, attracting favorable notice, achieving recognition.
4. Value for *Independence* Score: Having the right to do whatever one wants to do, being free to make one's own decisions, being able to do things in one's own way.

5. Value for *Benevolence* Score: Doing things for other people, sharing with others, helping the unfortunate, being generous.
6. Value for *Leadership* Score: Being in charge of other people, having authority over others, being in a position of leadership or power.

F. *The Survey of Personal Values*

The 6 values scores are:

1. Practical Mindedness
2. Achievement
3. Variety
4. Decisiveness
5. Orderliness
6. Goal Orientation

G. *The Survey of Study Habits and Attitudes, Form H*

The 7 scores yielded by this instrument are:

1. Delay Avoidance Score
2. Work Methods Score
3. Study Habits Score
4. Teacher Approval Score
5. Educational Acceptance Score
6. Study Attitudes Score
7. Study Orientation Score

H. *The Massachusetts Pupil Inventory (MPI)*

Below are listed suggested Generated Variables measured by the MPI and the corresponding MPI items. Next to each item is listed the variable name. This is merely a suggested list, and more information on item combining is discussed in the final section of this chapter.

Suggested Generated Variables from the MPI	*MPI Items*
1. General Student Background Information	1,2,3,6
2. Student Educational Background Information	11,12,13,14,15,16
3. Financial Status of Student	4,5
4. Foreign Language in Home	6,30
5. Educational Aspirations of Student, Mother, Father, peers.	17,41,62,63
6. Independence of Student	4,19
7. Socioeconomic Background	20-29
8. Educational Example of Older Siblings, Parents	33,35,51
9. Peer Group Factors	36,37,38,39
10. Self-concept	40
11. Social Activities	42,43,44
12. Family Financial Matters	53,54
13. Relationship with each Parent	55,56,57,58,59,60,61
14. Parental Interest in School Work	64,65
15. Control of Environment	67,68,75

Since Input Battery II is a truncation of Input Battery I, it is unnecessary to include a list of the subscores. It should be noted that there are two subscales of the DAT added, Verbal Reasoning and Numerical Ability. The MALPI does contain some differences from the MPI, but essentially the two instruments obtain the same information.

Process — Process information is to be collected in ten high-enrollment occupational education programs and to include only variables that are common across all programs. It was felt that this design offered the advantage of enabling comparisons of the effects of a given process variable in different programs, and thus contributes to analysis flexibility. Future generations of MISOE development can deal with specifying process variables within particular programs.

One additional constraint upon the choice of process mix variables was the fact that the MISOE research design specified product data was to be collected only once at the end of a given cohort's program. Since one of MISOE's stated objectives was to be able to establish the ability of a given process variable or of the individual variables which constitute a process mix to predict achievement as measured by product data, it followed that the process variables which we chose to investigate should be those variables which could be examined on a time series basis over the length of a given cohort's program, or those process variables that remain relatively stable over time. Therefore, we eliminated from consideration all process variables which were unique to a given time period within a cohort's program (e.g., the extent of teacher-pupil interaction in a given class), and concentrated instead of those variables which could be repeatedly measured over the length of the program (e.g., $\bar{X}$ teacher age).

The process variables which were finally selected fell into one of two following categories: non-construct-type process variables and construct-type process variables. The non-construct-type process variables were defined as those unidimensional process variables which are relatively easily measured or assessed (e.g., teacher age, number of years and type of previous work experience, etc.) The construct-type process variables were defined as those multidimensional conceptual process variables which because of their complexity are relatively difficult to quantify or asses (e.g., teacher morale). It was our belief that these complex, multidimensional construct-type process variables offered the most promise in terms of their ability to predict the criterion measure.

A Review of the three MISOE Process Batteries — Three process batteries were developed for the purpose of collecting process information. These batteries are: The Teacher Process Battery, The Administrator Process Battery and The Student Process Battery. Each battery consists of a grouping of self-report questionnaries or inventories. Other types of measures had been considered for the collection of process data but had ultimately been rejected for first generation MISOE.

A. The Teacher Process Battery

1. The Massachusetts Occupational Education Teacher Survey (MOETS)

The MOETS represents a combined version of two earlier instruments developed by MISOE Staff: The Massachusetts Teacher Inventory and the Occupational Education Survey. The major process variables included in the MOETS are:

a) Teacher Background: This category of process variables includes information concerning educational attainment, previous work experience, degree of inbreeding (a construct type variable which assesses the extent to which a given teacher is a product of the locality in which he/she teaches.)

b) Current Professional and Extraprofessional Work Activities: Included in this group of variables is information concerning teacher load (i.e., amount and type of current teaching activities) and extent of moonlighting activities (i.e., amount of time spent working on other jobs concurrently with teaching).

c) Teacher Activities Directed Towards Keeping Abreast of Recent Developments in His/Her Occupational Area Specialty Subject: This construct-type process variable attempts to assess the extent to which and the means by which occupational education teachers keep up with the recent knowledge and practices that develop in their trade area. The hypothesis is that the extent to which occupational education teachers keep up with their trade will be significantly related to pupil achievement (i.e., teachers who keep up with their trade will be significantly more effective as measured by pupil performance on impact objectives). A committee of occupational education teachers were consulted in order to determine the range of activities in which teachers engage in order to keep up with new developments in their trade areas. The questions were developed using this information.

2. The Teacher Program Questionnaire (TPQ)

The TPQ is a semantic differential attitude scale developed by Dr. Ralph C. Wenrich of the School of Education at the University of Michigan. Originally, the scale was used to assess attitudes toward occupational education. We are using the scale to assess, in this case, the positiveness of a given teacher's attitude toward the particular occupational education program that is his/her teaching specialty area, as measured by a single score representing an average of his/her response to each of the twenty scaled items.

3. The Image of Vocational Education Questionnaire (IVE)

The IVE is a Likert scale attitude questionnaire, also developed by Dr. Wenrich, to assess an individual's attitude toward vocational education. We will use a single average score to represent the positiveness of a given teacher's attitude toward occupational education in general.

4. The Purdue Teacher Opinionnaire (PTO)

The PTO is a commercially available Likert-type attitude questionnaire which is designed to provide a measure of teacher morale. The PTO met MISOE standards in terms of being psychometrically sound and was included in the Process Battery because it was hypothesized that teacher morale might be found to be significantly related to pupil achievement.

5. IQ as Measured by the Verbal Reasoning Scale of Form L of the Differential Aptitude Tests

MISOE staff examined several commercially available short-version IQ tests in our search for an appropriate instrument to include in the Teacher and Administrator process batteries including, the California Short Form Tests of Mental Maturity, the Otis-Lennon Tests of Mental Ability, the Otis Quick Scoring IQ Test. MISOE was particularly interested in obtaining a measure of verbal intelligence. Coleman (1966) had used a measure of verbal facility of teachers in his 1966 study and had found some relationships between this and student achievement. We hypothesized that a measure of teacher verbal reasoning might be even more positively related to pupil achievement.

The Verbal Reasoning Scale of the Differential Aptitude Tests is aimed at the evaluation of an ability to abstract or generalize and to think constructively, rather than at simple fluency or vocabulary recognition. It appeared to be the type of measure that the staff had been looking for. The only reservations were: firstly, would the test provide adequate discrimination given our sample of teachers and administrators, (i.e., would it top out?) and, secondly, would the teachers and administrators resent taking a test which had been administered to part of our student sample?

The Differential Aptitude Tests are, according to the Sixth Mental Measurement Yearbook (Buros, 1965), appropriate for grades 8-13 and adults. Furthermore, several studies are reported in the DAT Manual on the appropriateness of the DAT for administration to college freshmen at several different types of schools. In addition, we examined the content of the Verbal Reasoning Scale and decided that it probably would be appropriate for our sample of teachers and administrators. This decision was also based upon the fact that the Verbal Reasoning Scale correlates quite highly with other measures of verbal IQ, as reported in the test manual, and it has been shown that Verbal IQ scores are fairly stable over time. Our second concern that teachers and administrators might resent being tested on an instrument given to the student sample was mitigated by the fact that there would be a considerable time lag between the student and teacher administrations.

6. The Planning Activities Sheet for Teachers and Administrators (PASTA).

One of the construct-type process variables which we decided to investigate in first generation MISOE was termed "Planfulness." Travers states in *An Introduction to Educational Research* (1969, p. 42) that "the emerging concept of the curriculum held by research workers and others is that it consists of all the planned conditions and events to which the pupil is exposed for the purpose of promoting learning. . ." It is the planning for those conditions and events that we decided to investigate with the Planfulness process variable.

The decision to investigate the planfulness process variable was based upon the hypothesis that the amount of planning and/or the type of planning activity engaged in by teachers might prove to be significantly related to student outcome behaviors (i.e., achievement as measured by product data). There is a definite dearth of previous research in this area as was discovered when we conducted a search of the literature for studies relating the benefits of educational planning to student achievement.

Two interactive dimensions of teacher planfulness to be examined in the process research design are:

1) The Planning Mode: How many hours of planful activity occurred under each of the following planning modes?
   a) By the teacher planning alone?
   b) By the teacher planning with others at an administratively initiated meeting (initiated at the department head level or above).
   c) By the teacher planning with others at a nonadministratively initiated meeting (initiated below the department head level).

2) The number of Planful Hours Expended in Each of Nine Areas of Educational Activity

The educational planning areas selected for inclusion in this instrument were those major planning areas which we hypothesized would be most likely to be related to pupil achievement. A committee of occupational faculty met for one month on a weekly basis with a MISOE staff member to help determine which educational planning activities should be included in the instrument. It should be noted that the PASTA was developed for administration to both teachers and administrators. Thus, the educational planning activities chosen were, in addition, those that are performed by either or both of these groups. The planning activity variables measured by the PASTA are:

1. # Hours/week planning instructional activities.
2. # Hours/week planning which occupational capabilities are to be attained by students.
3. # Hours/week planning student evaluation.
4. # Hours/week planning the sequencing and/or coordination of learning tasks.
5. # Hours/week planning budgetary matters.
6. # Hours/week planning for instructional materials to be used by students.
7. # Hours/week planning student disciplinary procedures.
8. # Hours/week planning staff policies.
9. # Hours/week planning scheduling.

The unit of measure employed in the PASTA is the self-reported number of planning hours spent by a given teacher or administrator on each of the nine areas of educational activity by each of the three planning modes. The total number of planning hours by each of the three modes will be investigated as a process variable as will the total number of planning hours expended on each of the nine educational activities. The overall number of planning hours is a third process variable value yielded by this instrument.

B. The Administrator Process Battery

The Administrator Process Battery is essentially a truncated version of the Teacher Process Battery developed for administrators above the Department Head level. (Department Heads are considered as teachers rather than administrators, with the exception of the Planfulness instrument previously discussed). The instrument included in the Administrator Process Battery are:

1. The Massachusetts Administrator Inventory (MAI)

   This instrument is a truncated version of the MOETS and includes information on educational and occupational background, as well as the inbreeding construct-type process variable discussed earlier in connection with the MOETS. The remainder of the Administrator Battery contains instruments used in the Teacher Process Battery.
2. The Image of Vocational Education Questionnaire (IVE)
3. IQ As Measured by the Verbal Reasoning Scale of Form L of the DAT

4. The Planning Activities Sheet for Teachers and Administrators (PASTA).

C. The Student Process Battery

The Student Process Battery consists of two instruments which attempt to assess student attitudes.

1. The Student Program Questionnaire (SPQ)

This instrument is identical to the semantic differential type Teacher Program Questionnaire employed in the Teacher Process Battery except that it attempts to assess the positiveness of a given student's attitude toward the particular educational progress in which a student is enrolled.

2. The School Sentiment Index (SSI)

The School Sentiment Index was developed as a criterion referenced measure by the Instructional Objectives Exchange of the University of California at Los Angeles. The SSI is a Likert-type attitude scale containing 83 statements which pertain to five aspects of student attitude toward school. The five subscale scores yielded by the SSI are described as follows:

a) Attitude Toward Teachers -- i.e., one's subjective feelings about teacher behavior with respect to mode of instruction, authority and control, and the interpersonal relationship of teacher to pupils.

b) Attitude Toward Learning -- i.e., one's attitude toward the learning experience, independent of attitude toward school, teachers and subjects, as reflected in intellectual curiosity, willingness to study, voluntarism, interst in problem solving, etc.

c) Attitude Toward School Structure and Climate -- i.e., one's attitude toward his school as a social center, a rule-making and rule-enforcing entity, and an extracurricular opportunity system.

d) Attitude Toward Peers -- i.e., one's feelings regarding the structure and climate of relationships within the peer group, rather than toward particular individuals within that group.

e) Attitudes Toward School in General -- i.e., one's general orientation toward schooling, independent of a particular school. In addition, a single total score can be obtained yielding a global estimate of attitude toward school.

We came across the SSI in our search for an instrument to assess student attitude toward school. We were impressed with its comprehensiveness in terms of assessing attitude toward many aspects of the school situation. Our only reservation was that, because of the criterion-referenced nature of the instrument, there was no description in the manual of the psychometric properties of the instrument. However, it was decided that since this information was not available we could use our own future data to obtain reliability and validity estimates for this instrument.

Product information has been previously described and will only be briefly overviewed here. It includes:

1. Number of TERMOBS completed per student, as moderated by quality scores.
2. A measure of General Educational Development (ITED).
3. Completor/Noncompletor.

All product measures are developed on SDS(2) students, with SDS(1) secondary students and postsecondary, community college students yielding both completor/

noncompletor and general educational development data. SDS(1) adults and noncommunity college, post secondary students are limited by product description to completion or noncompletion.

Impact. The design of the MISOE sample data systems is probably unique, and somewhat pioneering, in explicitly distinguishing the short range outcomes of education from longer range impacts of product upon society. There is, of course, the direct impact on the former student as reflected in his employability, job satisfaction, and ability to enjoy life and citizenship. Beyond that and, indeed, inseparable from it, lies the impact on society of having the right numbers of persons available with the right skills needed in the labor force, citizens earning steady incomes, supporting their families at comfortable levels, returning economic values to the state in terms of productivity, payment of taxes, consumer demand and participation in the social and cultural fabric of America.

These and other dimensions are not readily measured with any available instruments, although various dimensions have been subjected to measurement by military and industrial establishments. Therefore, it was necessary to create our own instruments to ensure coverage of impact dimensions not usually tapped, but needed to ensure a relevance and connectability of impact to the rest of the MISOE design, with all its variety of former students and with the expectation of studying impact one year, five years and ten years following the end of the program. Impact is to be studied for both completors and dropouts, and this replication over time extends the longitudinal design of the MISOE sample data system, permitting the capability of analyzing career development and the effects of experience on the individual and society.

Two instruments are used to obtain impact data. The first, in several forms, is an extensive inventory completed by the former student. One group of questions concerns the respondent and his life-style; e.g., family status, activities, voting behavior, economic behavior, mobility and attitudes toward life and work. A second group of questions concern the respondent's working career, employment and unemployment history, types of employers and job satisfaction. There are some items asking for more detailed information about family income, goods owned or being bought on credit, and net worth. Several items are designed to estimate if the respondent was unemployed for any appreciable length of time, his unique process to re-enter the labor market. The impact instrument also develops information about a variety of state services, including welfare, the lottery, etc.

The in-house developed impact instrument, the Massachusetts Educational Impact Instrument (MEII), also develops information about the student's attitude toward education and whether or not he is continuing his education in some form, and at what level. There are also a few questions about military service experience. Finally, the MEII asks permission of the respondent to contact his or her supervisor on the current or most recently held full-time job, and to provide the name and address of that supervisor.

The supervisors named by the respondents are then contacted by way of the second impact instrument which was developed by the MISOE staff and is called the Massachusetts Job Evaluation Inventory (MJEI). The MJEI is essentially a job rating form. This instrument seeks some information about the rater, his opportunity to observe the work of the former student and whether the rater has held the same job himself. Following a number of items on which the supervisor rates the former student in general terms, he is asked to do so in terms of more specific traits and behaviors. Ratings of the most specific traits and behaviors by supervisors are rated against others on the same job and compared to what the supervisor believes the job requires. Each of these traits is ranked in terms of its importance to the job.

It is in impact space that MISOE goes beyond the mere assessment of retained learning, and asks how it has been put to use. Because it will require some time before sampled cohorts have passed through the system and into what the MISOE staff calls impact space, it is planned to obtain a special cross-sectional sample to permit further field testing of the in-house developed instruments, as well as an opportunity to develop experience with the logistics of implementing a large followup study. The information resulting from this experience could provide a tentative basis for a descriptive summary of what happened to the students from earlier cohorts. Such information will not be connected in the MISOE longitudinal research design, but it will be gathered by the sampling design, thus providing a basis for both an assessment of impact on a cross-sectional basis, with an ability to make some inferential connections because of the relationship of the aggregated impact data to the MISOE sampling design.

Security Safeguard System

During this discussion of the structure and content of the MISOE sample data systems, it should be apparent to the thoughtful reader that the information supplied by individuals to the MISOE data systems must be handled with great care by the MISOE staff. To respect the rights and privacy of individuals asked to provide confidential information to MISOE, a security safeguard system has been designed. Its purpose is to prevent anyone from being able to associate information about an individual with his name and address, while still enabling longitudinal data to be collected and referenced to an individual's data record. The system has been carefully specified and is currently being documented. At this time, we can only share a few of the basic principles of this system:

1. Names and addresses needed for impact follow-up surveys are kept in a file completely separated from the MISOE data system file;
2. The data files and the name and address files will have different ID's and these ID's can only be linked by a third file containing the two sets of ID numbers.
3. The name and address and link files will be stored in a separate institution from the Department of Education, with its own computer capability and data files.
4. All data are arbitrarily coded.
5. All retrievable information is available only in summary form.
6. Special logistics are used to assign and handle identification numbers.

The security safeguard system is an improved alternative of the highly praised safeguard system developed by the American Council on Education, One DuPont Circle, Washington, D.C. The added costs for such security are more than offset by the maintenance of public confidence in MISOE. A management and information system of the scope and importance of MISOE simply cannot afford any breach of that confidence.

Generated Variables (Gen Vars)

MISOE IPPI batteries include a large number of instruments, and these instruments, in turn, contain many items. In many instances, individual items are of only limited usefulness. Their basic purpose is to describe a variable in concert with other items from an instrument. An example of a Gen Var has already been offered with the Massachusetts Pupil Inventory (MPI). It was suggested that certain items could be summarized to yield a measure of a variable, i.e., Item 64, 65 describing "parental interest in school work." This is what MISOE means by a Gen Var.

For many commercial instruments, individual item scores will not be included on the student record, only the scale score. For example, from the ITED only one score for Vocabulary will be stored in the data files, and this is also an example of a Gen Var.

Gen Vars can be determined a priori in MISOE by simply summing equally weighted items of an inventory or test instrument, or by some form of analysis. Gen Vars can also be developed interactively by a user from individual items of inventories, by TERMOBS, or by subscores of commercial tests. The usefulness of this option should become apparent during the reading of Chapter 8.

Conclusion

This chapter has described the MISOE sample data systems in nontechnical detail. It has not included any information about costs or expenditures, a fundamental part of the sample data systems. This is a purposeful omission due to the specialized nature of MISOE cost systems.

Chapter 5 describes the MISOE cost analysis systems in detail, including those of the sample data systems. For those interested in a full understanding of the MISOE sample data systems, a careful reading of Chapter 5 is recommended. For those who are skimming their way through the four chapters which describe the structure of MISOE, the best advice is to continue skimming through Chapter 5. However, since economic analysis is basic to policy development at the state level, it is advisable to know the source of cost information. The casual reader might be interested in returning to Chapter 5 after working through the policy formulation example of Chapter 8.

CHAPTER 5

ECONOMICS OF PUBLIC INVESTMENT IN EDUCATION AND MISOE COST ANALYSIS SYSTEMS

Gerald Downey

The purpose of this chapter is twofold: (1) to provide the reader with an economist's view of education as a social investment, (Part I); and (2) to offer a description of the basis for MISOE cost systems, (Part II). Part I should be of interest to those concerned in learning about some of the economic assumptions and principles in cost benefit analysis, while Part II describes the source of MISOE economic data. The reader who is not overly committed to MISOE (yet) should skip Part I, and quickly skim Part II, such that he at least has a "feel" for the source of MISOE cost information.

PART I: THE ECONOMICS OF PUBLIC INVESTMENT IN EDUCATION

The improvement in the quality of human capital through education and training provides a social rate of return through the increase of future output of the society just as does investment in nonhuman capital, such as plant and equipment. Research suggests that the rate of return on investment in human capital may be substantially higher than the return on investments in capital goods. Theodore Schultz (1961) states that investment in education by society has allowed western nations to grow at a much faster rate than with investment in nonhuman capital. The Denison study (1962) found that since 1929 improvements in the quality of labor and capital (technological advance) have accounted for over one-half of the total economic growth in the United States; it also suggests that if the growth in population is eliminated because it does not significantly raise output, then improvement in the quality of labor has accounted for over two-thirds of the economic growth in the United States since 1929.

Job training occurs in the private sector as well as the public sector. For example, firms provide both formal and informal training in the private sector at their own expense. The public sector also subsidizes other forms of job training outside the normal educational process.

Private Goods, Collective Goods, Externalities and Public Investment

The resources of our society are limited, but at the same time the wants of our society are virtually unlimited. Since the economic resources that can be used for education are also limited, the problem of public resource allocation arises. The economist is interested in the public resource allocation problem and is looking for the most efficient method of training students to be productive members of the labor force.

In a market society the vast majority of goods and services are met by private enterprise. If markets are competitive markets, prices reflect the values of goods to consumers and marginal costs to the producers of private goods. Food and clothing are examples of private goods. However, there are some goods and services for which the marketplace functions improperly these are collective goods. O. Eckstein defines collective goods as follows:

> These are goods and services that simply cannot be provided through the market. They have two related qualities. First, they inevitably have to be supplied to a group of people rather than on an individual basis. Second, they cannot be withheld from individuals who refuse to pay for them. (Eckstein, 1967).

National defense is an example of a collective good. Each individual member of the society benefits from this service. There is no way of withholding this service from those unwilling to pay for it as the seller of a private service could. Thus, the distinction between a private good and a collective good can be based on an exclusion principle. If persons can be excluded from benefits of a good or service it is considered to be a private good or service; if exclusion is not possible it is considered to be a collective good or service.

In some cases price may not reflect all benefits to be derived from a good because it does not take into consideration the social benefits of the good. These social benefits are called externalities or external economies. Where there are externalities present, price may reflect marginal private benefits but not marginal social benefits. Collective goods or public goods are extreme examples of this. Since external benefits are not taken into consideration by the marketplace, the reliance upon the private market to supply collective goods results in a less than optimal allocation of resources to their production.

The previous statement suggests that in any situation where some costs or benefits remain outside of the price-marginal cost decision-making process, resource allocation becomes inefficient. For this reason, where externalities are important, public investment in the production of certain goods and services may be necessary in order to improve resource allocation.

Several authors have called attention to the importance of externalities in education. For example, O. Eckstein has pointed out:

> Everybody gains from living in a democracy with an educated citizenry. Also, some of the economic benefits of having an educated labor force accrues to employers through lower production costs, and to customers through lower prices, though it's

impossible to determine precise amounts (Eckstein, 1967).

B. A. Weisbrod has commented similarly:

> Persons receiving external benefits from a student's education may be divided into three broad groups although the same people may be in more than one: (1) Residence-Related Beneficiaries — Those who benefit by virtue of some relationship between their place of residence and that of the subject; (2) Employment-Related Beneficiaries — Those who benefit by virtue of some employment relationship with the subject; (3) Society in General (Weisbrod, 1964).

Thus, schooling benefits persons other than the student. His present family as well as his future family also benefit. His children will benefit from the informal training they receive in the home. His neighborhood and his community will also benefit from the social values he obtained from receiving schooling.

If education provides social benefits, decision-makers should take this into consideration in the allocation of public funds to schooling. It is also true that external benefits may differ between educational alternatives within and among schools.

Public Intervention into Education in Order to Redress Imperfections of the Competitive System

Another major source of market failure is the presence of serious imperfections in the competitive mechanism. Education is one of the areas in which the presence of market imperfections has caused underinvestment by the private sector. Therefore, intervention has become necessary by the public sector in order to redress the imperfections of the competitive system. Intervention has taken the form of the investment of public funds in providing educational training.

In a competitive market, workers would purchase training themselves because they would obtain all the benefits. However, in an imperfect market workers may have imperfect foresight regarding the advantages of training and may also have a short time horizon regarding their working life. Many workers are uninformed about possible future employment opportunities due to investment in training. It may also be true, that lack of access to capital on the part of the workers keeps them from purchasing the necessary training. Imperfections on the buyer-side of the labor market (i.e., monopoly power) may also cause underinvestment in training by workers.

Intervention by the public sector is therefore necessary in the area of educational training. It is necessary in order to insure that potential social benefits will be obtained and that no excessive social cost will be incurred by the society.

Cost-Benefit Analysis and Public Education Decisions

In the private sector of our economy the marketplace evaluates goods and services. Inefficient firms that do not satisfy the needs of consumers do not survive in the long run. However, the marketplace is not available in the public sector to test the efficiency of public goods. Thus, cost-benefit analysis is used as a substitute for the marketplace to test the efficiency of public goods. Since education is a public good, cost-benefit analysis can be used to evaluate alternative forms of public investment in education.

As an overview of cost-benefit analysis, the cost and benefits of each form of public education are estimated. If the marginal social cost exceeds the marginal social benefit, investment of public funds may be undesirable. If the marginal social benefits exceed the marginal social cost, the alternative can be considered from an investment standpoint. If the marginal social benefits exceed the marginal social cost for more than one alternative, the alternatives can be ranked by computing the cost-benefit ratios or the pay-back period. Public funds should be first expended on the alternative with the highest cost-benefit ratio or the shortest pay-back period. However, as expenditure of funds increase on one activity, its marginal benefits drop, thereby reducing the cost-benefit ratio and allowing funds to be spent on other alternatives. The benefits per dollar of public funds should be equalized at the margin. This can be accomplished by expanding the expenditure of public funds up to the point where the cost-benefit ratios of all alternatives are equal. The procedure is to discount the streams of benefits and costs for each alternative at some given rate of interest. The alternative where discounted benefits exceeded discounted costs by the largest amount would be selected first for the investment of the limited public funds. The aim of the decision-maker should be to allocate the limited public funds available for investment in education in the most cost effective manner possible.

Problems in the Measurement of Cost and Benefit

Measurement of cost presents a problem for cost benefit analysis. The cost of providing education falls on the individual, the community, and society at large. However, some of these costs are difficult, if not impossible, to measure in dollar terms. Unless all of these costs can be measured in monetary terms, it is impossible to measure the total cost of education. For instance, the cost of education to the individual includes lunch and pin money as well as the earnings he foregoes by remaining in school after the legal quit age — this may be a very substantial sum. The cost to the community includes the current cost of operating the school, the cost of land and buildings, the foregone interest that could be earned on public funds tied up in land, building, and equipment, and the tax revenues lost if these public properties were privately owned. The cost to society at large consists of both individual and community costs.

Measurement of benefits tends to be more difficult to measure than cost. In cost-benefit analysis the major emphasis is placed on measuring monetary earnings and employment behavior. However, it is difficult to obtain information on earnings and employment behavior of students over long periods of time, and comparison made between students at a point in time shortly after graduation may be misleading.

It is also true that education provides external benefits to society which are difficult to quantify, such as good citizenship, reduction of crime and delinquency, an educated labor force for employers, and the potential for higher rates of economic growth for the society at large. There is also the problem of including all the social benefits as well as quantifying these benefits. Even though these social benefits are difficult to quantify, an effort should be made to develop proxies or indices to place a value on them. However, these monetary social benefits are not taken into consideration in cost-benefit analysis but are used in the more detailed cost-impact analysis.

Discount Rates and Investment Criteria

Since the various investment alternatives may have different profiles of cost and benefits over time, discounting is used to reduce these future flows to their present value. We would then be able to look at each investment alternative and compare them to one another. The purpose of discounting is to assign weights to these profiles of costs and benefits so that consideration can be given to risk and productivity of the investments as well as the public and private time preferences. Generally, more than one discount rate is selected because market interest rates may vary over time due to economic conditions and changes in the discount rate by the Federal Reserve Board.

In terms of investment criteria, three basic rules have been used for public expenditure decisions: the net present value rule, the cost-benefit rule and the internal rate of return rule.

The first two are the most commonly used. The net present value rule would select investment alternatives where the present value of benefits exceeds the present value of costs. The alternatives can be ranked by the highest present value first, etc. This technique is normally used after the students have been in the labor market for a number of years. Where only the benefits for one year are known, the number of years the benefits would have to continue to make up the present value of the extra cost could be used as a ranking criteria. Chapter 8 offers an example which suggests the use of cost-benefit analysis in policy formulation.

PART 2: PROGRAM COST ACCOUNTING FOR MISOE (CDS & SDS)

Important groups within American economy today are highly critical of public education. This criticism comes from legislators, parents, students, teachers and other interested parties. It is also true that at all levels of government, educational expenditures constitute a substantial part of their total expenditure budgets this is especially true at the local level. However, there are also other public services that are in need of these resources. Since the resources of the public sector are limited, a conflict exists in terms of how these limited public resources should be allocated. This conflict, as well as the criticism of the quality of American education, will force educators in the future to provide more and better education of how they expend the limited resources made available to them.

It should also be pointed out that even within education there is a great deal of competition for the limited public resources available: at the secondary level, academic vs. vocational-technical education; and at the postsecondary level, junior colleges vs. four year colleges and universities. There is also competition between levels. Thus, in order to obtain their share of the limited public resources available, each educational alternative should be able to demonstrate that it is operating in an efficient manner. This requires a system of accountability through which educational managers can demonstrate that they are achieving the maximum output possible with the limited resources made available to them. The purpose of this chapter is to describe the cost accounting system for stipulating costs in the MISOE data systems.

Existing Cost and Effectiveness Information and the Needs of Educational Decision-Makers

Frequently managers make decisions on the distribution of funds to occupational programs with limited information on the cost of the programs or the effectiveness of their decisions. There is little evidence that the full cost of a program or its cost effectiveness is used for decision-making purposes.

Cost information in terms of dollars spent annually by communities and dispersed by the Federal Government and a state is usually available. However, this information is very gross in nature and does not adequately describe the cost of education in such a way that it would be useful for decision-making. For instance, at the local level the total cost of individual programs and the per pupil cost of training for individual programs is generally not available. Only average current cost information is available by individual schools or in some cases, for the whole school system. However, administrators know that substantial differences occur in individual program cost within and among schools of various types and by level of training. The effectiveness of administrative decisions is determined by the ability of program completors to obtain a job (in most cases any job) and by follow-up studies which are biased in many cases.

Interviews with vocational administrators at the LEA level indicate that they desire information on the cost of providing training for individual programs within their jurisdiction. They also need better follow-up information on program completors to determine the effectiveness of the training provided. (Downey, 1971)

Currently, funds (resources) are allocated on the basis of proposals local educational agencies submit. In many cases these proposals are of the "blue sky" variety, and administrators have little data to compare the proposals and for making decisions. Thus, it is difficult to determine whether a proposal should be funded or not. What program managers really need to know is the cost of establishing new programs and the cost of adding additional students to an existing program that has been established. Program directors also need information of the training effectiveness of programs they fund. At the present time managers have little, if any idea of how effective training is or what happens to the program completors once they enter the labor market.

Thus, it can be concluded that at the present time managers are making decisions on the allocation and distribution of public funds (i.e., resources) to occupational education programs with little idea of the cost or the effectiveness of their decisions. The profit motive of the private sector would prevent this situation from existing for very long in private firms. In the past there was little incentive for public agencies such as education to become more efficient. However, now pressure from interested parties and a reduction in the priority list for education makes it imperative that education become more efficient in the allocation of its limited resources. Program cost information and per pupil cost information must be made available to vocational administrators for decision-making purposes. They also should have information on the effectiveness and impact of their decisions on society.

It is clear that a major function of the Management Information System for Occupational Education is to improve the efficiency of the decision-making process. Efficiency is defined as achieving the most with a given amount of resources, or achieving a given goal with the least amount of resources. An efficient management process assumes that all the goals are in fact stated and there is a regular process of determining the degree to which these objectives and goals are achieved and at what cost. It also assumes that there is a way of describing the relationship between elements of the educational program and educational outcomes which can be defined in terms of dollars. Unless educational managers have access to such information on a regular basis, we cannot expect them to behave in a rational way. Therefore, a rational management process for occupational education is dependent upon a continuous flow of information which describes the goals and objectives of occupational education, the degree to which they are accomplished, and the elements which contribute to the accomplishment of the stated objectives. All this information must be available in terms of cost.

Review of MISOE Census Data System Report Forms For Expenditures

There are three basic reporting groups within the school system – the department head, the school principal, and the superintendent of schools. At the department level, the basic reporting forms are the Fall Occupational Teaching Survey, the Fall Report, the End-of-Year Funding and Expenditure Report, and the End-of-Year Report.

The Fall Occupational Teaching Survey provides information on the staff characteristics of occupational department members as well as their teaching assignments. Thus, individual faculty members can be keyed to specific occupational programs in regard to what group of students they are teaching. Their teaching salary and administrative salary (if any) can be prorated to the individual occupational program(s) that they teach. Since teaching salaries account for a substantial part of current program cost, this is extremely important information in the determination of the cost of individual occupational programs.

The Fall Report is prepared for each individual occupational program within the school. It contains information on the grade level and type of student enrolled in the program by USOE code for all grades below the final grade and the final grade. It also provides the TERMOBS to be completed by the final grade. The question of how long does it take to get a program completed in a particular occupational program is also answered. Information on the instructional area(s) used for specific student groups in a particular program is also presented. Thus, instructional area(s) can be tied to student groups and teaching staff information. This provides important information for analysis of pupil/teacher ratios and square footage per student in individual occupational programs. A table is also completed regarding the breakdown of student's time in each program by USOE code and type of student. This information will be used for the proration of educational expenditures between the nonoccupational and occupational training areas. Other information is provided on how the programs are funded, type of handicapped student enrolled (if any), and the history of this particular occupational program.

The End of Year Report on Funding and Expenditures provides data on whether or not the program is federally funded. However, the most important information contained in this report refers to current occupational program expenditures. Descriptions of selected current expenditures are requested by individual occupational education program. This information, when combined with end of year expenditures reported by the superintendent of schools, will be used in arriving at the cost of training for individual occupational programs. This report also collects information on equipment expenditure incurred by the program during the school year by type of expenditure (new or replacement), and USOE code(s).

The End-of-Year Report from the Head of the Occupational Education Department reports on the status within the department by student group, type of student, grade level, and USOE code(s). It indicates what happened to the original enrollees in the program. Did they become dropouts, repeaters, or program completors? This report also requests information on how the various types of students spend his/her time learning in the program by USOE code(s).

At the school principal's level the basic reporting forms are the Fall Principal's Report and the Principal's End-of-Year Report. The Fall Principal's Report provides information on individual school enrollment in occupational and non-occupational programs (by grade, race and sex). This is the basic enrollment data used in proration of educational expenditures. The Fall Principal's Report also provides information on the use and size of instructional area. For instance, it provides total instructional areas by type of rooms and also breaks out the rooms and floor space used for occupational training. It also indicates which rooms are used for occupational training, the floor space and student capacity of the rooms, who uses the rooms, and when the rooms are free of classes.

The principal's End-of-Year Report gives the number of individual school graduates by grade level, sex, race, and type of student (non-occupational and occupational). It also provides data on program completors on a school basis. This report also gives the average daily membership (ADM) and average daily attendance (ADA) by type of student (occupational and non-occupational) which can be used to determine program cost per student based on an average ADM for a particular type of student.

At the Superintendent of School level the basic reporting forms are the Fall Report and the Supplement to the Superintendent's End-of-Year Pupil and Financial Report. The Superintendent's Fall Report provides expenditure information which will be used to calculate an implicit rent on both a school and per student basis. It also contains enrollment and staff information on a system-wide basis.

The Supplement to the Superintendent's End-of-Year Pupil and Financial Report provides important expenditure information for determining program cost within the individual school. Each school which offers occupational training program(s) must complete this supplemental packet which requests school committee expenditures in the form of school totals and for each program area in which occupational training programs are offered. For most communities that have only one comprehensive high school, completion of these tables present little problem because most of the data requested can be found in the End-of-Year Pupil and Financial Report prepared by the Superintendent of Schools of the community. However, the information is presented by program areas and not by school totals. School administrators must therefore select out of the End-of-Year Report the expenditures that are relative to their school(s) which offer occupational training programs.

Estimating Current Cost At The Program Level For MISOE CDS

Current cost consists of the 1000-5000 accounts (administration, instruction, other school services, operation and maintenance of plant services, and fixed charges). The Supplement to the Superintendent's End-of-Year Report reports these current costs by school total and by program area(s) in which occupational training programs are offered. Where more than one occupational program is present within a program area, per student charges can be determined for many of the educational expenditures that were assigned to the area. It is also possible to classify many of the expenditures as being either occupational or non-occupational. Those expenditures that cannot be classified as either of the above are classified as "all other" and will be prorated to the occupational and nonoccupational expenditure types based on class time spent in the two training areas.

The expenditure information by program areas reported in the Supplement to the Superintendent's End-of-Year Report will be combined with the expenditure information reported by individual occupational programs in the End-of-Year Funding and Expenditure Report in order to estimate the current cost of each individual occupational program. Past studies have indicated that teaching salaries, supplies and textbooks constitute the majority of current cost in individual programs. (Corazzini, 1968 and Downey, 1971). MISOE-CDS can directly associate occupational teaching salaries, supplies and textbook expenditures, department head salaries, maintenance of equipment expenditures, and other special reported current expenditures with individual occupational programs. The remaining expenditures would be prorated to the individual occupational programs on the basis of proration formulae and techniques.

For illustrative purposes, several tables have been generated of current program cost in a hypothetical high school. Two occupational programs and the academic program of this high school will be presented and briefly reviewed. In Table 1 (Program Code 00001 – Automechanics – Occupational Day Program) the vast majority of *instructional services* expenditures can be classified as either occupational or nonoccupational expenditures. Expenditures classified as "all others" were prorated to occupational and nonoccupational expenditure types on a 50% – 50% basis, based on the mix of occupational and nonoccupational training taken by the students. The same technique was used for supportive services. The summation of the subtotals for both instructional services and supportive services determines the total current cost of training in the program ($142,987) and this total has been broken out into the occupational ($82,082) and nonoccupational ($60,905) portions. Also, the current cost of per pupil training is computed (in total and by expenditure type) for three different basis – beginning enrollment, program completors, and average daily membership. The assumption is made that average daily membership is 80% of fall enrollment in all programs. The cost per pupil and cost per student hour of instruction are also computed for the instructional services and supportive services expenditure areas. The data indicates that occupational training is more expensive than academic training in this program and that instructional services represent approximately 75% of current cost. Also, when beginning enrollment in the program is adjusted for program completors and/or ADM, the current cost of per pupil training increases substantially.

In Table 2 (Program Code 00004 – Office Education – regular day program) the "all other" column of expenditures was prorated 33.3% to occupational and 66.7% to nonoccupational based on the

TABLE 1
OCCUPATIONAL DAY PROGRAM -- AUTOMECHANICS
Program Code (00001); Dept. Code 1703
Beginning Enrollment = 75 Students
End of Year Completors = 63 Students
Average Daily Membership = 60 Students

Expenditures	Total	(1) Types of Expenditures: Occupa-tional	(2) Nonoccupa-tional	(3) All Other
Instructional Services:				
(2100) Supervision	$ 3,728	$ 1,500	$ 2,228	$ --
(2200) Principal's Office	5,690			5,690
(2300-01) Professional Salaries-Teaching	55,388	38,500	16,888	
(2300-04) Contracted Services-Teaching	7,455		7,455	
(2300-05) Supplies-Teaching	18,728	15,000	3,728	
(2400) Textbooks	3,500	500	3,000	
(2500) Library Services	3,728			3,728
(2600-01) Professional Salaries—Audio-Visual	1,500			1,500
(2600-05) Supplies—Audio-Visual	750		750	
(2700) Guidance Services	3,000			3,000
(2800) Psychological Services	1,575			1,575
(2900-01) Professional Salaries—Ed. TV	1,500			1,500
(2900-05) Supplies—Ed. TV	750		750	
Other Instructional Expenditures	—			
Subtotal	$107,292	$55,500	$34,799	$16,993
Proration of All Other Expend. by Time Spent in Nonoccupa. & Occupa. Areas		8,497	8,496	--
Total Instruc. Services Expend. by Type of Expenditure	107,292	63,997	43,295	--
Supportive Services:				
(1000) Administration	2,250			2,250
(3000) Other School Services	9,375			9,375
(4110) Custodial Services	9,800			9,800
(4120) Heating of Building	2,100			2,100
(4130) Utility Services	490			490
(4210) Maintenance of Grounds	196			196
(4220) Maintenance of Building	7,350			7,350
(4230) Maintenance of Equipment	1,525	1,000	525	
(5000) Fixed Charges	2,609			2,609
Subtotal	35,695	1,000	525	34,170
Proration of All Other Expend. by Time Spent in Nonoccupa. & Occupa. Areas	—	17,085	17,085	—
Total Supportive Services Expend. by Type of Expenditure	35,695	18,085	17,610	—
Total Current Cost of Training in Program	142,987	82,082	60,905	--
Current Cost of Train. Per Pupil -- Beginning Enrollment	1,906	1,094	812	
Current Cost of Train.-Per Prog. Completor	2,270	1,303	967	
Current Cost of Train.-Per Avg. Daily Mbrshp.	2,383	1,368	1,015	
Instructional Services-Cost Per Student	1,430	853	577	
Instructional Services-Cost Per Student Hour	1.99	1.19	.80	
Supportive Services-Cost Per Student	476	241	235	
Supportive Services-Cost Per Student Hour	.33	.33	.33	

TABLE 2
REGULAR DAY PROGRAM – OFFICE
Program Code (00004); Dept. Code 1400
Beginning Enrollment = 135 Students
End of Year Completors = 121 Students
Average Daily Membership = 108 Students

Expenditures	Total	(1) Types of Expenditures: Occupational	(2) Nonoccupational	(3) All Other
Instructional Services:				
(2100) Supervision	$ 6,750	$ 750	$ 6,000	$
(2200) Principal's Office	9,900			9,900
(2300-01) Professional Salaries-Teaching	72,532	32,000	40.532	
(2300-04) Contracted Services-Teaching	13,500		13,500	
(2300-05) Supplies Teaching	7,550	800	6,750	
(2400) Textbooks	5,900	500	5,400	
(2500) Library Services	6,750			6,750
(2600-01) Professional Salaries Audio-Visual	2,700			2,700
(2600-05) Supplies Audio-Visual	1,350			1,350
(2700) Guidance Services	5,400			5,400
(2800) Psychological Services	2,835			2,835
(2900-01) Professional Salaries-Ed. TV	2,700			2,700
(2900-05) Supplies-Ed. TV	2,350	1,000	1,350	
Other Instructional Expenditures	--			
Subtotal	140,217	35,050	73,532	31,635
Proration of All Other Expend. By Time Spent in Nonoccupa. & Occupa. Areas		10,545	21,090	
Total Instruc. Services Expend. by Type of Expenditure	140,217	45,595	94,622	
Supportive Services:				
(1000) Administrative	4,050			4,050
(3000) Other School Services	2,700			2,700
(4110) Custodial Services	17,562			17,562
(4120) Heating of Building	3,804			3,804
(4130) Utility Services	878			878
(4210) Maintenance of Grounds	351			351
(4220) Maintenance of Building	13,172			13,172
(4230) Maintenance of Equipment	1,050	100	950	
(5000) Fixed Charges	4,725			4,725
Subtotal	48,292	100	950	47,242
Proration of All Other Expend. by Time Spent in Nonoccupa. & Occupa. Areas		15,747	31,495	
Total Supportive Services Expend. by Type of Expenditure	48,292	15,847	32,445	
Total Current Cost of Training in Program	188,509	61,442	127,067	
Current Cost of Train. Per Pupil Beginning Enrollment	1,396	455	941	
Current Cost of Train.-Per Prog. Completor	1,558	508	1,050	
Current Cost of Train.-Per Avg. Daily Mbrshp.	1,745	569	1,176	
Instructional Services-Cost Per Student	1,039	338	701	
Instructional Services-Cost Per Student Hour	.97	.32	.65	
Supportive Services-Cost Per Student	358	117	241	
Supportive Services-Cost Per Student Hour	.25	.08	.17	

mix of training taken by students in the program. *Instructional service* expenditures tend to dominate in arriving at the total current cost of training and the calculation of current cost of training per pupil. Adjustment of beginning enrollment for program completors and ADM cause the cost of training per pupil to increase substantially.

Table 3 presents the nonoccupational (academic) program regular day program area. It provides expenditure information on students who are only taking academic training. As in the occupational programs presented previously, total current cost can be derived by summing *instructional services* and *supportive services*. The current cost of training per pupil can be derived based on beginning enrollment and ADM. Instructional and supportive service expenditures can also be determined on a per student and per student hour basis.

A brief review of the previous tables indicates that there are substantial differences in the current cost of the individual programs (both occupational and nonoccupational) within the same school. This is the usual case and the present reporting systems are typically not able to detect these differences within program areas. MISOE-CDS will be able to describe these differences, besides providing comparisons over individual programs within the same school. Comparisons can also be made in the same school by *instructional services* and *supportive services* expenditures, by occupational and nonoccupational expenditure type, by cost per pupil (original enrollment, completors, and ADM) and cost per student hour of instruction for instructional services and supportive services expenditures.

MISOE-CDS would also allow educational administrators to make a cost comparison between schools, by program, by school type, by school size, over region, etc. For example, Table 4 presents the per pupil current cost and enrollment data for six different occupational programs in comprehensive secondary schools across the state. This table shows that substantial differences exist in the current cost of programs within schools of the same type.

Estimating Capital Cost for MISOE-CDS

Capital cost consists of land, building(s) and equipment, plus an imputed rent (opportunity cost) for the use of public funds for these purposes. However, serious problems exist in attempting to measure the capital cost of education. For instance, should historical costs, replacement costs, or current assessed valuation be used to measure the capital costs? Each of the above is subject to some limitations.

An alternative technique that can be used in estimating the capital cost is the "capital recovery factor" (CRF). The use of this technique can account for both rent (interest) and depreciation.

The capital recovery factor is the factor which "... when multiplied by the present value of capital costs, is the level (average) end-of-year annual amount over the life of the project necessary to pay interest on and recover the capital costs in full (Hirshleifer, 1960).

This formula is is follows:

$$c = \frac{C_O\, i(1+i)^n}{(1+i)^n - 1}$$

when c is the capital recovery factor (annual capital cost); C_O is the present value of capital in use: 1 is the social opportunity cost rate of capital or investment funds; and n is the number of years (the life of project) over which benefits

TABLE 3
REGULAR DAY PROGRAM AREA
Nonoccupational (Academic) Program
Beginning Enrollment = 393 Students
Average Daily Membership = 314 Students

Expenditures	Total	Types of Expenditures (1) Occupational	(2) Nonoccupational	(3) All Other
Instructional Services:				
(2100) Supervision	$ 19,650		$ 19,650	
(2200) Principal's Office	29,082		29,082	
(2300-01) Professional Salaries-Teaching	176,991		176,991	
(2300-04) Contracted Services-Teaching	39,300		39,300	
(2300-05) Supplies-Teaching	19,650		19,650	
(2400) Textbooks	15,720		15,720	
(2500) Library Services	19,650		19,650	
(2600-01) Professional Salaries-Audio-Visual	7,860		7,860	
(2600-05) Supplies-Audio-Visual	3,930		3,930	
(2700) Guidance Services	15,720		15,720	
(2800) Psychological Services	8,253		8,253	
(2900-01) Professional Salaries-Ed. TV	7,860		7,860	
(2900-05) Supplies-Ed. TV	3,930		3,930	
Other Instructional Expenditures				
Subtotal	367,596		367,596	
Proration of All Other Expend. by Time Spent in Nonoccupa. & Occupa. Areas				
Total Instruc. Services Expend. by Type of Expenditure	367,596		367,596	
Supportive Services:				
(1000) Administration	11,790		11,790	
(3000) Other School Services	7,860		7,860	
(4110) Custodial Services	51,125		51,125	
(4120) Heating of Building	11,075		11,075	
(4130) Utility Services	2,555		2,555	
(4210) Maintenance of Grounds	1,022		1,022	
(4220) Maintenance of Building	38,345		38,345	
(4230) Maintenance of Equipment	2,767		2,767	
(5000) Fixed Charges	13,755		13,755	
Subtotal	140,294		140,294	
Proration of All Other Expend. by Time Spent in Nonoccupa. & Occupa. Areas				
Total Supportive Services Expend. by Type of Expenditure	140,294		140,294	
Total Current Cost of Training in Program	507,890		507,890	
Current Cost of Train. Per Pupil Beginning Enrollment			1,292	
Current Cost of Train. Per Program Completor				
Current Cost of Train. Per Avg. Daily Mbrshp.			1,617	
Instructional Services-Cost Per Student			935	
Instructional Services-Cost Per Student Hour			.65	
Supportive Services-Cost Per Student			357	
Supportive Services-Cost Per Student Hour			.25	

TABLE 4
PER PUPIL CURRENT COST AND ENROLLMENT DATA IN INDIVIDUAL PROGRAMS IN COMPREHENSIVE SECONDARY SCHOOLS ACROSS STATE

		1970	1971	1972	1973	(proj.) 1974
Auto Mechanics (17.0302)	ac/p	$1565.	$1590.	$1575.	$1575.	$1560.
	enroll	500	600	700	800	900
Blueprint Reading (17.0500)	ac/p	$1350.	$1402.	$1515.	$1687.	$1809.
	enroll	332	350	370	461	501
Carpenters (17.1001)	ac/p	$1275.	$1300.	$1318.	$1402.	$1515.
	enroll	1002	980	980	910	850
Electrical (17.1002)	ac/p	$1488.	$1550.	$1575.	$1670.	$1611.
	enroll	1500	1400	1375	1550	1605
Fabric Maint. Service (17.1600)	ac/p	$1005.	$ 995.	$ 990.	$1007.	$1101.
	enroll	200	210	205	250	260
Consumer Education (09.0104)	ac/p	$ 900.	$ 905.	$ 907.	$ 910.	$ 928.
	enroll	1010	1100	1210	1400	1600

are returned. Even this technique is subject to some limitations. For instance, beside the problem of establishing the present value of the capital in use, arbitrary judgments must be made regarding the values of n and i.

In the MISOE Census Data System, the Superintendent of Schools is requested to complete a table entitled "Supplementary Expenditure Information" in the Fall of the year. This table provides most of the necessary information (the year(s) the school was built and/or added to or remodeled and the cost of land, building, and equipment associated with each of the above) for computing the capital recovery factor (CRF) for each school in the community that offers occupational education programs. However, it is still necessary to make judgments as to the value of the social opportunity cost rate of capital (i) and the number of years over which benefits are returned (n) for each school involved. These problems are not overwhelming, and realistic estimates can be made for values of (i) and (n). Thus, the CRF can be used to calculate an implicit rent for each school that offers occupational training programs. Dividing the implicit rent for the school by the day school enrollment will provide an implicit rent on a per pupil basis. The enrollment in day occupational programs can be multiplied by the implicit rent per pupil to obtain the implicit rent for the program.

The addition of implicit rent to the current cost of educational programs will provide estimates of total program cost and total cost per pupil in the program. Substantial differences can be expected to occur in the implicit rent charges, the total program cost of each program, and the total cost per pupil of each school. However, it must be pointed out that the per pupil implicit charge is the same for all students in the school for all program areas. Also the normal procedure is to charge implicit rent only to day school program areas and not every student in the school.

Estimating Program Cost For MISOE-SDS

In MISOE-SDS expenditures must be accumulated over the life of the program in order to determine the total cost of the program and the total cost per pupil of program completors. For instance, in a three year program beginning in September 1973 the yearly cost of the program must be accumulated until June, 1976. Table 5 (program code 00001 – automechanics – occupational) follow the current expenditures of this particular occupational education program over three years – the length of time it takes to get a program completor in this program. The program expenditure informa-

TABLE 5
SCHOOL X
Occupational Day Program – Automechanics
Program Code 00001; Dept. Code 1703
Summary Table

Expenditures	School Year 1973-74	1974-75	1975-76	Total Program Cost
Instructional Services:				
(2100) Supervision	$ 3,728	$ 4,000	$ 5,000	$ 12,728
(2200) Principal's Office	5,690	6,000	7,000	18,690
(2300-01) Professional Salaries–Teaching	55,388	58,000	60,000	173,388
(2300-04) Contracted Services–Teaching	7,455	7,500	7,000	21,955
(2300-05) Supplies–Teaching	18,728	19,000	20,000	57,728
(2400) Textbooks	3,500	4,000	1,500	9,000
(2500) Library Services	3,728	3,800	3,000	10,528
(2600-01) Professional Salaries–Audio-Visual	1,500	1,000	800	3,300
(2600-05) Supplies–Audio-Visual	750	500	400	1,650
(2700) Guidance Services	3,000	3,500	4,000	10,500
(2800) Psychological Services	1,575	1,600	2,000	5,175
(2900-01) Professional Salaries–Ed. TV	1,500	1,500	1,500	4,500
(2900-02) Supplies–Ed. TV	750	500	500	1,750
Other Instructional Expenditures	–	–	–	–
Subtotal	107,292	110,900	112,700	330,892
Supportive Services:				
(1000) Administrative	2,250	2,750	3,000	8,000
(3000) Other School Services	9,375	9,625	10,000	29,000
(4100) Custodial Services	9,800	10,200	11,000	31,000
(4120) Heating of Building	2,100	2,900	3,500	8,500
(4130) Utility Services	490	510	600	1,600
(4210) Maintenance of Grounds	196	204	200	600
(4220) Maintenance of Building	7,350	7,150	8,500	23,000
(4230) Maintenance of Equipment	1,525	1,375	1,100	4,000
(5000) Fixed Charges	2,609	2,391	2,500	7,500
Subtotal	35,695	37,105	40,400	113,200
Total Current Cost of Training in Program	142,987	148,005	153,100	444,092

tion from MISOE-CDS is the basic data source for MISOE-SDS. However, it must be summed over the length of the program in order to derive total program current cost — see Table 5 where the total current cost of training for this program are $444,092.

Table 6 provides a breakdown of enrollment and expenditures (current and capital) for each year over the life of the program. Enrollment is presented on a yearly basis with beginning enrollment broken out into the number of program completors and dropouts on a full time equivalent basis. The yearly current expenditure of the program can be separated into instructional services and supportive services, and occupational and nonoccupational expenditures. The implicit rent is added to the current cost in order to derive the total cost of the program. Total program cost can then be broken out into the portions associated with program completors and program dropouts and summed over the years of the program.

It is also possible to follow a cohort of students from one year to another and assign a share of the total program cost to them. For instance, in Table 7 the tenth grade students of the automechanics program are followed over three years. Beginning program enrollment is for strictly occupational students. Students not enrolled are non-occupational students who are taking an occupational course. Thus, SDS has information on what happened to each cohort of students as they moved from year to year through the program. Did they become program completors or dropouts? This question can be answered by SDS. Also, program cost associated with these groups of students can be broken out into the portions associated with the various types of completors and dropouts — this is illustrated in the center of Table 7. The bottom of Table 7 illustrates how total program cost can be associated with a cohort of 19 students who enrolled in the program in the tenth grade (1973-74) and completed the program in 1975-76. The cost per yearly completor from Table 7 is multiplied by the number of graduates to obtain the total cost per year of training. The addition of the cost per yearly completor over the three years provides the per pupil average total cost of training for this cohort of students in the automechanics program. The addition of the total cost per year over the three years provides the total cost of training this cohort of students over three years.

MISOE-SDS is also working on the problem of determining the cost of individual terminal objectives associated with this program. In other words, total program cost could be broken down into the cost of teaching the individual TERMOBS offered within the program. At the present time this process is in the early stages of development but hopefully it will become another of the MISOE tools in the future.

Conclusion

This description of the MISOE cost analysis component concludes the discussion of the information collected and stored in the data files. The next chapter describes how this information is connected together for interactive analysis and should at least be "rapidly skimmed" by the reader. The development of the data files is really the essential key to making an interactive, computing system a reality.

TABLE 6 SCHOOL X
Occupational Day Program Automechanics
Program Code 00001; Dept. Code 1703

	School Year						Total Program	
	1973-74		1974-75		1975-76			
Enrollment:								
Beginning Enrollment		85		80		70		
Program Completors		80		70		63		
Dropouts		5		10		7		
Expenditures-Current:								
Instructional Services								
a) Occupational	63,997		60,900		70,000		194,897	
b) Nonoccupational	43,295		50,000		42,700		135,995	
c) Total	107,292		110,900		112,700		330,892	
Supportive Services								
a) Occupational	18,085		18,553		20,200		56,838	
b) Nonoccupational	17,610		18,552		20,200		56,362	
c) Total	35,695		37,105		40,400		113,200	
Total Current Cost of Program		142,987		148,005		153,100		444,092
a) Occupational		82,082		79,453		90,200		251,735
b) Nonoccupational		60,905		68,552		62,900		192,357
Expenditures-Capital:								
Implicit Rent ($500 per student)		42,500		40,000		35,000		11[illegible],500
Total Program Cost		185,487		188,005		188,100		561,592
Total Program Cost of Completors		174,576		164,504		169,290		508,370
Total Program Cost of Dropouts		10,911		23,501		18,810		53,222
Total Program Cost per Completor and Dropout		2,182.20		2,350.06		2,687.14		7,219.40

TABLE 7 SCHOOL X
Occupational Day Program Automechanics
Program Code 00001; Dept. Code 1703
Cohort of Students Over 1973-74 1975-76

	1973-74			1974-75			1975-76		
	Grade 10			Grade 11			Grade 12		
Enrollment	Fall Report	Completors	Drop-outs	Fall Report	Completors	Drop-outs	Fall Report	Completors	Drop-outs
Beginning Program Enrollment	25	22	3	22	20	2	20	19	1
Students Not Enrolled	5	3	2	3	2	1			
Total Students	30	25	5	25	22	3	20	19	1
Program Cost Associated to Student Groups									
Completors-Begin. Enrollment		48,008			47,000			51,053	
Completors-Students not Enrolled		6,547			4,700				
Total Student Completors		54,555			51,700			51,053	
Dropouts-Begin. Enrollment			6,547			4,700			2,687
Dropouts-Students not Enrolled			4,364			2,350			
Total Student Dropouts			10,911			7,050			2,687

Total Program Cost Associated with the Cohort of 19 Students Enrolled in the Program Who Became Program Completors/Graduates After Three Years of Training in This Program

Grade	*School Year*	*No. of Graduates*	*Cost Per Yearly Completor*	*Total Cost Per Year*
10	1973-74	19	$2,182.20	$41,462
11	1974-75	19	2,350.06	44,651
12	1975-76	19	2,687.14	51,056
	Per Pupil Average Total Cost of Training		$7,219.40	
	Total Cost of Training Over 3 Years			$137,169

CHAPTER 6
MISOE INTERACTIVE COMPUTING SYSTEMS AND FILE STRUCTURE

Martin Breslow

This chapter will probably be high on the "quickly skimmed" list for readers. However, it serves two important functions and they are:

1. It provides a feel for the "real world" of interactive computing systems, and
2. It offers a description of the enormous flexibility of the MISOE data files.

This chapter is purposefully described in casual language, and a fairly rapid skimming of its contents should facilitate a reasonable understanding for dealing with Chapters 7 and 8. It would be sensible to expect that the casual reader might want to return to review this chapter after (or during) the reading of Chapters 7 and 8. In fact, the entire example of policy formulation offered in Chapter 8 could be conceived as taking place in front of the MISOE computing terminal sketched in Figure I of this Chapter.

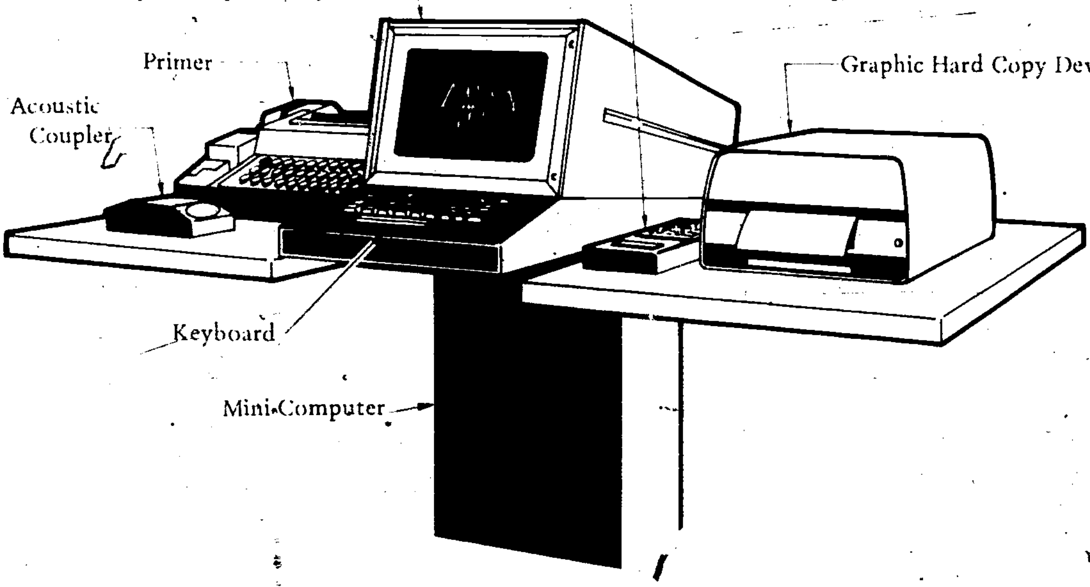
Hardware and Input/Output Devices

MISOE hardware and input/output devices provide for interaction between a manager (or user) and information files. The hardware and devices together are usually referred to as a terminal. The MISOE computer terminal is comprised of six separate pieces of hardware, and they are:

1. A graphic display scope and keyboard;
2. a printer;
3. an acoustic coupler;
4. a minicomputer;
5. a cassette tape recorder; and
6. a graphic hardcopy device.

The MISOE terminal, which could be described as a remote input and output device hooked together by electronic circuitry, is pictured in Figure I.

The terminal is connected to a time-sharing computer on telephone lines via the "acoustic coupler". The computer and the terminal communicate with each other by using devices which emanate and detect specific high-pitched sounds. The sound carries a code similar to the Morse



code, and these pulses are translated into a language the terminal can understand.

The user interacts with the computer by typing messages on the keyboard. The keys contain characters which represent letters or numbers or specific controls for the devices connected to the terminal. Certain keys enable the user to edit messages to the computer prior to transmission. The user can both delete and insert characters.

The graphic display scope operates much like a television screen. It can display tables, graphs, or any two-dimensional shape. Thus, the graphic display scope can be used to communicate in a variety of ways from the computer to the user. The graphic displays are controlled by the minicomputer.

Simultaneously, that which is displayed on the graphic display scope is also displayed on another display scope with the graphic hardcopy device. The graphic hardcopy device also includes a photocopy capability, and therefore the user can demand a hardcopy of any information he interactively develops on the scope.

Interactively developed information that is longer than the graphic display scope can be outputted on the printer. However, extremely long reports requested by management should not be transmitted through the MISOE computer terminal, but should be requested to be outputted on a high-speed printer at a computing facility.

The cassette tape recorder is used to prepare inputs or complex communications with the computer, prior to entering into a dialogue with the remote computer. The cassette tape recorder is helpful in facilitating efficient communication between the user and the computer. When the user is "logged" on to the time-sharing computer, the edited information on the tape can be rapidly communicated over the telephone lines to the computer.[1]

The Software of Interactive MISOE Software is another way of describing already written computer programs. The interactive software used by MISOE can be classified by three functions:

1. data management;
2. data manipulations; and
3. report generation.

Data management is the name which describes the structuring process for the stored information systems such that they are compatible with a process of interactive retrieval. The software packages available for performing these functions provide a technical language for specifying and editing the data, as well as a language for retrieving information. The retrieval language also includes some of the reporting and data manipulation capabilities.

The structure of the MISOE data files will be discussed in a later section of this chapter. Space limitations do not permit a description of the retrieval language. However, Chapter 7 will provide the reader with a generalizable description of how a user can interact with the MISOE data system. This chapter will also discuss the logical, mathematical, and statistical information manipulation operations that are available for interactive analysis on the part of the user. Statistical operations are performed by an interactive-statistical package. Requests for statistical analysis are made in a conversational, free-form language.

Special software is required to transform outputs from the data base management package and the statistical package into a form such that it can be displayed to the user on the graphic display scope. For tabular output, this is straightforward. For graphic output, software is necessary to specify scales along the axes.

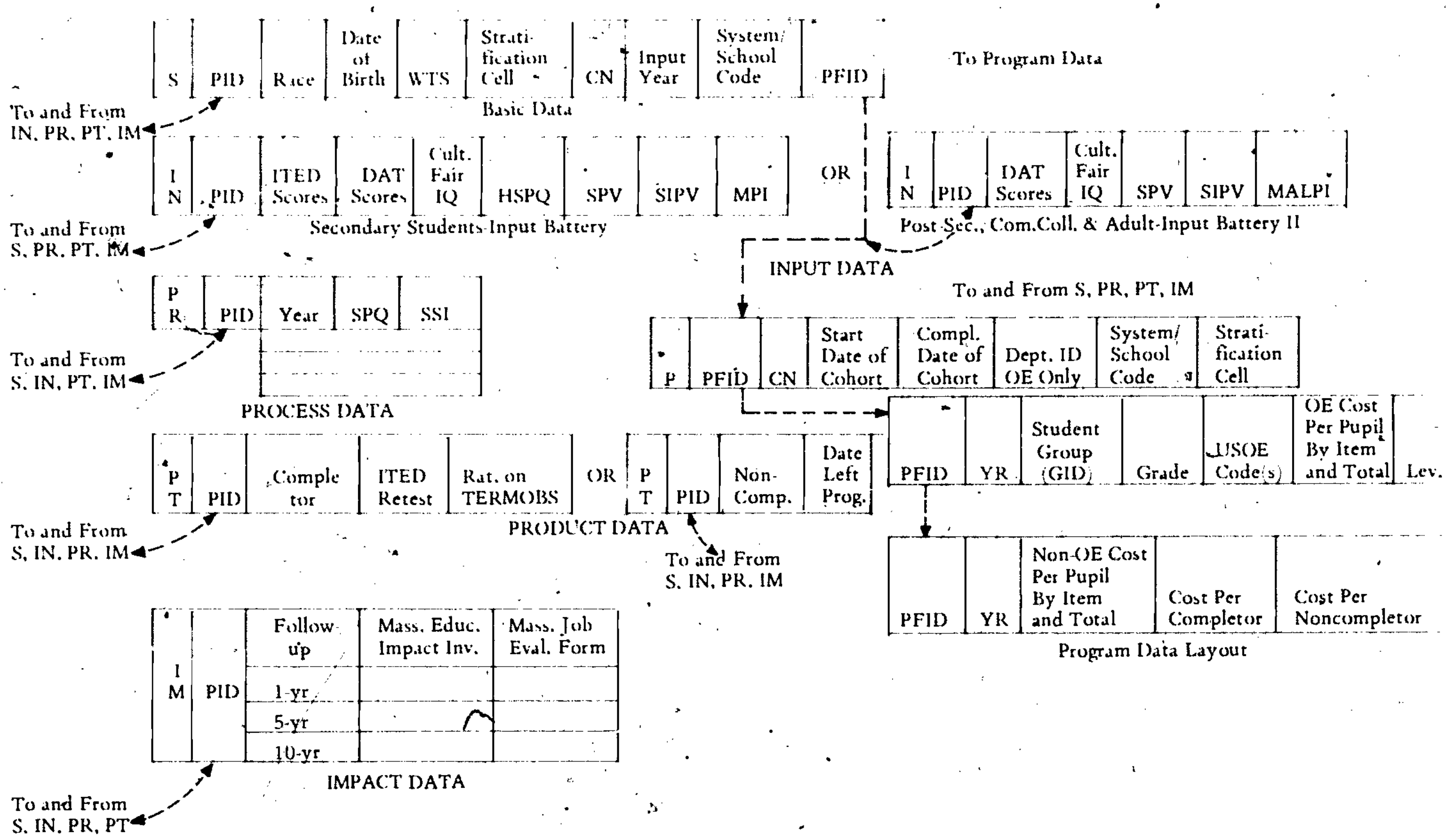
The three types of software packages (data management, statistical, and graphic) are connected together by a conversational time-sharing system. The time-sharing system includes an executive language in which requests involving the use of two or more of the software packages can be automated. Thus the process of going from the data management package to the statistical package and to the graphic package can be greatly simplified for the user.

Connectibility of Data Files The following section of this chapter will present a general overview of how the MISOE data files are organized for interactive analysis. This presentation will be more conceptual than actual, but is designed to help the reader understand the relatively uncomplicated nature of data file organization. In general, when a data base is created, information is read into a storage file with several descriptive fields. The process of storing information within an organized data file uses descriptive information on each data item in establishing connections among data items and across separate files. Certain data names are declared as "classifiers" (qualitative variables in Chapter 7). For example, an occupational education program can be classified by an ID number, a USOE code, or a number which identifies the town and school in which the program is offered. These "classifiers" connect data across data units, while data names called "identifiers", for example, a student's identification number, can connect together all information for a particular student (a data unit) *within* an organized data file.

Connectibility Within the MISOE CDS-SDS Data Files This section will briefly describe the structure of the MISOE data files, highlighting its connectibility. File

[1] Although MISOE was initially developed with a hardware configuration described by Figure 1, there are commercially available alternatives whose construction slightly alters the described configuration.

FIGURE 2 LAYOUT OF SDS STUDENT DATA



structure to attain maximum data connectibility is absolutely essential to an interactive computing system.

Figures 2, 3 and 4 describe the file arrangements of the MISOE Sample Data System.

In Figure 2 the first row on the upper left hand corner, described as Basic Data, contains information identifying certain static components of the students in the sample. PID stands for Permanent Identification Number and every student, teacher and administrator in SDS is assigned a unique PID. A student's PID is an identifier or classifier. The student's PID connects together all basic and IPPI information on an individual student. Figure 2 simply sketches these connections. The second row contains a student's Input Data, the third row is Process Data, the fourth row is Product Data and the fifth row is student's Impact Data. Notice it is all connected together by a PID.

Each program from which students are sampled in the Sample Data System is assigned the same identification number it carried in the Census Data System. This is called the PFID. Census Data System information describing certain characteristics of the programs from which sample students are taken are connected to the PFID. Thus, information describing the individual student as arrayed in the left hand side of Figure 2 and information which describes certain characteristics of the program from CDS information can be connected together. This is a particularly crucial connection for expenditure information.

To help unscramble Figure 2, it might be useful to know that most of the abbreviations describing the input batteries stand for specific instruments; CN represents cohort number; and WTS describes the space where sample weights will be attached to each student file, such that the user never will be able to access unweighted information. Figures 3 and 4 display the layout for the data files for teacher and administrators. Note that the PID serves to connect together each teacher's and administrator's data. Student information is connected to teacher information (but not vice versa), by way of the PFID. Student data is connected to administrator data by way of a system school code which is adopted from the CDS system. Thus, the information describing teachers and administrators becomes extensions of student process information.

The SDS data files have been designed such that student information is connected to program, teacher and administrator data, but information describing programs, teachers and administrators cannot be connected back to students. That is, these connections are one-way. Further, teacher information is not connected to administrator information. This provides a technical safeguard against using MISOE information to "evaluate" individual schools, teachers, or administrators within the sample.

On the other hand, information in CDS is all "two-way connected" (on the assumption it is public information).

Figure 5 is a graphic presentation of the CDS Data file. The following description of the CDS data file assumes that each of the abbreviated identifiers within this schematic layout is self-explanatory. LEAs are identified by a system code, a unique number assigned to each LEA. Since the system code is present on all the CDS files, it forms the basis for connecting LEA information to all other data in the file.

Three digits are added to the system code to form a "system and individual school code", which identifies a school

FIGURE 3   LAYOUT OF SDS TEACHERS' DATA

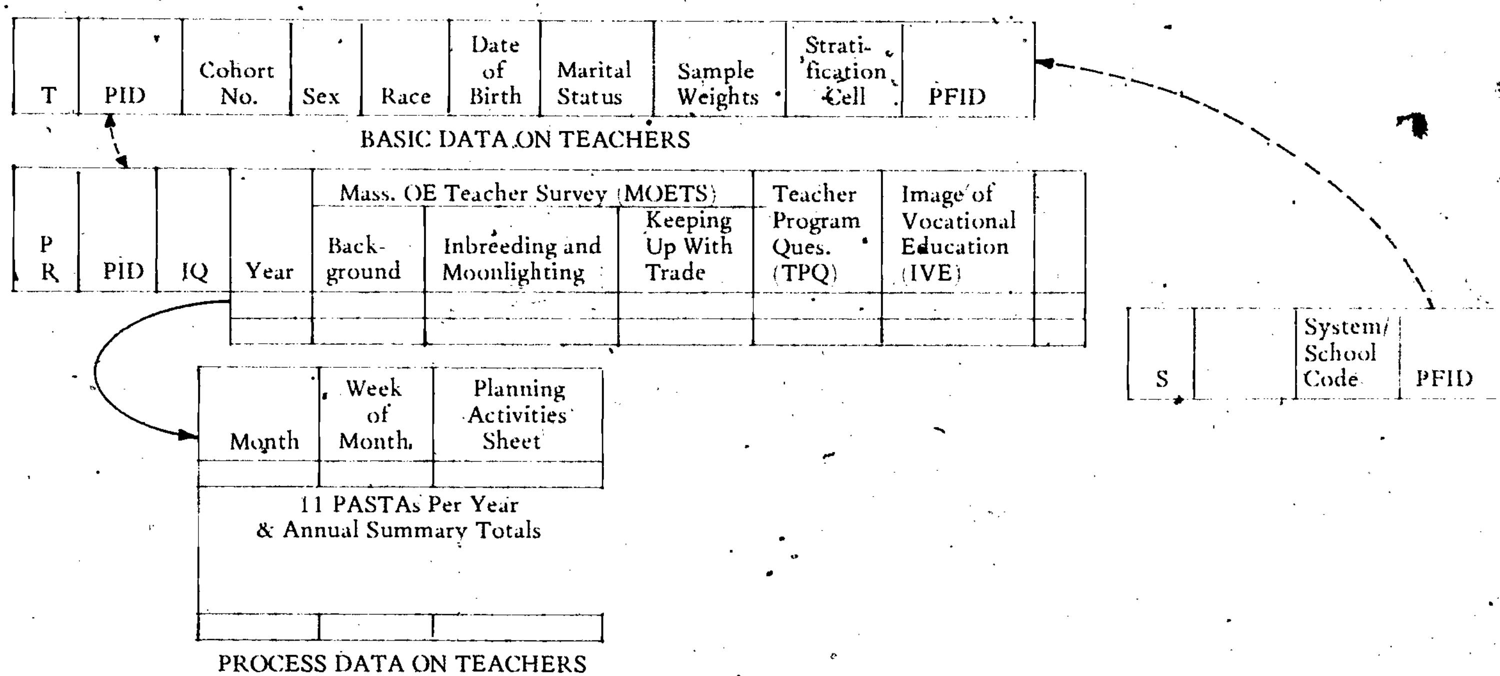


FIGURE 4 LAYOUT OF SDS ADMINISTRATOR DATA

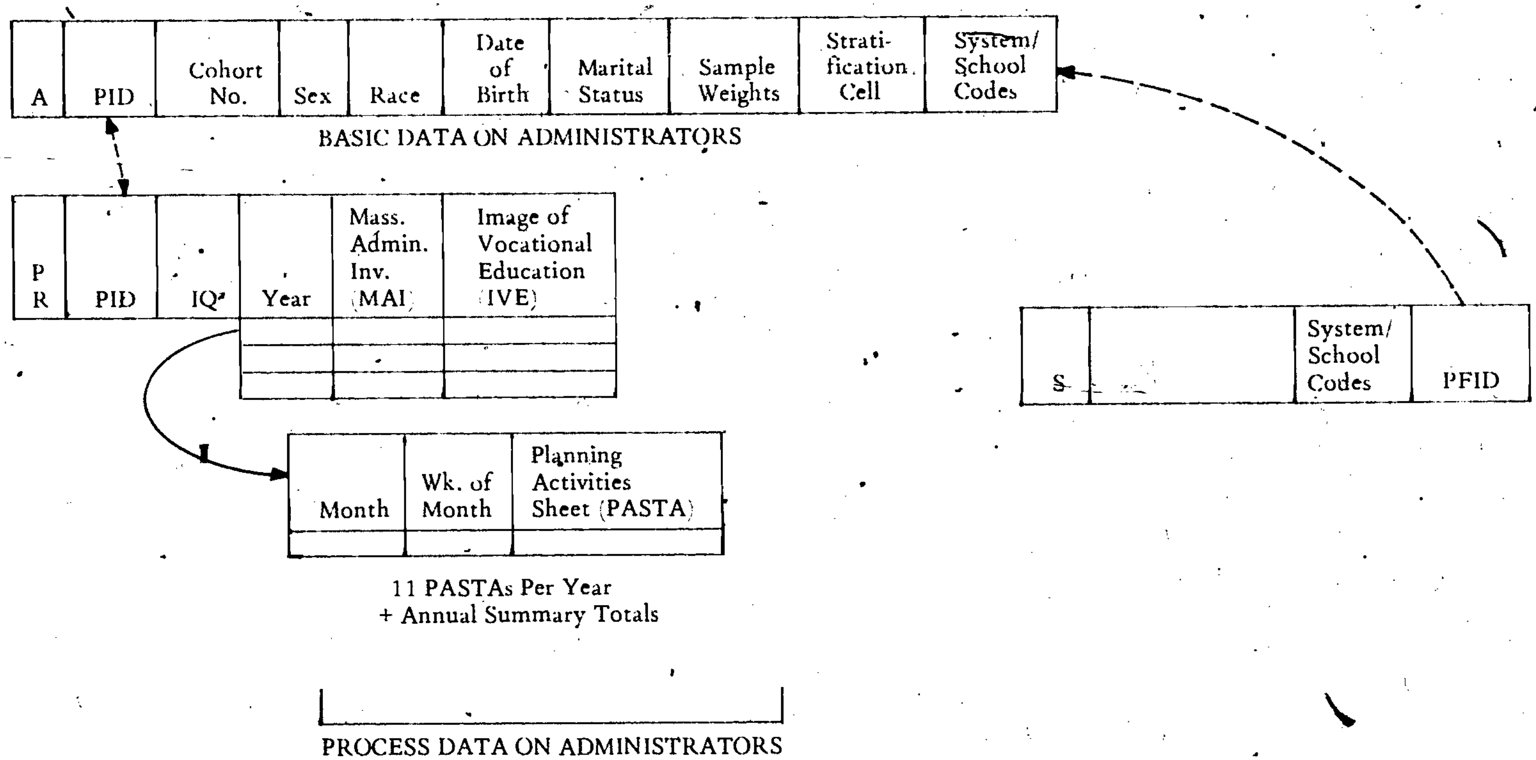


FIGURE 5 — CDS DATA LAYOUT

L	System Code	Political Districts	SMSA	Mass. Educ. Region	Year	LEA is or is not in SDS	Expenditures OE/Non-OE By Item	Revenues By Law	Enrollment OE/NOE By Grade, Sex	Staff Central & Itinerant OE/NOE By Grade, Sex

System Code: To and From S, OETS, P

LEA DATA

S	System/School Code	School Type	Year	School is or is not in SDS	Expend. OE/NOE By Item	Value of Land, Bldg. & Equip.	Revenues By Law	Enrollment OE/NOE By Grade, Race & Sex	Other Enrol. of Completor Sp.,Ed. & Summer-OE/NOE	Staff OE/NOE by Race, Sex, & Lev.	Admin. Survey	Use and Suit. of Instruc. Areas

System/School Code: To and From L, OETS, P

SCHOOL DATA

OETS	Year	Staff Member ID	Dept. ID	System/School Code	Individual Background Data	Teaching Assignment: Time Teach. Student Groups By Prog., Levels, Grade, USOE: Time Teach. Non-OE	PFIDS	Student Groups IDS Within Each Program (GIDS)	Teaching & Admin. Salaries Incl. Fed. Funds Applied to Salaries

System/School Code: To and From L, S

PFIDS: To and From P

OE TEACHER SURVEY (OETS)

P	Prog. ID (PFID)	Dept. ID	System/School Code	Prog. Type	Level	USOE Code(s)	Is or Is not in SDS	YEAR	Expenditures 1) By USOE Code & Item 2) From Fed. funds by USOE Code & Item 3) Revenue Providing Laws	Enrollments 1) Student Groups def. by USOE codes & Grades by race, Sex, & student type 2) Completors, Repeaters, Dropouts Transfer-outs By stud. group race & sex	Staff Totals	TERMOB No. Comb. offered to stds. in prog. by USOE codes Where TERMOBS are offered in curricula SDS TERMOB difficulty data	Instructional Areas by Student Group, Grade & USOE codes

Prog. ID (PFID): To and From OETS

System/School Code: To and From L & S

OE PROGRAM DATA

within an LEA and ties together an individual school's data. All the CDS information describing a particular occupational education program (row 4, Figure 5) and the information describing occupational education staff members within a school (row 3, Figure 5) contain the school's identifying code number in the individual files. This cross-file connectibility allows a user to interactively analyze programs and teachers by school, and permits a display of information describing the school in which an occupational education program is nested.

The identification codes (PFID) of the occupational education program(s) a staff member teaches is stored with his information. Furthermore, the identification numbers of the individual student groups (GID) he teaches within each occupational education program is also stored within the teacher's file. Thus, information describing teachers is connectible to program enrollment information. Since student groups are defined by grade and USOE code combinations, occupational education staff can be classified by grade and USOE code.

The program file contains a Department ID in addition to various codes named above. Thus, when a department has more than one occupational education program, they can be separately classified.

Conclusion

It is hoped that this chapter has communicated an uncluttered conception of two important elements of MISOE:

1. The physical hardware with which a user must come to grips, and
2. The scope and flexibility of the data files.

It is not necessary for a user to ever know much more than is presented in this chapter about file structure and hardware to interact with MISOE data systems. As a matter of fact, it is not necessary to know anything about the structure of the data file layout. However, an overview of the file structure could be helpful in understanding the analytical flexibility of MISOE.

Chapters 7 and 8 describe the very essence of MISOE. Chapter 7 stipulates how a user can interact with the MISOE data systems in policy formulation, while Chapter 8 presents an example of the development of a statewide policy for occupational education.

In order to judge the usefulness of MISOE as a support mechanism to policy formulation, it is necessary for the reader to experience, at least vicariously, policy development with an interactive computing system. Chapter 7 provides an outline of the few specific skills required to access the MISOE data systems through data file indices, while Chapter 8 is intended to provide a feel for interactive policy formulation. Both chapters should be rather carefully considered by those concerned with evaluating the potential of MISOE in making better man's capability to formulate policy for occupational education at the state level.

CHAPTER 7
INTERACTING WITH MISOE DATA, OPERATIONS AND OUTPUT INDICES

Elizabeth Weinberger

Introduction

The fact that MISOE is an *interactive* computer system has been stressed many times earlier in this *Journal.* What does it mean to interact with a computer system from the point of view of the educational manager? How does one go about interacting with a computer? What are the benefits that can be derived from such interaction? It is the purpose of this chapter to attempt to provide response to questions such as these. The chapter has been divided into two parts. Part I is concerned primarily with introducing and explaining the tools provided to the educational manager for interacting with the MISOE system. These tools are: the three types of indices to the system that provide coded listings of the data available; the operations that can be performed on this data; and the types and modes of information outputs available. The second part of the chapter provides several examples of the interaction process and is essentially geared towards demonstrating how this process might work. Since the man-machine interactive component of MISOE is still in the developmental stage, this description of the process is meant to be suggestive rather than descriptive of the final product.

PART I: A DESCRIPTION OF THE MISOE INDICES

A Brief Overview of the MISOE Data and Operations Indices

There are three types of indices to the MISOE interactive computer system: (1) *The Data Indices,* (2) *The Operations Index,* and (3) *The Output Index.* The Data Indices contain hierarchically ordered listings of the major data classifications stored in the MISOE data files and their respective code numbers. Since there are two major categories of MISOE data. CDS data and SDS data, two separate Data Classification Indices were developed: *The CDS Data Classification Index* and the *SDS Data Classification Index*. Each of these is further subdivided into a Qualitative Variables Index and a Quantitive Variables Index. *The Operations Index* contains a coded listing of the various operations that may be performed for purposes of analysis, retrieval and/or display on stored information for selected variables listed on either the CDS or SDS Data Classification Indices. The Operations Index is divided into three sections which reflect the types of operations accommodated by the system: *Logical Operations; Mathematical Operations* and *Statistical Operations*. *The Output Index* provides a coded listing of the various types and modes of output of retrieval information that can be requested by the user of the system. The purpose of this chapter is firstly to provide the potential user of the MISOE interactive computer system with a description of the major indices to the system, and secondly, to provide the potential user with an understanding of the process by which one can interact with the MISOE computer system through the use of these indices for purposes of analysis, retrieval or display of information.

A Brief Introduction to the Use of the MISOE CDS and SDS Data Classification Indices

As previously mentioned, there are two data classification indices: the CDS Data Classification Index and the SDS Data Classification Index. The data classified in each of these indices is divided into one of two data types:

1. *Qualitative Data* is that coded qualitative information upon which only logical (i.e., nonmathematical operations can be performed. Examples of qualitative variables are: sex, race, school type. Qualitative variables are primarily useful in classifying data for purposes of distribution or aggregation.
2. *Quantitative Data* is that coded quantitative information upon which both logical and mathematical operations can be performed. Examples of quantitative variables are: number of students enrolled in a given program, average number of hours per week that a given program is taught, number of full time nonteaching staff in a given LEA.

The CDS and SDS Data Classification Indices are each divided into two parts: a Qualitative Variables Index and a Quantitative Variables Index. Thus, there are actually four data indices. Each data index is accompanied by a Table of Contents which lists the major variable classifications included in that index by identifying code number and page location, (see Figure 1). The Table of Contents has been organized for the purpose of data retrieval and is a truncated but representative portion of the Table of Contents to the CDS Qualitative Variables Index and is shown on page 76. Thus, an educational manager who was interested in locating information on occupational education staff members from the CDS Qualitative Data Index would know that the data classification for "O. E. Staff" is located on pages 14-15 of that index and is identified by code numbers in the 400's range.

The CDS and SDS Data Classification indices contain hierarchically ordered and coded breakdowns of the data classification categories listed in the accompanying Table of Contents. The coded subcategories are alphabetically

FIGURE 1 - ORGANIZATION OF THE MISOE DATA INDICES

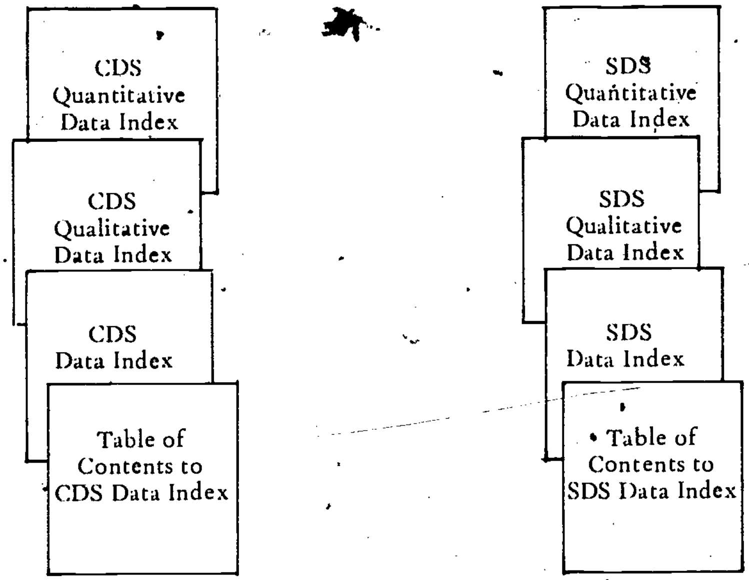


	Table of Contents to the CDS Qualitative Variables Index		
	Major Data Classifications	Code No.	Page No.
Data Category →	Organizational and Geographic	300	12-13
	System/School Codes	301	12
	LEA Types	302	13
	Occupational Education Staff	400	14-15
Data Subcategory →	Teacher/Teacher's Aide	402	15
	Fulltime/Parttime	403	15
	USOE Codes	500	16

Major Categories of CDS Qualitative Variables by Code Number		
Organizational and Geographic Breakdowns	300	
Occupational Education Staff	400	
USOE Codes and USOE Code Categorizations	500	
TERMOB Related	600	
Miscellaneous	700	
Economic		701-710
Enrollment, Student and Other Staff Oriented		711-720
Instructional Area		721-730
Time Related		731-740
Other		741-799

ordered within each of the major data classification categories. Each of the Data Classification Indices is individually discussed in the following section.

The CDS Qualitative Variables Data Classification Index

The major data classifications included in the CDS Qualitative Variables Index and their respective coded numbers are summarized on page 76. To use the CDS Qualitative Variables Data Classification Index, the user would first refer to the Table of Contents for this index, as previously described, and find the page number and code number of the particular qualitative variable in which he was interested.

Suppose that the hypothetical educational manager mentioned earlier is interested in information on occupational education teachers with Master's Degrees. He would consult the Table of Contents to CDS Qualitative Variables (see page 76) where he would find that occupational education staff variables are located on pages 14-15 of the Qualitative Variables Index and are identified by code numbers in the 400's range. He would open the CDS Qualitative Variables Index to the specified pages and look at the list of variables with code numbers in the 400's range. A representative section of this index is illustrated on this page. He would find that code number 407 identifies the

Representative Section of the CDS Qualitative Variables Index

Occupational Education Staff	400		
Fulltime/Parttime		405	
Fulltime			405.1
Parttime			405.2
Highest Level of Educational Attainment		407	
Bachelor's Degree			407.05
Bachelor's Degree + 30 credits			407.07
Master's Degree			407.07

data category Highest Level of Educational Attainment. Since the information that he is interested in falls within this data category, he would then look at the data subcategory until finding the particular qualitative variable category in which he is interested (i.e., OE teachers with Master's Degrees). Code number 407.07 identifies the category Occupational Education Teachers with Master's Degrees. Thus, he would specify code number 407.07 to obtain data within that category.

The CDS Quantitative Variables Data Classification Index

The major data classifications included in the CDS Quantitative Variables Index and their respective code numbers are summarized below:

Major Categories of CDS Quantitative Variables by Code Number	
Expenditures	1000
Enrollment	2000
Staff	3000
Instructional Area	4000
Student Time	5000
TERMOBS	6000

The CDS Quantitative Variables Index would be used in much the same way as the CDS Qualitative Variable Indices. That is, the user would first refer to the Table of Contents to the Index with a particular data classification in mind and then to the index itself to find the code number that identifies the particular variable category in which he is interested. He would next specify that code number to obtain the desired information. For example, an educational manager might be interested in knowing the enrollment of each comprehensive high school in Massachusetts. Since the data in which he is interested (enrollment) is of the quantitative type and is CDS data, he would refer to the Table of Contents to the CDS Quantitative Variables Index. There he would find the following listing:

	Code No.	Page
Enrollment Data	2000	8-12
On LEAs	2301-2399	8
On Occupational Departments	2101-2199	9-10
On Occupational Programs	2001-2099	11
On Schools	2201-2299	12

In that he is interested in enrollment data on schools, he would then turn to page 12 of the CDS Quantitative Variables Index and would look at the variables coded 2201-2299. He would find the following listing for variables in which he is interested, enrollment in schools:

2201 Number of Students in School

Instructional Note: Specify School Selectors (QV 301B). Grade (QV 308). Race (QV 711) and Sex (QV 712) may be specified at the user's option

Therefore, he would know that he must specify code number 2201 in order to obtain the data in which he is interested. The instructional note accompanying this data item provides a listing of the additional data specifications that must or can be made in order to obtain the information desired. The CDS Major Data Selectors Summary Sheet (see Table I) contains a coded listing of the major qualitative variable categories by which CDS data items can be qualified or classified. Since the manager is interested in enrollment in comprehensive secondary schools, he would know that he must specify a School Selector identifying the School Type, i.e., *Comprehensive Secondary*. From the Major Data Selectors Summary Sheet he would note that School Type data is identified by code numbers in the range of 303.00 in the CDS Qualitative Variables Index. By using the Table of

TABLE I CDS MAJOR DATA SELECTORS SUMMARY SHEET

	QV-301A *System Selectors*
QV 301	System/School Code
QV 302	LEA Type
QV 315	State Senate Districts
QV 316	State Assembly Districts
QV 317	U.S. Election Districts
QV 318	SMSAs
QV 319	Educational Region
	BV-301B *School Selectors*
QV 301	System/School Code
QV 303	School Type
QV 313	School Organization
QV 301A	System Selectors
	BV-305 *Department Selectors*
QV 305	Department I.D.
QV 301A	System Selectors
QV 301B	School Selectors
	BV-401 *Staff Member Selectors*
QVs401-409:	411-413 Staff Characteristics
QV 305	Department I.D.
QV 306	Program Selectors
QV 301 A&B	System Selectors and School Selectors
	BV-306 *Program Selectors*
QV 306	Program (Form) ID (PFID)
QV 309	Program Type
QV 311	Program Area Codes
QV 312	Codes of Program Area Distribution (Legal Classification)
QV 320	Program Is/Is not in SDS Example
QV 305	Department I.D.
QV 500S	USOE Code combinations
QV 301A	System Selectors
QV 301B	School Selectors

Contents to this index, he would find the page(s) in the index on which data items with that code are listed. In the index he would find that code number 303.20 identifies the data classification Comprehensive Secondary School. That is the School Selector that he would specify. Thus, in order to obtain data on the enrollment of each comprehensive high school in Massachusetts, the manager would specify two numbers: 2201 and 303.20. This is a very simple example for demonstration purposes.

The SDS Data Classification Indices

As previously mentioned, the SDS and CDS Data Classification Indices are similarly organized. That is to say that there is an SDS Qualitative Variables Index with an accompanying Table of Contents, and an SDS Quantitative Variables Index also accompanied by a Table of Contents. Since the SDS data indices are used in much the same manner as the CDS data indices, this section of the chapter will be geared toward detailing the content of these indices rather than their usage.

The SDS Qualitative Variables Data Classification Index

The major coded data classification included in the SDS Basic Variables Index are summarized below:

Major Categories of SDS Qualitative Variables by Code Number	
Cohort Number	100
Grade	200
Level	300
Stratification Cell Number	400
USOE Code Number	500
TERMOB Number	600

The SDS Quantitative Variables Data Classification Index

The major data classification included in the SDS Quantitative Variables Index and their respective code numbers are summarized below:

Major Categories of SDS Quantitative Variables by Code Number	
Input Data on Students	1000
Process Data on Teachers	2000
Process Data on Administrators	3000
Process Data on Students	4000
Product Data on Students	5000
Impact Data on Students	6000
Economic Data	7000

SDS data, like CDS data, is hierarchically organized. Thus within each of these major data categories there are subcategories and within each of the subcategories there are further breakdowns. The subcategories for all of economic data consist of listings for the instruments used to obtain the data. These instruments fall into one of two categories: commercially or otherwise available instruments and instruments developed inhouse. For the commercially or otherwise available instruments (indicated by an asterisk) the within instrument subcategories consist of the various scores yielded by the instrument. For all of the other instruments and inventories (i.e., those developed inhouse) the within instrument subcategories consist of data on each individual item or variable, as well as data on a priori generated variables. (An a priori generated variable is a variable which has been arbitrarily generated from the combination of two or more individual items prior to empirical analysis of the data yielded by the instrument). It should be noted that all processes including economic data in SDS are strictly mathe-

TABLE 2

MAJOR CATEGORIES OF SDS QUANTITATIVE DATA BY CODE NUMBER

Input Data	1000	
Cognitive	1100-1300	
* Iowa Tests of Educational Development		1100
* Differential Aptitude Test		1200
* Culture Fair I.Q. Test		1300
Noncognitive		
* High School Personality Questionnaire		1400
* Surveys of Interpersonal and Personal Values		1500
* Survey of Study Habits and Attitudes		1600
Student Master Identification Form		1700
Student Master Identification Form-Update		1800
The Massachusetts Pupil Inventories-MPI(A)		1900A/B
General Demographic and Family Background Data-MALPI(B)		1910A/B
Socioeconomic Background Data		1920A/B
Student Relations with Parents		1930A/B
Parental Interest in Student's Education		1940A/B
Educational and Occupational Background Status and Aspirations		1950A/B
Peer Relations and Comparisons		1960A/B
Interests and Activities		1970A/B
Process Data on Teachers	2000	
The Massachusetts Occupational Education Teacher Survey (MOTES)		2100
* The Teacher Program Questionnaire (TPQ)		2200
* The Image of Vocational Education (IVE)		2300
The Planning Activities Sheet		2400
* The Purdue Teacher Opinionaire		2500
* Verbal Reasoning I.Q.		2600
Process Data on Administrators	3000	
* The Image of Vocational Education		3100
The Planning Activities Sheet		3200
The Massachusetts Administrator Inventory		3300
* Verbal Reasoning I.Q.	4000	
* The Student Program Questionnaire		4100
* The School Sentiment Index		4200
Product Data	5000	
* Iowa Tests of Educational Development-Retests		5100
Completion/Noncompletion Data		5200
Terminal Objectives Data		5300
Impact Data	6000	
Massachusetts Educational Impact Inventory		6100
Massachusetts Job Evaluation Form		6200
Economic Data	7000	

*Commercial Instruments

TABLE 3
A SAMPLE FROM THE OPERATIONS INDEX WITH ILLUSTRATIVE EXAMPLES OF THE VARIOUS OPERATIONS

1.00 *Logical Operations*	
1.10 Logical Combinations	
1.11 And (&):	e.g., all students who are both female *and* in office education programs
1.12 Or (inclusive A):	e.g., all students who are either female *or* in office education programs
1.20 Logical Relations	
1.21 Greater Than (GT):	e.g., all teachers with I.Q.s *greater than* 120, or
1.22 Less Than (LT):	with I.Q.s less than 120, or
1.23 Equal to (ET):	with I.Q.s equal to 120
1.24 Not Equal to (NE):	e.g., all students with family incomes not equal to $10,000 or more
1.25 Not	e.g., all students who are not in occupational education
2.00 *Mathematical Operations*	
2.10 Plus (+):	e.g., number of students enrolled in Cosmetics programs *plus* the number enrolled in Homemaking programs
2.20 Minus (-):	e.g., the costs of specific OE programs *minus* expenditures on equipment in those programs
2.30 Times (x):	to find the total number of hours a given program meets each semester, the number of hours that the program meets daily *times* the number of program sessions held that semester might be requested
2.40 Divided by (÷):	It might be requested that total program cost be *divided by* number of students in the program to find the per pupil cost of a given program
2.50 Exponentiation:	Mathematical operations used primarily to perform statistical operations
2.60 Square:	
2.70 Square Root:	
3.00 *Statistical Operations*	
3.01 Count (data items):	e.g., a count of the number of schools offering a particular program
3.02 Sum (data items):	This operation is used to generate the basic summations upon which most analysis operations depend, e.g., ΣX, ΣX^2, $\Sigma X_1, X_2$, etc.
Operations 3.03, 3.04, and 3.05	consists of the scaling or ordering of data items
3.03 Sort (data items):	It might request that students scores on the ITED Reading Test be sorted by sex
3.04 N tile Rank (data items):	A manager might want to know the percentile rank of a given score on the Input Battery
3.05 Scale by N-tile (data items):	This operation consists of the scaling of items (e.g., scores on tests) by their percentile rank
3.06 Mean (data items):	These operations all involve measures of central tendency (e.g., mean, median or modal income of automotive mechanics graduates
3.07 Median (data items):	
3.08 Mode (data items):	
3.09 Range (data items):	These operations all involve measures of dispersion (e.g., the range of scores on a test, the variance in test scores and the standard deviation associated with a given mean test score
3.10 Variance:	
3.11 Standard Deviation:	
4.00 *Measures of Relationship*	
4.10 Stepwise Multiple Regression (R):	This is the operation used to select the independent variables which are to be included in a regression equation. It consists of the insertation of variables, one after another until the regression equation is satisfactory. Variables whose contribution to predicting the dependent variable is nonsignificant are removed from the regression model. This process is continued until variables cannot enter the regression equation, and variables cannot be removed from the equation
4.20 Multiple Regression:	This operation obtains information about a dependent variable in terms of several independent variables, e.g., the relationship between teacher salary, teacher load, student attitude toward school, and teacher satisfaction
4.30 ϕ	Operations used primarily to determine relationships between variables, one or more of which are noncontinuous
4.40 ϕ/ϕ max	
4.50 ϕ max	
4.60 chi square	
4.70 contingency coefficient	

matical, with the exception of benefit/cost analyses. Refer to Chapter 5 for a discussion of this. (A more complete listing of the variables available in the SDS Data Indices is provided in Table 2.)

The Operations Index

The process of analysis, retrieval and/or display of information stored in the MISOE data files frequently requires that certain operations be performed on selected variables listed in the CDS or SDS Data Classification Indices. The function of the Operations Index is to provide a coded listing of the operations that may be performed; thereby enabling the person who is interacting with the system to specify the code that identifies the particular operation he wishes to have performed on the data. Several examples of the use of the Operations Index will be provided at a later point in this chapter. The Operations Index is divided into three sections reflecting the three major categories of operations:

1. *Logical Operations:* those operations that can be performed on either nonordered data (such as qualitative variables or ordered data such as quantitative variables. The operations included in this category are used primarily to classify or combine data units; they are particularly useful for specifying the particular group or thing upon which data is to be collected or distributed.
2. *Mathematical Operations:* those operations that can be performed on ordered data (i.e., quantitative variables) only.
3. *Statistical Operations:* those operations that entail statistical manipulations of the data.

Each of the major categories listed in the Operations Index as well as many of the specific operations within each category are detailed in Table 3.

The Output Index

It is anticipated that MISOE data will be available in any of four modes: (1) *on-line* and (2) *off-line* printing for inhouse users; (3) the *terminal* scope and (4) *print-out* (hard copy). There are also three types of output forms or modes of output that will be provided: (1) *Tabular* Outputs, (2) Standard *Statistical* Analysis Outputs and (3) *Graphic* Outputs. The Output Index as illustrated in Table 4 provides a coded listing of each of the output modes and types available to the user.

TABLE 4
A SAMPLE OF THE OUTPUT INDEX

1.000 *Output Type*
- 1.100 Tabular Outputs
  - 1.110 Comparison Table
  - 1.111 Unordered Listing
  - 1.112 Simple Ordered Listing
  - 1.113 Ranked (Diagnostic) Listing
  - 1.114 Cross-tabs
  - 1.115 Frequency Distribution
  - 1.116 Cumulative Frequency Distribution
  - 1.117 Correlation Matrices
- 1.200 Standard Statistical Analysis Outputs
- 1.300 Graphic Outputs
  - 1.310 Discrete Subgroup
  - 1.311 Bargraphs
  - 1.312 Pie-charts
  - 1.313 Point-Scatter Plots
  - 1.320 Continuous Subgroup Linear Point-to-Point
  - 1.321 Least Square Fit
  - 1.322 Moving Average
  - 1.323 Ogive
  - 1.324 Lorenz Curve

2.000 *Output Mode*
- 2.10 At the Terminal
- 2.20 At Remote Batch Printer (Hi-Speed)

The second part of this chapter, as previously mentioned, provides actual examples of some of the ways in which an educational manager might interact with the MISOE computer system by using the three types of indices described earlier in this chapter. The examples offered are meant to provide the user with some feeling for the flexibility that is permitted by the process of interacting with the system. These examples are by no means exhaustive in fact, they have been purposefully simplified for demonstration purposes. It is our hope that these examples will serve as stimuli to the imagination, thereby encouraging the reader to think of the many other possibilities provided by the MISOE man-machine interactive process.

PART II: A SUGGESTED PROCESS FOR INTERACTING WITH THE MISOE COMPUTER SYSTEM

As described earlier, the MISOE data files contain an extensive array of information of enormous potential value to the educational manager. The second half of this chapter concerns the means by which an educational manager may gain access to the information stored in the MISOE data files by using the various indices to the computer system described in Part I. It is important to understnad that in order for the educational manager to interact intelligently with the MISOE computer system, it is necessary for him to have a thorough familiarity with the various indices. This familiarity will be assumed throughout this section.

A Process for Retrieving Information from the System:

A systematic process has been suggested for retrieving information from the computer through the use of these three indices. It is assumed that the educational manager has a particular question in mind when attempting to retrieve data from the computer system. The first step in the information retrieval process in therefore:

Step 1 = *Explicit statement of the question that initiated the probe* in other words, what is the question that the information retrieved from the computer system is meant to answer? A simple example of an explicitly stated question that an educational manager might ask is: What is the average starting salary of all occupational education completors who participated in cooperative study programs as opposed to those who did not participate in cooperative study programs?

Step 2 = *Selection of the appropriate Data Index* the manager must select either the CDS Data Index or the SDS Data Index, depending upon whether the data that is sought pertains to the census or the sample population. The question stated above would require the use of the SDS Data Index because the information sought concerns *all* occupational education completors.

After the first two steps have been completed, the manager is ready to begin using the three major indices (Data, Operations and Output) to interact with the system and answer his question.

Step 3 = *Restatement of the probe question* — The probe question is restated by specifying the following four factors from the question: the *target*, the *criterion*, the *output*, and the *classification*. More than one of each can be specified.

1) *The Target: the person or thing to be described by the data.* The target is specified by referring to the appropriate (CDS or SDS) Qualitative Data Index and the Operations Index, if the target is a function of any operation (i.e.. girls and boys = logical operator "plus"). There may be more than one target if more than one person or thing is to be described. For example, in the question specified in Step 1 there are two targets:
   a) Occupational education completors who participated in cooperative study programs
   b) Occupational education completors who did not participate in cooperative study programs

   Note that part of the specification of the target is the specification of any qualifiers that define the target.
2) *The Criterion: the data which describes the target.* The criterion in the question specified in Step 1 is the average starting income of each of the target groups. The criterion is specified by referring to the appropriate Data Index (either Qualitative or Quantitative depending on the type of data involved) and the Operations Index to either stipulate the statistic in which the criterion is to appear (e.g.. the statistical operation "mean" for average starting income), or, to create a more complicated criterion. A generated variable is an example of a more complicated criterion that can be requested by having scores on two or more individual data items summed by stipulating the mathematical operation "plus".
3) *The Output: naming the type and mode of display of the retrieved criterion data.* Output is specified by referring to the Output Index. For example, the manager who specified the question in Step 1 might request that the average starting income of the target groups be displayed in a comparison table at the terminal.
4) *The Classification:* naming the rows and/or columns (or, in the case of the graphs, naming the points along each of the axes) by which the criterion data on the target is to be classified. (When the criterion data falls into one cell, classification is not applicable. For example, if the specified criterion was simply "average starting income of completors", classification would not be applicable). Classification of the criterion is specified by referring to the appropriate CDS or SDS Data Index or Indices (Qualitative, Quantitative or both) for the names of the rows and/or columns by which the criterion data is to be classified, and the Operations Index for any operations required in order to classify the data in the desired manner. For example, the manager in our earlier example might request that the average starting income of each of his two target groups be classified as in the following manner:

TABLE 5
AVERAGE STARTING INCOME OF OE COMPLETORS WHO DID PARTICIPATE IN COOPERATIVE STUDY PROGRAMS VERSUS AVERAGE STARTING INCOME OF THOSE WHO DID NOT

	X Starting Income
Cooperative Study	$8,620
No Cooperative Study	$7,200

To classify the criterion data (that is, average starting income) in this manner, the manager would have specified that row 1 be cooperative study; row 2 be no cooperative study, and that one column be labeled x starting income. This is an example of a very simple data classification; more difficult classifications will be presented later on.

Let us now suppose that the manager, having looked at Table 5, decides that he would like to reclassify his criterion data, average starting income, by school size as measured by enrollment, because he suspects that participation in a cooperative study program has more influence upon the average starting wages of OE completors from large schools than upon the average starting wages of OE completors from small schools. He therefore requests a comparison table with the same rows specified as in Table 5 (i.e., cooperative study and no cooperative study) but with the following three column names to classify average starting wage data of OE completors by enrollment of the school attended. He chooses the following three enrollment classifications: less than 1,000, between 1,000 and 2,000, greater than 2,000. (Note that the Logical Operation "less than", "equal to" and "greater than" would have been specified in order to create this classification of the criterion.) An example of the data yielded by this classification of the criterion is presented in Table 6. The reclassification of the data presented in Table 5 into Table 6 provides a very simple example of one way in which an educational manager might interact with the data in the MISOE computer system through the use of the system indices. Several more complicated examples of the man-machine interactive process are provided at a later point.

TABLE 6
AVERAGE STARTING INCOME OF OE COMPLETORS WHO PARTICIPATE IN COOPERATIVE STUDY PROGRAM VERSUS AVERAGE STARTING INCOME OF THOSE WHO DID NOT BY SCHOOL SIZE

	School Size (Enrollment)		
	less than 1,000	1,000-2000	2,000 or more
Coop. Study	$9,280	$8,620	$7,960
No Coop. Study	$7,500	$7,543	$6,567

There is an exception to the previously stated rule that classification consists of the naming of the rows and/or the columns by which the criterion is to be classified. In the case of regression analysis, classification consists of the naming of the independent variables (i.e., those variables which are used to predict the criterion). The dependent variable (i.e., that variable which is predicted) and the appropriate statistical operation (i.e., stepwise or multiple regression) constitute the criterion in the case of regression analysis.

Now that the reader has been familiarized with the process by which an educational manager may interact with the MISOE computer system through the use of the various indices, the remaining part of this chapter will be spent on providing several examples of this process. It is hoped that these examples, in addition to providing you with a better understanding of the man-machine interactive process, will also provide you with some feeling for the flexibility and range of the MISOE system. You will notice that nothing has been said thus far to indicate how the educational manager would use the information obtained by interacting with the system to better his planning and decision-making capabilities; that topic is fully discussed in Chapter 8. It should also be noted again that the purpose of the discussion thus far has been to provide the potential users of the MISOE system with an overview of the man-machine interactive process; the actual technical details by which this interaction is to occur were purposely excluded from this chapter because they are still in the developmental stage.

Some Examples of the Interactive Process for Retrieval of Information from the MISOE Data Files

Example 1. Suppose that an educational manager wants information on the total expenditures in comprehensive schools for all office education programs over the last five years. Once he has explicitly stated his question (Step 1 in the retrieval process), he then decides (Step 2) whether the data that he seeks, expenditures for office education programs in comprehensive schools, is CDS data or SDS data. He decides that it is CDS data because it concerns all office education programs, not only those in the sample, and therefore selects the CDS Data Indices to refer to throughout the remainder of the process. Step 3 in the retrieval process consists of the restating of the probe question by specifying the target, criterion, output and classification. He uses the CDS Data Indices, the Operations Index and the Output Index to specify these:

Target: all office education programs in comprehensive schools (specified from the CDS Qualitative Data Index)

Criterion: total expenditures over the last five years specified from the CDS Quantitative Data Index (economic data) and the Operations Index (since the mathematical operation "plus" is required to sum expenditures in years 1 through 5)

Output: a comparison table (specified from the Output Index)

Classification: not applicable (the criterion data consists of one number)

The information retrieved would consist of one number indicating the total expenditures in comprehensive schools for all office education programs over the last five years, e.g., $500,000,000.

Example 2. Suppose that an educational manager is interested in getting an idea of how much it costs to train a student in automotive mechanics at the postsecondary level by looking at currently occurring spending patterns. He asks the following question: How many schools with automotive mechanics programs at the postsecondary level have per pupil yearly costs in the following ranges: less than $600, $600-899, $900-1,199, $1,200-1,499, $1,500 or more. He decides that he would like the information to appear in a bargraph. With the CDS Data, Operations and Output Indices in hand, he is ready to restate his question as follows:

Target: schools with automotive mechanics programs at the postsecondary level (specified from the CDS Qualitative Data Index)

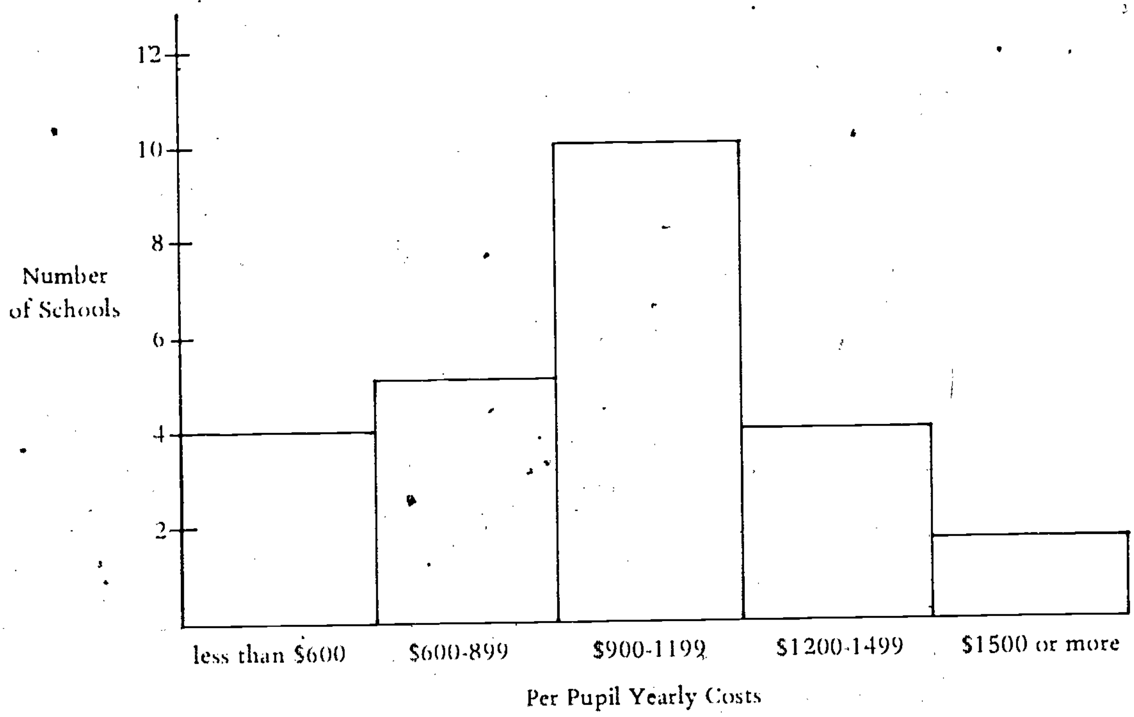
Criterion: number of schools (specify from Operations Index the statistical operation "count"). Specify that which is to be counted, i.e., the target schools from the CDS Qualitative Data Index.

Output: Bar graph

Classification: 1) the following per pupil yearly cost range points on the X axis: less than $600, $600-899, $900-1,199, $1,200-1,499, $1,500 or more (note that this classification requires specification of the logical operations "less than" and "greater than"). 2) the following numbers of schools on the Y axis: 2, 4, 6, 8, 10, 12. The information that would be retrieved from the system as a result of this probe is illustrated in Figure 2.

From this graph, the educational manager might note that the modal per pupil yearly cost range for automotive mechanics programs at the post-secondary level is between $900 and $1,199. He might then decide that he would also like to know the *average* per pupil yearly cost of automotive mechanics programs at the post-secondary level in comprehensive and self-contained schools because he suspects that it is more costly in the comprehensive schools. He would then begin the probe process over again.

FIGURE 2
NUMBER OF SCHOOLS WITH AUTOMECHANICS PROGRAMS AT THE POST-SECONDARY LEVEL BY PER PUPIL YEARLY COSTS OF THOSE PROGRAMS



Example 3. Suppose that an educational manager is *considering approving new occupational programs* and his main concern is the additional costs that would be incurred by creating these new programs rather than by continuing to place students in already existing non-occupational education programs. He decides that it would be useful to look at a comparison table showing the per pupil yearly cost of nonoccupational education programs, occupational education programs, and differences in costs between occupational and nonoccupational education programs. Furthermore, he suspects that these cost differences may vary

considerably by region. He therefore would like to have these cost figures displayed by educational region. His probe would be restated as follows:

Target: occupational education programs; nonoccupational education programs. (Another example of a multiple target-specified from the CDS Qualitative Data Index).

Criterion: per pupil yearly costs and cost differences specified from CDS Quantitative Data Index and the Operations Index

Output: comparison table

Classification: (1) Rows 1 - per pupil yearly cost of occupational education (specified from the CDS Quantitative Data Index and the Operations Index)
2 - per pupil yearly cost of nonoccupational education (specified as above)
3 - per pupil yearly cost differences between occupational education and nonoccupational education. (Note that row 3 is created by specifying the mathematical operation "minus" and subtracting one row from another).
(2) 6 colums - one for each educational region

Table 7 shows the information that would be generated by this probe. The manager might note that the difference in per pupil yearly costs of occupational and nonoccupational education does vary considerably from region to region. He might hypothesize that these differences are a function of the different types of programs offered in the different regions. After looking at the table, he might then decide that he wants to know which programs are offered in that region in which the cost differences were the greatest (Region 2), and the costs associated with each of the programs. This probe would be stated as follows:

Target: occupational education programs in Region 2

Criterion: (1) OE programs offered in Region 2
(2) per pupil yearly costs of each program offered
(3) 5 year average earnings of graduates of those programs. (This is an example of a multiple criterion specified from the Data and Operations Indices).

Output: comparison table

Classification: Rows 1 - per pupil yearly cost of occupational education programs
2 - average 5 year earnings of graduates of those programs
Columns - one column for each occupational education program offered in Region 2.

The information yielded by this probe is shown in Table 8. After seeing this data, the manager might decide to initiate a benefit-cost analysis, or he might want to see even finer breakdowns of the data.

Example 4. A particular educational manager is considering trying to improve the attitude that students enrolled in occupational education within his school district have toward a specific program in which they are enrolled. He suspects that students who have a more favorable attitude toward their program will be more satisfied with the jobs that

TABLE 7
COMPARISON OF OCCUPATIONAL COST BY PUPIL BY REGION

	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6
1. Annual Per Pupil Cost of OE	$1,872	$2,421	$1,924	$1,761	$1,772	$1,831
2. Annual Per Pupil Cost of NOE	$1,421	$1,581	$1,221	$1,201	$1,126	$1,201
3. Annual Difference	$ 451	$ 840	$ 723	$ 560	$ 646	$ 630

TABLE 8
REGION 2 ECONOMIC DATA BREAKOUT

Per Pupil Yearly Costs of Occupational Education Offered in Region Two

	Auto Mechanics	Electronics	Woodworking	Child Care
Per Pupil Yearly Costs	$ 2,716	$ 2,618	$ 1,923	$ 1,762
Average 5 Year Earnings of Graduate	$50,000	$60,000	$50,000	$32,000

they eventually receive than students with less favorable attitudes. He notices, after browsing through the SDS Quantitative Data Index, that student attitude toward a program is a variable measured by the Student Program Questionnaire; he also notices that job satisfaction is assessed by items on the impact instrument. The question he asks is: Does student attitude toward an occupational education program have an independent effect on job satisfaction, controlling other variables such as ability? This question might be restated for the probe as follows:

Target: all SDS(2) students followed up in impact space for 3 years

Criterion: (1) job satisfaction score yielded by the impact instrument (could be a Gen Var) – the dependent variable

(2) the Statistical Operation, regression

Output: Standard statistical analysis output – the regression coefficient

Classification: scores on the Student Program Questionnaire – (the dependent variable)

The regression coefficient and summary table yielded by this probe might convince the manager that he should indeed try to improve the attitude of students toward their programs if he wants to increase the likelihood that they will be satisfied with the jobs that they eventually receive, in which case he might try to manipulate the educational process so as to improve attitudes (i.e., by offering more courses) or the data might convince him that he should look at the relationship between some other process variable or variables and job satisfaction because student attitude and job satisfaction were not found to be highly related. This example was provided in order to demonstrate a simple case of regression analysis and the unique specification of criterion and classification for regression analysis as mentioned earlier. An actual summary table that would be yielded by such an analysis has, however, not been generated for the example.

Conclusion

From these few examples, it is hoped that the reader will have been able to gain an appreciation of the enormous flexibility that an educational manager would have in interacting with the MISOE computer system. The number of probes and consequently the different types of information that a manager could request by using any combination of the three indices to the system is virtually unlimited. The only major restraint upon the user is that the data in which he is interested exists within the system.

CHAPTER 8
PLANNING FOR OCCUPATIONAL EDUCATION WITH MISOE

William G. Conroy, Jr.

The single purpose of this chapter is to provide the reader with a simulated experience in statewide planning for occupational education with an interactive computer system. So that this presentation will not be masked by a morass of technical and organizational tangle, several simplifying assumptions are stipulated to set a representative but uncluttered stage for describing a man-computer planning dialogue.

Assumption #1. The example planning experience is focused upon a division for the management of occupational education (DOE) within a state department of education.

Assumption #2. The results of the planning function by DOE result in policy recommendations to a Chief State School Officer. It is assumed that the Chief State School Officer synthesizes policies from special interest divisions within the Department of Education and takes appropriate action with either the State School Board, the Legislature, or both, to implement policy.

Assumption #3. Policy recommendations of the Division of Occupational Education must reflect concern for the relationship between the occupational and human development of students, in light of a comprehensive range of goals for public education. These goals are typically designed to reflect the values of the larger society and its expectation of public education.

Assumption #4. Policy recommendations must include a description of the expected impact of the results of specific policy on society in the future. Policy recommendations which do not connect education with the society it is designed to serve are not permitted.

Assumption #5. Policy recommendations must consider the cost of the policy recommended, as well as the value to society of the benefits received. The quantification of policy recommendations in terms of dollars is assumed essential, as resources for public education are limited and competitively allocated as a result of the perceived contribution of education to societal goals in comparison to other worthy activities like health care for the aged, national defense, family assistance, prison reform, environmental protection, highways, etc.. Accordingly, rational decision making is described as the selection of an alternative process or program designed to accomplish a specified goal at the minimum cost. It follows that planning describes the process of developing (creating) alternatives to accomplish explicit objectives, and the role of an interactive computer system is to connect man the planner and decider with information and operations which help estimate the state of the world in relationship to specific goals and the likely consequences of alternative plans.

Assumption #6. The example planning experience assumes a twenty-five year fully operational MISOE as described in this publication. The year of the simulated planning experience is 1976.

Assumption #7. Although local education agencies, special interest groups and advisory councils are not included in this example, it is assumed that their influence has been accounted for by DOE.

The Policy Making Process

Policy recommendations are defined as statements which clearly describe specific action to be taken to accomplish specified goals. A policy statement includes both the action to be taken and the goals to be accomplished. Goals for educational policy include a description of both the short term capabilities and skills to be learned by students and the expected impact of these students on society in future time.

The action section of a policy recommendation stipulates a change in some part of the educational system which is designed to bring about the accomplishment of specified goals. Researchers frequently call changeable components variables (things which can be varied). These variables not only include all components of the educational process, from teachers to textbooks but the range of students to be served. The research community has somehow come to describe the change process as manipulation of variables. Frequently, the so-called humanist manager thinks of this description as dehumanizing jargon, but to the social scientist it merely describes the action part of a policy statement in an accurate way.

Even a cursory consideration of the policy setting process cannot avoid the concept of constraints. A constraint is simply an immovable given, something that cannot be changed or manipulated by management. Usually, the higher one goes in an organization, the fewer constraints that apply to a policy recommendation. For example, a constraint to planning from a superintendents's perspective is a requirement that all youth attend public education for a prescribed number of days each year until they reach an established age. Since this example assumes policy recommendations are made for the legislature by an administrative branch of state government, no constraints limit the range of alternatives available to DOE in probing policy alternatives.

Format for Simulated Man – Computer Planning Experience

The simulated planning experience describes the development of a single policy recommendation by DOE. In reality, this experience would be repeated for each policy recommendation, and finally the relationships among policy recommendatins would be examined before submission to a chief state school officer. It is assumed that relationships among policies from special interest management divisions of the total department of education would be examined by the Chief State School Officer.

The development of a policy recommendation results from a series of inquiries or hypotheses initiated by management, a dialogue between management and computer to estimate current values of policy related variables or relationships among these elements, and finally an analysis of the results of this information. Each man-computer dialogue results in an information statement by the computer to the manager. Each inquiry, dialogue, and analysis experience is described as a probe. A twenty-five probe example is offered to describe how MISOE is designed to support the development of policy recommendations for occupational education at the state level.

The call system described in Chapter 7 constitutes the basis for the man-computer dialogue. To avoid interfering with the logical flow this example, call detail required to describe each man-computer interaction will be simplified in conversational language.

Probe #1

Management Inquiry. DOE begins policy development by speculating about the differential impact of students of

TABLE 1
COMPUTER INFORMATION STATEMENT
Target: Males, Completors & Dropouts, Cohort 1,
SDS 1 & 2, All Strata, Secondary, Criteria: M. SD.

	Secondary Completors				Dropouts		Sec & 4 Yr. Coll
	OE 1	NOE 2	OE No Cont 3	NOE No Cont 4	OE No Cont 5	NOE No Cont 6	7
1. Ave Income	$12,600.	$12,823.	$11,573.	$ 8,171.	$10,941.	$ 5,531.	$13,172.
	1,120	2,764	736	681	431	736	4,732
2. Spouses Ave Income	$ 6,230.	$ 6,173.	$ 6,010.	$ 4,271.	$ 4,312.	$ 4,112.	$ 6,217.
	281	270	173	371	297	297	321
3. Family Ave Income	$14,173.	$13,722.	$13,872.	$10,731.	$12,312.	$ 8,103.	$15,731.
	873	2,581	761	531	1,073	431	271
4. Net Worth	$22,731.	$21,473.	$20,764.	$10,731.	$14,731.	$ 4,172.	$28,743.
	3,241	2,973	3,101	1,073	431	211	2,763
5. Ave Mo Unemp	1.2	2.2	1.3	3.7	2.1	4.7	1.0
	.3	1.1	.3	.6	1.1	2.1	1.1
6. Ave No Depend	4.1	4.2	4.1	5.2	5.1	6.2	3.2
	.4	.6	.2	1.3	2.1	2.8	1.4
7. Unemp Benefits	$ 1,812.	$ 1,769.	$ 1,873.	$ 2,731.	$ 2,173.	$ 3,219.	$ 741.
	96.2	345.2	81.2	142.3	273.2	213.1	87.2
8. Welfare Benefits	$ 456.	$ 531.	$ 572.	$ 2,172.	$ 932.	$ 3,991.	$ 351.
	14.1	25.2	35.2	278.6	41.2	432.7	11.6

Note: All Dollar Values Adjusted to 1976 Dollars.

occupational and nonoccupational education on society over ten years. This seems a reasonable place to begin, as occupational education is usually an extra cost program, compared to nonoccupational education. DOE decides to estimate the differences, if any, of eight economic variables for secondary students who either completed or dropped out from occupational (OE) or nonoccupational (NOE) education and either continued or did not continue their education beyond the secondary school. The economic variables include: income, spouse's income, family income, net worth, months unemployed, number of dependents, unemployment and welfare benefits received. The request is for information averaged by student group for fifteen years since completing secondary education. The request is made for all students in the sample data systems for all sample strata.

Management Analysis. An inspection of the Computer Information System reveals that secondary level OE and NOE completors do not differ greatly on these economic variables, with the exception of NOE completors who do not continue education. They make several thousand dollars less per year, on the average, as do their spouses; their family income is several thousand dollars less; their net worth is about one half of the other groups, they are unemployed longer; and collect more unemployment and welfare benefits. All secondary completors (cl. 7) who completed four years of college collected less unemployment and welfare benefits than OE completors who did not continue education, and are slightly better off, on each economic measure. Surprisingly, OE dropouts do not seem to fall that far behind the average scores for all OE and NOE completors on this array of economic variables, although they are clearly not as successful in terms of these measures as program completors. This is particularly true of net worth.

NOE dropouts clearly constitute a disaster group in terms of these indices. When compared to OE completors who did not continue education, they earn less than one half the income, have achieved only a 20 per cent net worth position, are unemployed three times as long, collect twice as many unemployment benefits and about seven times as much welfare.

Probe #2

Management Inquiry. DOE next decides to determine if these differences exist for females as well as males, i.e., secondary completors and dropouts of OE and NOE programs who either continued or did not continue education. The inquiry is made for the same economic variables.

Management Analysis. The Computer Information Statement clearly indicates that this distinction is of the same relative magnitude for males and females. A reasonable conclusion from these first probes would be that there seems to be a systematic difference between NOE students who dropped out of school and did not continue their education and the other groups, and that these students are systematically worse off on all measures.

Probe #3

Management Inquiry. The next concern of DOE is to determine if this difference extends to variables beyond basic economic indices. From items of instruments of the data indices, DOE aggregates (a priori) several variables on which to compare the groups, and they are:

TABLE 2
COMPUTER INFORMATION STATEMENT
Target: Males, Completors & Dropouts, Cohort 1,
SDS 1 & 2, All Strata, Secondary, Criteria: M, SD.

	Secondary Completors				Dropouts		Sec & 4 Yr. Coll
	OE 1	NOE 2	OE No Cont 3	NOE No Cont 4	OE No Cont 5	NOE No Cont 6	7
1. Ave Income	$ 7,431. 600	$ 5,631. 843	$ 6,721. 724	$ 5,012. 521	$ 5,971. 412	$ 3,821. 811	$ 8,149. 121
2. Spouses Ave Income	$12,431. 432	$12,621. 822	$10,973. 921	$ 8,012. 412	$ 8,312. 511	$ 5,213. 712	$16,118. 512
3. Family Ave Income	$14,473. 415	$13,011. 941	$13,001. 412	$10,120. 591	$10,011. 431	$ 7,246. 713	$18,941. 912
4. Net Worth	$22,174. 1,025	$21,596. 441	$20,001. 512	$16,141. 891	$17,143. 491	$10,931. 1,212	$21,936. 642
5. Ave Mo Unemp	2.3 1.3	3.1 1.7	2.6 1.7	3.7 1.8	2.9 2.1	4.1 2.0	2.1 1.3
6. Ave No Depend	4.0 2.1	4.3 2.1	4.2 2.0	4.9 2.4	4.4 2.4	5.4 1.9	3.8 .8
7. Unemp Benefits	$ 683. 72	$ 978. 142	$ 691. 92	$ 1,112. 138	$ 742. 119	$ 2,172. 216	$ 431. 42
8. Welfare Benefits	$ 500. 70	$ 643. 182	$ 542. 61	$ 842. 146	$ 625. 41	$ 2,132. 412	$ 301. 121

Note: All Dollar Values Adjusted to 1976 Dollars.

economic productivity, community services, voting behavior, job satisfaction and participation in sports. DOE assumes that community service, voting behavior and participation in sports represent a range of nonoccupationally related behavior which is associated with the general goals of total secondary education. This inquiry is made for the same secondary group, i.e., secondary completors and dropouts who either continued or did not continue education beyond the secondary level.

Management Analysis. The data reveal little differences between OE and NOE completors, with OE program completors slightly more productive, satisfied with their jobs and involved in community service than their NOE counterparts. OE completors who did not continue education enjoy an advantage to NOE completors who did not continue education. OE dropouts and OE completors do not seem very different, except in terms of job satisfaction, while NOE dropouts are at the same relative disadvantage on this range of variables as they are on the economic indices. Secondary completors who complete college are not much different than OE

TABLE 3
COMPUTER INFORMATION STATEMENT
Target: Males & Females, Completors & Dropouts, Cohort 1,
SDS 1 & 2, All Strata, Secondary, Criteria: M, SD.

	Secondary Completors				Dropouts		Sec & 4 Yr. Coll
	OE	NOE	OE No Cont	NOE No Cont	OE No Cont	NOE No Cont	
	1	2	3	4	5	6	7
1. Productiv	7.2	6.1	7.0	4.9	6.8	3.7	7.2
Gen Var (1)	1.1	3.1	2.1	3.4	2.1	1.8	.9
2. Comm Serv	8.1	6.1	7.9	6.2	7.6	4.1	7.1
Gen Var (2)	1.2	2.3	1.5	2.6	2.4	3.1	2.8
3. Voc Behav	5.1	5.0	4.9	4.2	4.9	3.1	5.0
Gen Var (3)	1.1	1.3	1.2	1.8	1.6	1.2	1.7
4. Job Statu	8.1	6.1	7.8	5.1	5.9	3.1	8.0
Gen Var (4)	2.1	3.1	2.0	2.4	2.8	4.1	4.1
5. Part Spor	4.2	4.2	4.0	3.8	4.1	2.1	5.2
Gen Var (5)	3.1	3.8	3.1	3.0	3.1	2.8	3.2

	Inst	Items		
Gen. Var. (1)	( )	( )	( )	( )
Gen. Var. (2)	( )	( )	( )	( )
Gen. Var. (3)	( )	( )	( )	( )
Gen. Var. (4)	( )	( )	( )	( )
Gen. Var. (5)	( )	( )	( )	( )

completors who do not continue education, as described by this information.

Probe #4

Management Inquiry. DOE now inquires of the extent of what is beginning to appear to be a probable social problem upon which occupational education might exert a favorable impact, the NOE dropout. Previous questions have been made of the sample data systems, with weighted (to the population) responses. In this case, however, management is interested in a description of the total population of dropouts, and discovers from the CDS Data Index that such information is available. As a way of assessing the relative size of the dropout problem, DOE frames its inquiry in terms of OE and NOE males and females, classified by school and geographical settings. It requests that this information be displayed in relationship to enrollments, and asks for averages over the last ten years.

Management Analysis. This Computer Information Statement indicates that the problem seems to have considerable scope and is concentrated on NOE males, who account for 82 per cent of the annual secondary dropout total of over 35,000 students (10 per cent of the secondary enrollment). Seventy-six per cent of these dropouts are located in cities of 75,000 or

TABLE 4
COMPUTER INFORMATION STATEMENT
Target: Annual Dropouts & Annual State Enrollment,
CDS, Male & Female, Secondary
Criteria: Count, % of Total Dropouts

	Annual Dropouts from Programs In All Secondary Schools				Total Annual Sec'dry School Dropouts	Total State Enroll
	OE		NOE			
	Male	Female	Male	Female		
	1	2	3	4	5	6
1. Statewide	2,534 7%	1,859 5%	28,682 82%	2,050 6%	35,125	351,250
2. Cities of 75 Thousand or More	712 2%	532 2%	10,621 53%	860 2%	20,825 59%	178,126
3. Cities & Towns Between 10 & 75 Thousand	1,364 4%	975 3%	8,312 23%	741 2%	11,392 32%	112,914
4. Regional Schools	408 1%	214 .5%	1,328 4%	300 1%	2,250 6.5%	38,121
5. Cities & Towns of Less Than 10 Thousand	50 .5%	38 .5%	421 1%	149 .5%	658 2.5%	22,089

over or in cities or towns of between 10,000 and 75,000. According to this information, public education produces over one quarter of a million NOE dropouts every 10 years, 82 per cent of whom are males from NOE programs and who seem to be systematically less than equal to OE completors and dropouts on a number of economic and social indicators.

Probe #5

Management Inquiry. This is simply a technical request to cross tab the dropout description more efficiently than in Probe 4 for the same population, annual number of dropouts over the last ten years, arrayed by sex and program type.

Management Analysis. None.

Probe #6

Management Inquiry. The next inquiry of DOE is designed to discover if there are systematic differences between average educational costs to society for groups of students that seem to be systematically different in terms of their economic and social welfare. This inquiry is made for a cohort of students in the Sample Data Systems and specifically asks about the average expenditure per student for NOE and OE students who complete or drop out of secondary programs and do not continue education. The request also inquires about the average annual private economic benefits (salary from job) and social benefits (total taxes paid), averaged over students within groups. Both social

TABLE 5
COMPUTER INFORMATION STATEMENT
Target: CDS, Male & Female, Secondary, Dropouts,
Criteria: Count & % of Total Dropouts

	Annual Male Dropouts (1)	Annual Female Dropouts (2)	Annual Total Dropouts (3)
(1) Annual OE Dropouts	2,534 7%	1,899 5%	4,393 12%
(2) Annual NOE Dropouts	28,682 82%	2,050 6%	30,732 88%
(3) Annual Total Dropouts	31,216 89%	3,909 11%	35,125

TABLE 6
COMPUTER INFORMATION STATEMENT
Target: Males, SDS 1 & 2, Cohort 1, All Strata, Secondary
Criteria: (1) Average Private and Social Benefits Over 15 Years
(2) Per Completor Cost

	Per Pupil Program Costs	Annual Per Pupil Benefits (2) Gen Var (1) Private	Gen Var (2) Social
1. All NOE Dropouts No Cont Education.	$3,000. SD 800	$ 5,531. SD 736	$ 897. SD 147
2. All NOE Sec Completors No Cont Education	$5,100. SD 310	$ 8,171. SD 631	$1,797. SD 145
3. All OE Sec Dropouts No Cont Education	$5,500. SD 625	$10,941. SD 431	$2,335. SD 107
4. All OE Sec Completors No Cont Education	$6,521. SD 350	$11,573. SD 736	$2,893. SD 184

(1) Completor Cost = Total Cost / All Completors
(2) All Dollars Values Adjusted to 1976 Dollars

	Inst	Items
Gen Var (1)	( )	( ) ( ) ( )
Gen Var (2)	( )	( ) ( ) ( )

and private benefits are Gen Vars, determined from specifying instruments and items from the SDS Data Index. Social and private benefits are specified at dollar values adjusted to the 1976 dollar.

Management Analysis. It is evident from this dialogue between man and computer that, on the average, the public cost for NOE dropouts is about one half of that for OE completors, but that the social benefits (in terms of taxes) is almost three times as large. It is interesting to note the relative differences between OE dropouts and completors. The cost is not much different, which might suggest that students don't drop out early in programs, and the average benefits over fifteen years are also not very different. This could be a case of educational overkill, but is tangential to the major thrust of the current probe (but could be returned to by DOE as the basis for a second probe series).

Probe #7

Management Inquiry. The next inquiry by DOE management is designed to determine differential relationships between costs and benefits for all NOE dropouts and all OE completors. This information is requested for the same cohort, and for all strata in the sampling design[1] and, of course, for males only. Specifically the request is to determine the realtive costs compared to fifteen years social benefits of all OE secondary completors and all NOE dropouts. Also requested is a display of the extra costs of all dropouts had they all been transferred to become OE completors, as well as the extra social benefits that would have been achieved if NOE dropouts had maintained about the same level of social payback to government as had the average OE completor. It should be noted that costs and benefits are presented in constant 1976 dollars

TABLE 7
COMPUTER INFORMATION STATEMENT
Target: NOE Dropouts, OE Completors, SDS 1 & 2,
Cohort 1, All Strata, Secondary
Criteria: (1) Costs & 15 Yr Benefits for Student Groups
(2) Extra Costs & Benefits Had NOE Dropouts Been OE Completors

	NOE Dropouts	OE Completors	Extra Costs & Benefits if NOE Dropouts Were OE Completors
Costs	$ 86,046,000.	$ 187,035,322.	$100,909,322.
15 Yr Social Benefits	$385,916,310.	$1,244,655,390.	$858,739,080.
Cost/Benefit Ratio	1/4	1/7	

[1] For simplicity, this probe series is limited to 1 NOE cohort over all strata.

(resulting from economic assumptions and data treatment), with a result of providing a basis for cost and benefit comparisons.

Management Analysis. The computer statement requires little explanation. For every dollar invested in NOE dropouts, four are returned over a period of fifteen years, while seven are returned to society for every dollar invested in OE completors. It would cost society an extra $100,989,322 to have prepared NOE dropouts as OE completors, but they could expect additional benefits over fifteen years to exceed $850,000,000. Obviously, these data are based on a variety of shaky assumptions. For example, it is not all likely that NOE dropouts could be expected to succeed at the same rate as OE completors, or for the same cost. Further, if they did, it is not certain that they would generate the same level of social benefits as current OE completors, on the average.

Probe #8

Management Inquiry. In light of these sweeping assumptions, required to make sense of the data and which render it not very useful for anything but an assessment of differential impact, much more specific information is required by management for the purpose of developing a recommendation to do something about a

TABLE 8
COMPUTER INFORMATION STATEMENT
Stepwise Multiple Correlation
Independent Variable: Input Battery
Dependent Variable: NOE Dropouts / OE Completors

Target: Males, OE Completors & NOE Dropouts, Cohort 1, SDS 1 & 2, All Strata, Secondary
Criteria: M., SD., % of Contribution of Independent Variables to Criterion (NOE Dropouts)

R = .78

	ITED Reading Total	MPI Family Support For Education	MPI Control of Environment	HSPQ Emotional Stability
NOE Dropouts	33.3 SD 7.1	2.4 SD 1.2	6.6 SD 1.1	5.0 SD 1.1
OE Completors	42.3 SD 4.1	7.2 SD 2.1	9.3 SD 1.3	8.2 SD 2.1

Independent % Contribution of Variables to Variance of NOE Dropouts	ITED Reading Total	MPI Family Support For Education	MPI Control of Environment	HSPQ Emotional Stability
	21%	17%	12%	11%

problem other than to merely recognize its most obvious characteristics.[2]

DOE now seeks of the computer system information which describes the basis upon which NOE dropout and NOE completors are different before they enter secondary school. This question is framed in terms of the total MISOE input battery which is administered to all students in the sample data systems. Using a statistical operation called stepwise multiple regression, the manager asks for a listing of the input variables upon which all OE male completors were different than all NOE dropouts. Again, this question is asked for all strata, and secondary students only.

Management Analysis. Of all the variables in the MISOE Input Battery (subscores and a priori Gen Vars), only four are significant in differentiating all NOE dropouts, on the average, from all OE program completors, and they are:

1. reading skills;
2. family support for education;
3. perceived control of the environment by the student; and
4. emotional stability, as measured by the High School Personality Questionnaire.

Taken together, these variables account for approximately 60 per cent of the difference between these two groups of students, with reading explaining about 20 per cent of the variance; family support for education about 17 per cent and control of the environment and emotional stability about 12 per cent each. A conclusion from this dialogue with the computer could be that if all dropouts had the same scores on these input variables, they might be expected to succeed at the same rate as OE completors, and therefore to impact upon society with approximately the same range of behavior. Of course, this information suffers from the same problem of over aggregation as did the information from previous probes, in that comparisons are made between groups across wide ranges. Even though that is true, DOE management suspects that the variables which appear to separate all successful OE completors and all NOE dropouts seem to be subject to change or manipulation. Reading scores can be improved, family support for education is not totally beyond the reach of public education, and perceived control of environment and personality adjustment seem the legitimate focus of counseling and guidance. Although much more specific information is required for the development of a useful policy, it seems particularly encouraging that there are no differences in so-called IQ or other apparently difficult to change aptitudes.

Probe #9

Management Inquiry. Having discovered the average raw scores of NOE dropouts and OE completors upon input batteries which differentiated these groups, DOE is now concerend in learning the relative distance between these groups by a constant metric, i.e., standard scores. DOE is also concerned about the differences between NOE dropouts and other identifiable groups by these measures.

Management Analysis. This inquiry reveals that NOE dropouts are over two

[2] This is a major commercial for the MISOE data design, which not only allows the recognition of a problem, but provides for its solution. Assessment of impact only identifies problems, while assessment of student progress at points in educational time and which is unrelated to impact and unconnected to anything else, provides little assistance for systematic progress.

standard deviations below OE completors in reading, family support and control of environment at program entry time, and approximatley the same distance below NOE completors as described by these measures. They are not quite as "comparatively disadvantaged" in terms of emotional stability. It is interesting to note that they are only about one standard deviation below OE dropouts on these measures, and not different at all in terms of emotional stability.

This information is another way of saying that if their scores on these variables could be improved about two standard deviations before they became enrolled in OE programs, they could be expected to succeed at the same rate as all OE completors. Again, the data is still too gross for policy recommendations, other than enormous generalizations, and considerably more probing of the computer system is required to develop a specific policy recommendation which is likely to successfully treat an apparent problem.

TABLE 9
COMPUTER INFORMATION STATEMENT
Target: Mixed Dropouts & Completors, SDS 1 & 2, Cohort 1, All Strata, Male, Secondary
Criteria: Standard Scores of NOE Dropouts to OE Completors, NOE Completors, OE Dropouts

	ITED Reading Total	MPI Family Support For Education	MPI Control of Environment	HSPQ Emotional Stability
OE Completors	-2.2	-2.3	-2.1	-1.5
OE Dropouts	-1.2	-1.1	-.98	-.21
NOE Completors	-2.0	-1.9	-1.8	-1.4

Probe #10

Management Inquiry. In summary of the developing policy formulation logic developed by DOE in dialogue with MISOE during the last nine probes, an apparently significant problem has been isolated, the NOE male dropout. Public education produces over one quarter of a million male NOE dropouts every ten years, at a substantial loss to both the human beings who experience this failure and to society at large. In social benefits alone, the loss to society is somewhere around 7,000,000 dollars for each dropout cohort every fifteen years. These

TABLE 10
COMPUTER INFORMATION STATEMENT
Target: Male SDS 1, Cohort 1, All Strata, Secondary, NOE Dropouts
Criteria: % of Dropouts Who Fall Within + Or - 1 SD, Mean of Predictive Input Variable

74%

Note:
Population: 74% of 28,682 = 21,225

dropouts can be differentiated from successful OE completors in terms of four indices prior to entering OE programs, and it is reasonable to conclude that, on the average, the NOE dropout could be expected to do about as well as all students who enter OE programs if these differences could be overcome. However, there is a wide range of occupational education programs currently operational at the secondary level (approximately 96), and one would expect that the differences in terms of chances of success for NOE dropouts among programs would be significant. Further, DOE management could expect that differences in success rates within specific OE programs would vary considerably for specific types of students and that these differences could be explained by the educational processes within programs or by various configurations of TERMOBS acquired by completors within specific programs. Considerably more information is required by DOE management to develop a policy to attack an apparently significant problem.

Since considerable variance can be anticipated among NOE dropouts, a next reasonable inquiry by DOE management is to determine the estimated number of NOE dropouts that can be described as being similar to those who are different than OE completors on the four so-called predictive input variables, i.e., reading capability, family support for education, perceived control of environment and emotional stability, but otherwise similar. Probe 10 seeks to discover the number of NOE male dropouts from all strata who fall within one standard deviation of the mean of all NOE male dropouts on the predictive input variables and are not different than OE completors on all other input variables.

Management Analysis. The computer statement requires little explanation. Approximately 74 per cent of the annual 26,682 male NOE dropouts fall within this range. Obviously, OE management concludes than an annual pool of approximately 21,000 human beings represent an appropriate target for major policy development at the state level. From here on DOE refers to this group of students as the NOE Target Group.

Probe #11

Management Inquiry. At this point in the planning process DOE management is moving towards a conclusion that part of a policy recommendation should include what could be described as a remedial effort designed to help the NOE Target

TABLE 11
COMPUTER INFORMATION STATEMENT
Target: Males, OE Completors & Dropouts, SDS 1 & 2, Cohort 1, All Strata, Secondary
Criteria: Differential Success Rates of OE Completors

OE Completors Whose Scores On Predictive Input Variables Fall:	Rate of Success
Within + Or - 1 SD of Mean of all Successful Completors	87%
Within + 1 SD of Mean of All Successful Completors	94%
Within - 1 SD of Mean of All Successful Completors	72%
Within + Or - 1 SD of NOE Dropouts	37%

Group become more like successful OE completors at program entry. This program could occur at the junior high school, or at a summer session prior to enrollment in regular OE programs. Obviously such a program would have as its goal increasing the capability of NOE Target Groups on four predictive input variables and might include a power reading program, participation on the part of the family NOE Target Group students in a process designed to help them discover ways to be more supportive of their children's problems in school (and probably beyond), and an intensive counseling experience which would be focused on helping students develop confidence and self understanding. However, even if successful, such a program could not be expected to move a large number of NOE Target Group students up to the level of OE successful completors on all predictive input variables, although it would be reasonable to expect that, if successful, it would account for some movement in this direction. Therefore, DOE management decides it would be useful to develop information about successful OE completors who tend to be similar to the NOE Target Group in terms of having achieved scores on the predictive input variables within the range of expectations for the NOE Target Group at the end of the proposed remedial experience. This group is described as the OE Prototype Group, in that they can serve as proxies for the NOE Target Group in terms of program planning.

The first question by DOE management of the OE Prototype Group is to learn of their comparative success rate to other OE students differentially grouped by the predictive input variables.

Management Analysis. As Dialogue 11 indicates, 87 out of 100 students who fall within ± one standard deviation of the mean of all successful OE completors on the predictive input variables succeeded, on the average, across all OE secondary programs, 94 per cent who fall one standard deviation above the mean for all successful completors on the predictive variables succeeded, a little more than 72 per cent who fall one standard deviation below the mean succeeded in all OE programs (the OE Prototype Group), while only 37 out of 100 students who enrolled in occupational education and whose scores fall within ± one standard deviation of the mean for all NOE dropouts on the predictive variables succeeded, on the average.

Management is becoming committed to a policy position which would be designed to move NOE dropouts "up to speed" on the predictive input variables with a remedial program, and expect them to achieve and succeed at about the same rate as the OE Prototype Group. However, it is likely that large numbers of the NOE Target Group might find themselves in the very low range of the OE Prototype Group on the predictive input variables at initial enrollment time, and unique program considerations for this NOE Target Group should be investigated.

Probe #12

Management Inquiry. A prior consideration to investigating process alternatives for the NOE Target Group, is to estimate the costs and benefits of implementing the developing policy. The next man-computer dialogue is to estimate the average costs and benefits of male, OE completors, differentiated by scores on the predictive input variables.

Management Analysis. The results are approximately what DOE management might have expected. Program costs for OE completors tend to increase as they move toward the score of NOE dropouts and away from successful completors on the predictive input variables, while the social benefits for fifteen years tend to decrease.

TABLE 12
COMPUTER INFORMATION STATEMENT
Target: All OE Completors, SDS 1 & 2, Secondary, Cohort 1, Male, All Strata, Differentiated by Score on Input Variables
Criteria: Multiple

All OE Completors Whose Score on Predictive Input Variables Fall:	(1) 1 Yr Social Benefits Per Student	(2) 15 Yr Social Benefits Per Student
1. Within + Or - 1 SD of Mean of Successful OE Completors	$2,893.	$43,395.
2. Within + 1 SD of Mean of Successful OE Completors	$3,272.	$49,080.
3. Within - 1 SD of Mean of Successful OE Completors	$2,631.	$39,465.
4. Within + Or - 1 SD of Mean of NOE Dropouts	$2,211.	$33,165.

(1) Program Cost Per Completor Group
- (1) $6521.
- (2) $6322.
- (3) $6671.
- (4) $6912.

(2) All Dollar Values Adjusted to 1976 Dollars

Probe #13

Management Inquiry. Since at best a 72 per cent success rate can be expected for the NOE Target Group from the developing policy, DOE management next probes the computer to determine the associated program costs and benefits of all OE dropouts (averaged), differentiated by the predictive input variables.

Management Analysis. With OE dropouts the cost of the program tends to be less for dropouts whose predictive input scores fall below the mean for all successful completors (which is probably a function of the point in time at which they drop out), and this relationship holds for social benefits.

Probe #14

Management Inquiry. DOE management asks a deceptively complex question of MISOE (from a technical perspective). Management wants to know the costs and benefits for the OE Prototype Group, assuming a constant 1976 dollar. This calculation is to include both dropouts and completors in terms of their differentiated program costs and social benefits. At the same time management also seeks this same information for the

TABLE 13
COMPUTER INFORMATION STATEMENT
Target: All OE Dropouts, SDS 1 & 2, Secondary, Cohort 1, Male, All Strata, Differentiated by Score on Input Variables
Criteria: Multiple

All OE Dropouts Whose Score on Predictive Input Variables Fall:	(1) 1 Yr Social Benefits Per Student	(2) 15 Yr Social Benefits Per Student
1. Within + Or - 1 SD of Mean of Successful OE Completors	$2,335.	$35,025.
2. Within + 1 SD of Mean of Successful OE Completors	$2,712.	$40,680.
3. Within - 1 SD of Mean of Successful OE Completors	$2,001.	$30,015.
4. Within + Or - 1 SD of Mean of NOE Dropouts	$1,731.	$25,965.

(1) Program Cost Group
(1) $5500.
(2) $5321.
(3) $5200.
(4) $4871.

(2) All Dollar Values Adjusted to 1976 Dollars

OE group that succeeds at the 87 per cent rate and the 37 per cent rate. These data are to be calculated for the 74 per cent of the annual male dropouts each year.

Management Analysis. These results are indeed encouraging to DOE management. Given the average costs and benefits for all OE program completors and dropouts who succeed at about the 72 per cent rate (the Prototype Group), this interaction states that the cost benefit ratio (social benefits over fifteen years) is 1 to 6, a substantial improvement over the 1 to 4 rate for NOE dropouts on this single

TABLE 14
COMPUTER INFORMATION STATEMENT
Target: 74% of NOE Dropouts Had They Completed OE At Variable Rates
Criteria: Costs/15 Yr Benefits, C/B Ratios

	87% Rate	72% Rate	37% Rate
Costs	$135,776,331.	$133,038,184.	$119,590,441.
15 Yr Social Benefits	$899,191,020.	$782,591,625.	$608,540,040.
C/B Ratio	1/7	1/6	1/5

Note: All Dollar Values Adjusted to 1976 Dollars

benefit alone. It is interesting to note that while the cost benefit rate for students who fall within one standard deviation of all successful OE completors (the 87 per cent success rate) is as expected, the cost benefit ratio of the 37 per cent completion group is better than that of NOE dropouts, even with a 67 per cent dropout rate. Apparently, this could be another manifestation of the overkill phenomena, worthy of a separate probe. Anyway, all this is very rewarding for DOE management, since it suggests that even if, on the average, NOE completors do not quite measure up to the OE Prototype Group, they are likely to fall somewhere close to this proxy group in terms of success rate and will still be within a range that should represent improvement over the existing educational alternative.

Probe #15

Management Inquiry. DOE management now turns its attention to attempting to select occupations and programs for the NOE Target Group students from the approximately 96 occupational education programs now operational. The logic employed by DOE management is to determine the occupations in which OE Prototype students have been most successful. Success is defined by a comparatively high score on the social benefit Gen Var, or, operationally, to select those OE Prototype students whose social benefit score fall within a range of ± one standard deviation of all OE completors. This is a further refinement of the OE Prototype Group and is now the reference group for the descriptor OE Prototype Group. The request is designed to list those occupations (rank order) by the aggregate number of male completors who fall within the boundaries of this newly defined OE Prototype Group. The assumption is that these are the occupations in which the NOE Target Group is most likely to be successful.

TABLE 15

COMPUTER INFORMATION STATEMENT

Target: OE Prototype Group

(1) Males, Secondary, SDS 1 & 2, Cohort 1, All Strata, OE Completors
(2) Within 1 SD below mean on predictive input variables
(3) Who were employed in related occupation for which trained for at least 4 years, and
(4) Whose social benefits (Gen Var) were within 1 SD of mean for all OE completors of cohort 1, SDS 1 & 2, all strata

Criteria: Rank Order 10 Highest OE Codes by the Number of Completors of OE Prototype Group Students

(1) Auto Mechanics
(2) Machinists
(3) Auto Body
(4) Appliance Repair
(5) Distributive Occupations
(6) House Carpentry
(7) Mill Work & Cabinet Making
(8) Air Conditioning
(9) Office Machine Operator
(10) Quantity Foods Occupations

Management Analysis. It is necessary to evaluate these specific occupations in which the OE Prototype Group has been successful by anticipated manpower needs over the next ten years. Therefore, DOE submits these programs to the Department of Labor with the specific request to select the three OE programs in which high employment is expected during the next ten years.[3]

In summary of this probe, these occupations represent job descriptions in which the OE Prototype Group has succeeded, at least in terms of a desirable impact as described by social benefits. Further, these programs seem to offer the promise of high employment and the short term future.

Probe #16

Management Inquiry. DOE's next concern is to determine the occupational skills (TERMOBS) that should constitute the learning objectives of OE programs designed to prepare the NOE Target Group for entry level into these three occupations. DOE's continuing logic is to pursue the experience of the newly defined OE Prototype Group, i.e., students who fall within ± one standard deviation of the NOE Target Group on the input battery, who successfully completed an OE program preparing them for one of the three selected occupations, i.e., House Carpentry, Automotive Mechanics or Office Machine Operator, and whose score on the social benefit Gen Var is within one standard deviation of the mean for all OE completors. This is a further refinement of the OE Prototype Group, and is the final reference group for the descriptor OE Prototype Group from this point forward.

DOE's first question is to determine the average number of TERMOBS passed per OE prototype completor, the quality score (QS) on each TERMOB, as well as

TABLE 16
COMPUTER INFORMATION STATEMENT
Target: OE Prototype Group
Criteria: For 3 High Success OE Codes for Prototypical Completors:
(1) Mean SD TERMOBS Passed & Failed
(2) QS for TERMOBS Passed & Failed

	USOE Code 17.1001 Carpentry	USOE Code 17.0302 Auto Mech	USOE Code 14.0104 Office Mach Oper
Average Number TERMOBS Passed	31.2	28.3	29.1
QS	3.38	3.71	3.21
Average Number TERMOBS Failed	2	4	2
QS	1.8	1.7	1.9

[3] This list is purposely truncated to keep the example simple. The following list returns from the Department of Labor: (1) House Carpentry; (2) Auto Mechanics and (3) Office Machine Operator.

information about the number of TERMOBS failed.

Management Analysis. The data speaks for itself. The OE prototype completor passed about 30 TERMOBS per student with a quality score of about 3.5, while they only failed about two to three TERMOBS per student. This information seems to set a preliminary range for the learning objectives for the NOE Target Group.

Probe #17

Management Inquiry. Merely knowing the average number of TERMOBS passed does not provide the substantive information required to develop a very definite recommendation about the learning objectives for specific occupations for a particular group of target students. Accordingly, management now requests a listing of the TERMOBS passed by more than 80

TABLE 17
COMPUTER OUTPUT STATEMENT
Target: OE Prototype Completors
Criteria: List TERMOBS Passed by More than 80% Prototype Completors

	USOE CODE TERMOB #	17.1001 QS	USOE CODE TERMOB #	17.0302 QS	USOE CODE TERMOB #	14.0104 QS
	004	4.1	009	3.8	001	4.2
	005	3.8	010	4.7	002	4.8
	007	3.7	011	4.6	003	4.1
	009	3.3	012	3.2	004	4.7
	010	4.0	041	3.7	005	4.2
	016	4.4	042	3.9	007	4.1
	017	3.2	046	4.2	011	3.6
	019	3.8	051	4.0	018	3.3
	021	3.9	055	4.1	020	3.7
	022	4.6	056	3.7	022	4.2
	024	4.2	058	3.7	026	4.0
	026	3.2	062	3.2	027	4.7
	031	4.4	063	3.5	028	4.7
	038	4.1	067	3.7	029	4.6
	042	4.0	071	3.8	030	4.5
	050	3.9	073	4.8	071	3.7
	051	3.8	075	4.1	072	3.9
	052	3.4	076	3.6	076	4.1
	053	3.7	077	3.7	081	3.9
	071	3.9	078	3.2	082	4.2
	072	4.1	079	3.4	083	4.1
	074	4.7	084	3.4	087	4.0
	075	4.3	092	3.7	088	3.8
	080	3.7	094	4.2	092	3.5
	081	4.0	095	4.6	093	4.0
	082	4.1			095	4.2
TOTAL	26	3.93	25	3.87	26	4.07

per cent of the newly defined OE prototype students, by USOE Code.

Management Analysis. This list of TERMOBS represents those entry level occupational skills that a majority of the refined (through analysis) OE Prototype Group have passed, and represents a solid basis for program content recommendations. However, since occupations are frequently updating themselves in light of technological breakthroughs, and since these TERMOBS could include obsolete skills and might not reflect recent developments, these TERMOBS are now submitted to several industrial advisory groups (one for each occupation). The groups rate these TERMOBS from a perspective of usefulness in the marketplace during the next ten years, and add any new TERMOBS that seem important from the list of MISOE's continuously updated TERMOB information bank. This final list of TERMOBS constitutes the learning objectives for the occupational programs within each of the three analytically determined occupations for the NOE Target Group.

Probe #18

Management Inquiry. It is now possible for the DOE management to begin developing a policy recommendation which will describe the Target Group of students, a remedial program, and specific occupational skills or learning objectives within specific occupations. It is also possible to estimate, averaged over all OE programs, the costs and benefits of these programs for the Target Group of students. A more careful probe of the data files will permit a more specific estimation of costs and benefits for the Target Group. Of prior interest, however,

TABLE 18
COMPUTER OUTPUT STATEMENT
Target: OE Prototype Group & All OE Dropouts, Cohort 1, SDS 1 & 2,
Male, Secondary, All Strata, Whose Input Scores on Predictive Variables Fall Within 1 SD
of Prototype Group
Criteria: Stepwise Multiple Regression
Dependent Variable: Completors / Non Completors
Independent Variables: MISOE Process Battery, M SD, % of
Contribution to Variance of Independent Variables

R = .81

	Length of Coop. Prog.	Admin Init Plan: Stud Eval	Admin Init Plan: Inst Mat	Admin Init Plan: Inst Activ	Moon Light	Satis With Teach	Stud Attit Toward School	Cleric Teach Duties
OE Proto	8 Mo		12 Hr/Wk		2.1 Hr/Wk	18.4	16.1	2 Hr/Wk
Completors	SD .5		.12		1.1	2.1	1.1	1.1
OE Dropouts	3.1 Mo		7 Hr/Wk		9.6 Hr/Wk	9.3	11.2	5 Hr/Wk
	SD 4.2		3.2		1.2	2.4	3.2	7.2
% Contribution to Variance	17%		17%		12%	9%	7%	6%

is a description of the characteristics of the process variables of the occupational education programs for the Target Group. It appears reasonable to expect that the developing policy recommendation will suggest that new programs will be instituted for target students, to include both a preoccupational remedial program and occupational education programs designed to prepare the NOE Target Group with specific TERMOBS in named occupations. It is likely that the recommendation will suggest that the new programs be instituted and maintained by the staff of existing schools, and will involve some expansion of occupational education facilities and staff, with a concurrent reduction in the nonoccupational delivery system at the secondary level.

DOE's next logical information requirement is to estimate the characteristics of the occupational education programs for policy recommendation. To develop this information DOE decides to determine (in terms of the MISOE process battery) differences, if any, between all OE Prototype Students and all occupational education dropouts from all programs whose scores on the predictive input variables are like those of the OE Prototype Group and, of course, the NOE Target Group. Such a strategy will provide a broad based comparison for estimating the value of specific process elements for the NOE Target Group on the basis of successful past performance.

Management Analysis. The result of this interaction indicates that the OE Prototype Group can be differentiated from all occupational education dropouts who are similar to them in terms of the predictive input variables by six process variables of the MISOE process battery. Approximately 17 per cent of completion/noncompletion differences can be explained by the length of the cooperative program. The length of the average cooperative program for the OE Prototype Group is eight months. Administratively initiated staff planning of student evaluation, instructional materials and instructional activities account for about 15 per cent of the differences between completors and noncompletors. The OE Prototype Group are in programs where the average planning hours per week, on these three functions is twelve, while for occupational education dropouts planning time is only about three hours per staff member per week for these three functions.

Moonlighting is described by the MISOE process battery as working for pay in a nonteaching function, and this variable accounts for about 12 per cent of the variance between these groups. The OE Prototype Group is in programs whose faculty moonlight about 2.1 hours per week, while the average staff member's moonlighting score is about 10 hours per week for the occupational education dropouts. The perceived satisfaction of the faculty for teaching and the positive attitude of the students toward school in combination account for a little over 15 per cent of the differences between completors and noncompletors. Interestingly, the average faculty member spends about five hours per week on clerical teaching duties in programs attended by occupational education dropouts, as compared to about two hours a week for the OE Prototype Group.

In summary, these six process variables account for about a little over 60 per cent of the differences of occupational education dropouts for all secondary programs and the OE Prototype Group. This information provides documented clues about important characteristics or programs for the NOE Target Group. With the exception of satisfaction toward teaching and student attitude toward school, all these variables seem susceptible to manipulation by management, and could form a basis for program guidelines within a policy recommendation statement.

Probe #19

Management Inquiry. Other characteristics of OE programs are necessary to specify program components for the NOE Target Group in a useful policy statement. Probe 19 is designed to provide information for these program components in terms of average scores for OE Prototype Students on these program elements, and standard scores for the OE Prototype Group. These scores describe the differences between these program elements for the OE Prototype Group and those of all programs preparing House Carpenters, Auto Mechanics and Office Machine Operators. These standard scores provide an estimate of the degree of change, on the average, that should be sought to recondition existing programs to meet the needs of the NOE Target Group.

Management—Analysis. On program characteristics which do not seem to differentiate OE prototype completors, and a comparison group of noncompletors, but are nonetheless essential to planning, it appears that other than faculty inbreeding, the scores for OE Prototype Students are practically the same as for all programs preparing students in these occupations. Average age is forty-seven, with a fairly wide range, faculty degree status is not very different, with about one half at the bachelor's level or less, average years of experience in the field in which teaching is 3.1, which could constitute a surprise for existing standards, verbal IQ is high average, and the length of program, averaged over students, is 2.8 years. It appears that the faculties that tend to be associated with the OE Prototype Group tend to be somewhat less inbred than the average program, when inbreeding is described in the MISOE process battery as staff mix as differentiated by place of birth, place raised and place attended school, in relationship to the school in which currently teaching.

TABLE 19

COMPUTER INFORMATION STATEMENT

Target: OE Prototype Group & All OE Students Enrolled in House Carpentry, Auto Mechanics, Or Office Machine Operator, Cohort 1, SDS 1 & 2, Male, Secondary, All Strata

Criteria: (1) Difference in Standard Scores Between OE Prototype Groups and All OE Students in Selected OE Programs

(2) Mean, SD for OE Prototype Completors

	Average Age of Faculty	Faculty Degree Status	Average Yrs Empl In Field	Verbal IQ	Faculty Inbreed	Length of Program
Diff Between OE Proto Group & Others	-.11	+.11	+.11	-.12	-1.1	+.01
Score for OE Prototype Group	47 SD 14.2	25% No B. 36% Bach 29% Mast 10% Other	3.1 SD 2.1	112 SD 8.4	9.2 SD 2.1	2.8 SD .31

Probe #20

Management Inquiry. Management has developed a fairly reasonable basis for recommending specific occupational education programs, TERMOBS within occupations and program characteristics for the NOE Target Group of 21,000 students. Further, it seems possible to provide a beneficial experience for both the Target Group and society in terms of societal costs and benefits, without major alteration of existing programs. However, public education is obviously more broadly focused than career preparation. Therefore, DOE management is concerned with what could be described as the opportunity cost of occupational education, i.e., what is the price in terms of nonoccupational education lost.

The same logic that DOE has been pursuing to this point can be extended to provide an indication of the nonoccupational consequences of the existing mix of occupational and nonoccupational education as currently practiced. The appropriate comparison is the OE Prototype Group.

However, DOE management also selects NOE completors who fall within about the same range as the Prototype Group on the predictive input variables, all OE completors and all non-OE completors. The first request is for information describing the comparative general educational development of these groups (as measured by specific scales on the ITED posttest). The request is made to provide a standard score comparing the OE Prototype Group to other named groups.

Management Analysis. The OE Prototype Group seems to achieve less in reading and social studies than all OE and NOE completors, on the average. The reading composite was probably expected, given their scores before they entered the program. The social studies score was somewhat unexpected, but there could be some relationship between this and the reading score, as it might reflect the process by which social studies is presented in public education. It is encouraging to DOE that the OE Prototype Group does no worse (and slightly better) than their NOE counterparts on these measures of general educational development. DOE management concludes that although there seems to be no

TABLE 20
COMPUTER INFORMATION OUTPUT
Target: OE Prototype Group & All OE & NOE Completors, Cohort 1, SDS 1 & 2, All Strata, Secondary, By Specified Groups
Criteria: Standard Score Comparison of OE Prototype Group Score To All Other Completors on Selected ITED Posttest Subscales

	Reading Composite	Social Studies	Math	Science
NOE Completors Who Fall Within Same Range on Predicted Input Variables as OE Proto Group	+.91	+.01	+.62	+.71
All OE Completors	-1.12	-1.01	-.74	-.75
All NOE Completors	-1.64	-1.43	-.84	-.41

apparent opportunity cost to the traditional occupational-nonoccupational education mix currently offered for OE prototype students as measured by the Iowa Test of Educational Development, their recommendation will include a statement about these findings and a suggestion to seek improvement in these capabilities for the NOE Target Group students. However, this assessment does not provide any curricular clues to remedy this apparent deficiency, as a longitudinal information system does not include nonoccupational education.

Probe #21

Management Inquiry. To estimate the differential impact or opportunity cost of the current occupational education program mix at the secondary level for the NOE Target Group is a straightforward matter with MISOE's longitudinally connected Sample Data Systems. For five Gen Vars (interactively specified by management at the terminal), DOE management requests a comparison between the OE Prototype Group and the other groups specified in Probe 20. DOE specifies that these scores be expressed in standard scores which describe the difference between the OE Prototype Group and the other named groups.

Management Analysis. The most glaring finding is the substantial differences between the OE Prototype Student and their NOE counterparts. The OE Prototype Group appears to be consistently different (better) in terms of productivity, community service and job satisfaction, as measured by the MISOE impact instrument. There seems to be no differences in participation in sports. There seems to be little difference between OE Prototype Students and all OE and NOE completors on all of these measures, with the exception of voting behavior. This could be related to the social studies deficiency revealed in Probe 20, and further strengthens the recommendation to "beef up" the social studies program for the NOE Target Group.

Probe #22

Management Inquiry. Previous cost and benefit information was based on all OE and NOE averaged over all subgroups of

TABLE 21
COMPUTER OUTPUT STATEMENT
Target: OE Prototype Group & All OE & NOE Completors, Cohort 1,
SDS 1 & 2, All Strata, Secondary, By Specified Groups
Criteria: Standard Score Comparison of Selected Input Variables
(Gen Var) to Selected Completor Groups

	Productivity	Commun Service	Voting Behav	Job Satis	Particip Sports
NOE Completors Who Fall Within Same Range On Predict Input Variables As OE Proto Group	+2.1	+1.72	+1.12	+2.4	+.12
All OE Completors	+.73	-.74	-1.12	-.73	-.12
All NOE Completors	+.01	-.94	-1.94	+.01	-.74

TABLE 22
COMPUTER INFORMATION STATEMENT
Target: OE Prototype Group
Criteria: Cost by OE Code and Specified Functions and By Academic and By Nonacademic Per Completor

	USOE Code 17.1001			USOE Code 17.0302			USOE Code 14.0104		
	OE	Acad	Total	OE	Acad	Total	OE	Acad	Total
Staff	$2317.	$1222.	$3539.	$2550.	$1200.	$3750.	$2219.	$2001.	$4220.
Inst Mat & Equip	$1110.	$ 658.	$1768.	$1092.	$ 669.	$1761.	$ 810.	$ 513.	$1323.
Capit	$ 713.	$ 458.	$1171.	$ 708.	$ 435.	$1139.	$ 820.	$ 398.	$1218.
Total	$4140.	$2338.	$6478.	$4060.	$2590.	$6550.	$3849.	$2912.	$6761.

Note: All Dollar Values Adjusted to 1976 Dollars

students. Now, however, DOE requires more specific information for its policy recommendation. Accordingly, they request a cost description (estimated in 1976 dollars) for completors, line itemed by staff, instructional material and capital, for each OE program and its counterpart academic mix for these three occupations to be recommended for the NOE Target Dropout Group, i.e., House Carpentry, Auto Mechanics and Office Machine Operators.

Management Analysis. None.

Probe #23

Management Inquiry. Since the MISOE Cost System provides information about cost for dropouts, and since DOE management anticipates approximately a 28 per

TABLE 23
COMPUTER INFORMATION STATEMENT
Target: Prototype Dropouts
Criteria: Cost By OE Code and Specified Functions and By Academic and Nonacademic Per Dropout

	USOE Code 17.1081			USOE Code 17.0302			USOE Code 14.0104		
	OE	Acad	Total	OE	Acad	Total	OE	Acad	Total
Staff	$1761.	$1079.	$2840.	$1794.	$ 966.	$2760.	$1590.	$1060.	$2650.
Inst Mat & Equip	$1035.	$ 605.	$1640.	$1125.	$ 605.	$1730.	$1044.	$ 696.	$1740.
Capit	$ 460.	$ 270.	$ 730.	$ 490.	$ 321.	$ 811.	$ 450.	$ 300.	$ 750.
Total	$3256.	$1954.	$5210.	$3409.	$1892.	$5301.	$3084.	$2056.	$5140.

Note: All Dollar Values Adjusted to 1976 Dollars

cent dropout rate, costs are requested for OE prototype dropouts.

Management Analysis. None.

Probe #24

Management Inquiry. Management also requires specific information for OE Prototype Completors and Dropouts describing social benefits. Previous information has been averaged over all OE programs.

Management Analysis. This information is approximately what should have been expected as a result of previous probes.

TABLE 24
COMPUTER INFORMATION STATEMENT
Target: Prototype Dropouts & Completors
Criteria: Average Social Benefits Over 15 Years

	Annual Social Benefits	15 Yr Social Benefits
OE Prototype Dropouts	$2,231.	$33,465.
OE Prototype Completors	$2,701.	$40,515.

Note: All Dollar Values Adjusted to 1976 Dollars

Probe #25

Management Inquiry. The final inquiry of this probe series is a request for a specification of the comparative costs and benefits of a tentative policy statement recommending the initiation of a specific program for a specific target group. The reason for qualifying the policy as tentative does not reflect uncertainty on the part of DOE management, but rather a strategy of not firming up specific policy statements until they can be analyzed in light of a total array of policy recommendations.

TABLE 25
COMPUTER INFORMATION STATEMENT
Target: 21,255 NOE Dropouts
Criteria: Policy Alternatives in C/B Metric

	OE Alternative		Traditional Program	
	72% Success Rate 21,255 Students		21,255 Students	
	Per Pupil Cost		Per Pupil Cost	
	Completors	Dropouts	$3000.	
Sec Prog	$6630.	$5217.		
Jr. Hi Remed Program	$ 500.	$ 500.		
Total Cost	$143,139,387.		Total Cost	$ 63,765,000.
Total Benefits	$819,038,735.		Total Benefits	$285,986,025.
C/B Ratio	1/6		C/B Ratio	1/4

Note: All Dollar Values Adjusted to 1976 Dollars

Model Policy Recommendation

Goal. To provide an occupational education alternative for approximately 21,000 annual male dropouts from secondary public education as a planned social intervention designed to improve the economic welfare of this target group in terms of private benefits and to accomplish this in a way that represents a better social investment than the existing secondary educational program. The following table describes the anticipated costs and benefits associated with the implementation of the program recommended by this policy statement (show table).

Logic. Twenty-four thousand of the 28,000 annual male dropouts were found to have been enrolled in nonoccupational education. Although the cost of providing nonoccupational secondary education for these dropouts is approximately half of occupational education, the extra social benefits aggregated over only fifteen years favorably offsets this additional investment.

It was discovered that about 75 per cent of the male dropouts were no different than students who could be expected to suceed at about an 87 per cent rate on most pre-entry social and psychological measures, except for four crucial variables; reading comprehension, family support for education, perceived control of environment and emotional stability. The differences on these indices were significant. On the assumption that planned modification of these capabilities is within the range of the traditional role of public education in America, it is suggested that a remedial program just before entry into occupational education be initiated to improve the scores of these dropout prone students in terms of these so-called predictive input variables.

Given the distance between the male NOE dropout and the average successful OE completor, however, it is not assumed that a short term, intensive remedial program focused on these specific outcomes will bring a large proportion of the NOE dropout population up to a range equal to the average OE completor. It is therefore suggested that a simultaneous effort should be mounted, designed to develop OE programs in which the NOE dropouts are more likely to suceed than in the traditional occupational education program that seems to work well for the average student. On the assumption that the intensive remedial program just prior to entry into an occupational education program will be partially successful in moving the male dropout prone student toward the average scores of successful occupational education completors on these four critical, predictive variables, the characteristics of the recommended occupational education programs for this target group is based on the previous experience of similar students who have been successful in occupational education. The occupations for which this recommendation suggests that these students be prepared with entry level skills are those in which students like these have demonstrated success in the past and which offer high employment opportunities during the next ten years.

This recommendation states that these goals can be attained without a major alteration of currently existing programs which prepare students with entry level skills for these occupations, and about the same success rate can be expected for these male dropout prone students as exists for the current population enrolled in occupational education, i.e., a success rate of about 72 out of 100. Such an outcome would provide a substantial improvement to the existing public education alternative for these dropout prone students. Based on the experience of similar students, it can be assumed that a mix of occupational and nonoccupational education similar to that currently offered in traditional programs will not result in penalizing the male dropout prone students in terms of general education development.

Specific Program Recommendations

This section of the policy recommendation would include a specification of the Target Group, the occupations for which the Target Group should receive training, specification of the TERMOBS within each occupation, and a description of the program characteristics. Also included would be cost information. Since all this has been previously specified in the probe, it will not be repeated at this time. One recommendation that might be mentioned in passing is the description of an appropriate evaluation process to gauage the progress of participating LEAs during implementation, which would include measuring the process, product and input variables in light of the recommendations.

Implementation

The specification of implementation is beyond the scope of this chapter, although it is assumed that implementation recommendations would include:

1. A pilot phase;
2. A guidance component, which allows students an opportunity to assess their benefits and costs if they decide to participate in the recommended program;
3. Evidence of interaction with appropriate governmental agencies;
4. Appropriate funding mechanisms;
5. An opportunity for the local education agency to participate in program modification during the adoption phase. It is important not to stifle the potential impact of concerned human beings who are likely to have a million good ideas on how to operate a program. To use research information in program development requires the very best effort of the very best administrators. To conceive of MISOE as a substitute for good management is a mistake.

Epilogue

This probe has been simple minded in that it has generalized over a number of important distinctions that would need to be considered by management, which include school type, geographical setting, logistics of the delivery system, etc. Nor has this probe attempted to account for the rich variety of information of MISOE. The purpose of this exercise has been to demonstrate a proces. of managing with an interactive computer information system. It is this process that represents the goal and purpose of MISOE.

CHAPTER 9
EDUCATIONAL POLICY AND SYSTEM DYNAMICS

Michael Garet

Failures of rulers and statesmen to predict even the pragmatic outcome of their political decisions, let alone their moral and spiritual effects, may turn out to be not the exception but the rule; and the Augustinian despair that politics could be anything but evil may take hold once again of man's imagination (Deutsch, 1966).

The final outcomes of policy decisions in education are ill understood. The effects of programs implemented with great hope often seem inadequate when compared with their original intent, and unexpected secondary consequences often contradict program objectives. Recognition of this problem is not new: students of politics since the time of Plato have debated ways to improve the capacity of government to achieve just and human purposes.

This essay explores the methodology of a new discipline, system dynamics, as an approach to the analysis of decisions in education. System dynamics is a social system modeling process, which permits the examination, through computer simulation, of alternative social policies. Discussed in the essay are technical considerations underlying the system dynamics approach and methodological issues important in its application. In particular, the chapter addresses the uses of system dynamics in the Management Information System for Occupational Education.

Systems Analysis and Educational Policy

A number of empirical "systems analysis" methodologies have been suggested to improve understanding of broad social policy outcomes. The Planning-Programming-Budgeting System (PPBS) is perhaps the most widely known of these. Unfortunately, the hopes held by the proponents of these techniques have not yet been empirically substantiated through continued implementation in public affairs.

The fact that systems analysis methods have been little used in government is not too surprising: there is little incentive for their use; they are ill-understood by administrators and legislators; the techniques are time-consuming and difficult to apply; there are problems of validity, accuracy, and conflicting results; and there are few, if any, successful cases to use as examples. When the techniques are used, the uses are often not the ones proponents expect. For example, data from system studies have been used as ammunition for the various parties to the adversary procedures of interorganizational politics; as the cohesion of organizational alliances; as symbols for the persuasion of publics; and as new grounds for organizational creeds. (Biderman, 1966).

Harold Wilensky has suggested a number of requirements information must meet if it is to be taken into account by government policy-makers. It must be:

> *clear* because it is understandable to those who must use it; *timely* because it gets to them when they need it; *reliable* because diverse observers using the same procedures see it in the same way; *valid* because it is cast in the form of concepts and measures that capture reality (the tests include logical consistency, successful prediction, congruence with established knowledge or independent sources); *adequate* because the account is full (the context of the act, event, or life of the person or group is described); and *wide-ranging* because the major policy alternatives promising a high probability of attaining organizational goals are posed or new goals are suggested (Wilemsky, 1967).

Rarely is information with these qualities available to decision makers in government. The system dynamics approach suggests directions for the development of social intelligence having the characteristics Wilensky describes.

System Dynamics

Present policy issues, such as the low educational attainment of poor children or worker dissatisfaction, are the result of many diverse social conditions, some of which have accumulated over many years. These social conditions have emerged from the actions of individuals and groups within a complex network of values, laws, beliefs, and technologies. This fabric of social actions can be interpreted as a *social system*, and it is this conception which underlies the system dynamics approach.

A social system is composed of the interrelated actions of individuals and groups. As an illustration, the "economic system" involves such actions as producing goods and services, hiring and firing labor, and coordinating scarce resources; the "political system" includes such actions as giving and withdrawing political support, choosing goals and effecting policies, and amassing the productive capacity to carry them out.

Any real, "concrete" social system, such as a city or school, involves an unlimited variety of activities. Economic, political, educational, technological, and religious actions are interconnected. To study a particular "real" social system, it is therefore essential to select for analysis those few actions considered to be most important. A purposeful, simplified representation of a social system is termed a "*model.*" The most common social system models, in the field of economics, concern national income and unemployment. Other examples include models of United Nations peacekeeping, urban stagnation, and the political dynamics of developing nations. (See Alker, 1973; Forrester, 1969; and Brunner, 1971)

Models are important because they can be used as "laboratories" to gain understanding of a social system. A city map is a model that allows an individual to compare alternate routes in a city without actually traveling along them. In many cases, a model may be the only realistic way to gain experience with a system, because activity in the real system is infeasible, costly, or impossible. Models of forces in earth-moon space, for example, are used to plan Apollo moon-flight trajectories, since actual manned flight experiments would be expensive and dangerous. Particularly important are abstract models expressed in mathematical notation, because such models can be studied extensively using modern mathematical methods and computer analysis.

Jay W. Forrester, professor of management at the Massachusetts Institute of Technology, presents a strong argument for the use of models in social policy-making:

> Our social systems are far more complex and harder to understand than our technological systems. Why, then, do we not use the same approach of making models of social systems and conducting laboratory experiments on those models before we try new laws and government programs in real life? The answer is often stated that our knowledge of social systems is insufficient for constructing useful models. But what justification can there be for the apparent assumption that we do not know enough to construct models but believe we do know enough to directly design new social systems by passing laws and starting new social programs? I am suggesting that we now do know enough to make useful models of social systems. Conversely, we do not know enough to design the most effective social system directly without first going through a model-building experimental phase. But I am confident, and substantial supporting evidence is beginning to accumulate, that the proper use of models of social systems can lead to far better systems, laws, and programs (Forrester, 1971a).

The system dynamics approach emphasizes the development of models which explicitly take into account the *structure* of the social system under study. System structure describes the way in which present system conditions are transformed into future conditions – that is, the structure of a system is a set of rules from which all future system behavior can be derived, given present conditions (and given any future external influences on the system).

As a simple illustration, consider the abstract system containing only the five letters of the alphabet, A,B,C,D, and E. The following rules might describe the system structure:

A → C
B → A
C → D
D → B
E → B

These rules indicate how the system evolves through time. For example, if the system initially is in condition "E," it next moves to state "B," followed by "A" and so on (See Bellman, 1973).

In a social system, *feedback relationships* among actions and conditions in the system form the basis of system structure by determining the manner in which system conditions are transformed through time. Forrester describes the notion of feedback in detail:

> The most important concept in establishing the structure of a system is the idea that all actions take place within "feedback loops." The feedback loop is the closed path that connects an action to its effect on the surrounding conditions, and these resulting conditions in turn come back as "information" to influence further action. We often erroneously think of cause and effect as flowing in only one direction. We speak of

action A causing result B. But such a perception is incomplete. Result B represents a new condition of the system that changes the future influences that affect action at A (Forrester, 1971b).

For example, in the political relationship between a school system and the community, students and their parents seek certain services from the schools, and school professionals offer certain services to the community (although not always the services demanded). The educational services given affect students and their families, thus influencing their demands upon the schools. Similarly, the demands of students and parents upon the school system affect the schools and consequently influence the services given. This system view of school politics involves a basic feedback loop structure, which can be represented in a simple "loop" diagram (see figure 1, based on Roberts, 1972).

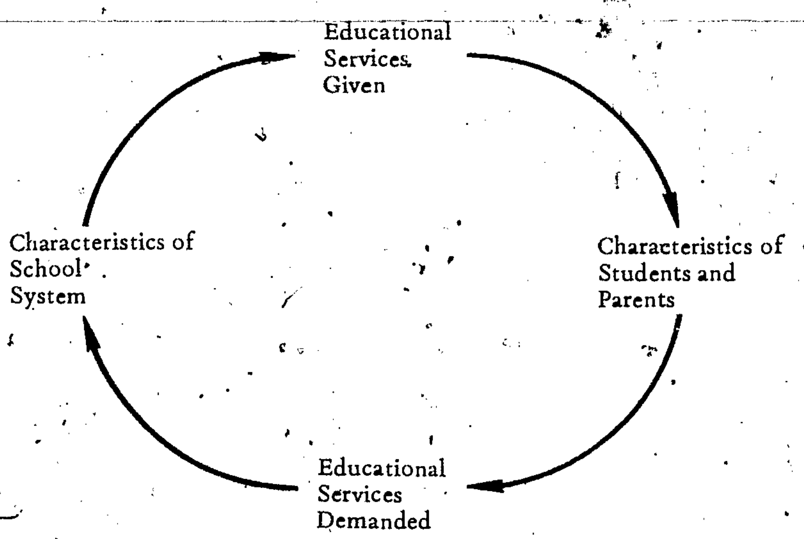


FIGURE 1. Simple Feedback Structure

In summary, a system dynamics model is a mathematical representation of the feedback loop structure of a social system, based upon several central assumptions about structure. First, the structure of a system is dynamic; that is, the structure accounts for the transformation of system conditions from one moment in time into the future. System structure indicates how present conditions lead to future conditions. Second, a structural model has as its purpose the explication of the dynamic behavior of a well defined concrete system. Third, the structure of a system dynamics model is closed; that is, all important feedback loops necessary to explain system transformations over time are contained in the model. All system actions which can lead to significant changes in system conditions should be included in the structure, and, similarly, all system conditions which can affect system actions in important ways should be included.

These fundamental assumptions are reflected in the detailed fabric of system dynamics models. In a model, each feedback loop is represented in terms of two kinds of variables -- *levels and rates.*

Level variables (often called state variables) represent the conditions of the social system at each moment in time. Levels describe accumulations of past system actions. In an economic model, the levels might include the number of employed and unemployed people in the labor force and the total value of productive capital. In a schooling model, levels might include, among others, the number of adults who have graduated from college and the number of high school dropouts.

Rate variables represent the actions in a system. In an economic model, for example, the hiring and firing rates affect the flow of individuals from the unemployed and employed. The investment and depreciation rates affect the level of productive capital. In a schooling model, the college graduation rate affects the number of adults who have graduated from college.

Flow diagramming is a convenient way to represent the level-rate formulation of a feedback loop structure. (See Pugh, 1970) The example in figure 2 is a simple flow diagram of the high-school enrollment process. Students enroll, some drop out, and others graduate. A rectangle is the symbol for a level; a "valve" is the symbol for a rate; a directed line indicates a flow into or out of a level, controlled by a rate; and a "cloud" is the symbol for a flow originating or terminating outside the system.

It is usually possible to "disaggregate" a single level into several others which together make up the original level. For example, in figure 2, the enrollment in high school is represented as one level. This might be decomposed, as in figure 3, into enrollment in tenth, eleventh, and twelfth grades. The appropriate degree of

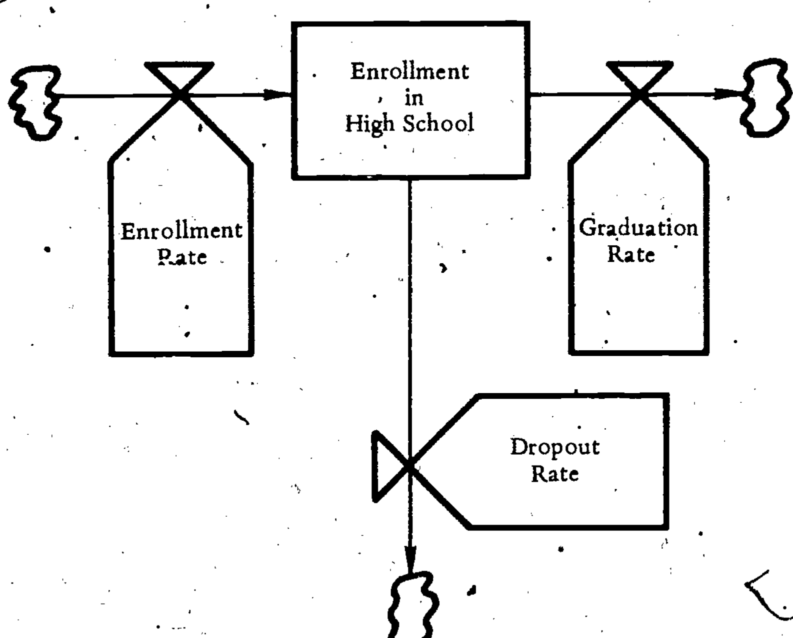


FIGURE 2: School Enrollment Flow Diagram

disaggregation in any particular model depends upon the purpose of the study.

It is not necessary that levels represent "countable" physical quantities, like the

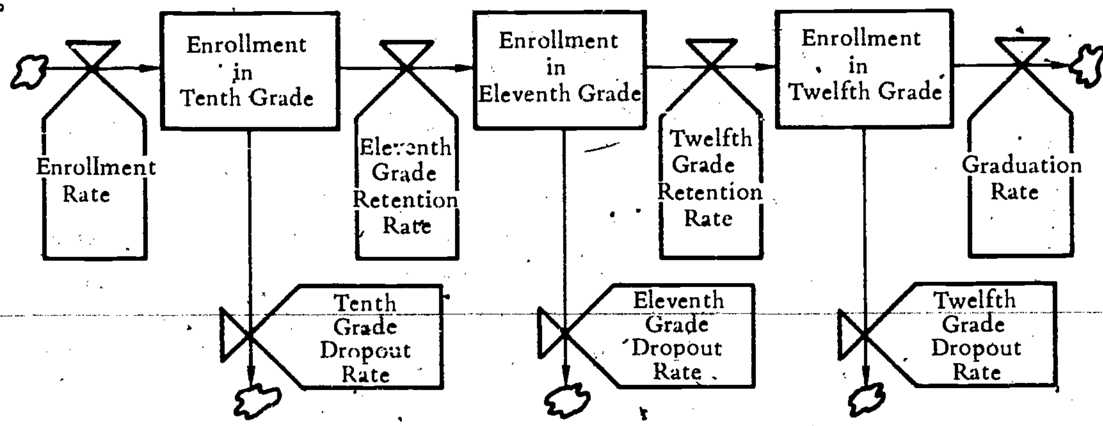


FIGURE 3: Disaggregated School Enrollment Flow Diagram

number of students in school or the number of classrooms. In figure 4, a student's achievement in English (language arts) is represented as a level. The student's learning rate controls the "flow" of achievement. Achievement might be thought of as the score on a standard achievement test, and the learning rate might be the change per year in the achievement score.

An information network forms the connecting tissue responsible for the self-regulating feedback character of a dynamic structure. The information fabric in a model indicates the way in which system conditions, represented by the level values, determine system actions, represented by the rate values. Information, in a system dynamics model, represents the patterns of observation and perception on which social actors base their actions. For example, the manager of a manufacturing plant may use formal decision-rules and data to set prices and to order supplies. A teacher may use informal observations and knowledge as a basis for curriculum preparation. In a social system, motivation patterns, social norms, formal laws, money, language, and explicitly measured data are all parts of

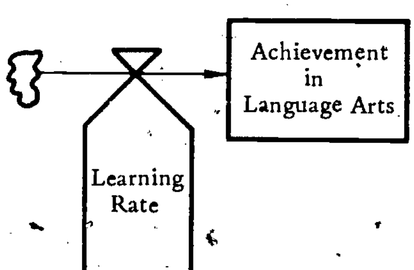


FIGURE 4: Student Achievement Flow Diagram

the "information" web.

The information network is in many ways the most interesting part of a model. Norms, laws, and language are subject to many transformations. System conditions as perceived by one group of actors may be very different from the conditions as perceived by another group. Conflicts and contradictions in perception can lead to important social behavior.

The flow diagram in Figure 5 illustrates information in a feedback loop structure. In the example, a hypothetical student's learning rate at any time is based upon his perceptions of his level of achievement. As his level of achievement rises, his perceived achievement rises, his motivation improves, and his learning rate increases. According to this simple structure, achievement and learning continue to grow without bound, for an increase in one is followed by an increase in the other. (This is certainly not a complete view of the learning process; usually, achievement stabilizes and does not grow indefinitely. Consequently, other feedback relationships must be at work which tend to slow the learning rate when achievement becomes large.) The dotted lines in the diagram represent flows of information; a circle is the symbol for a component of the information network.

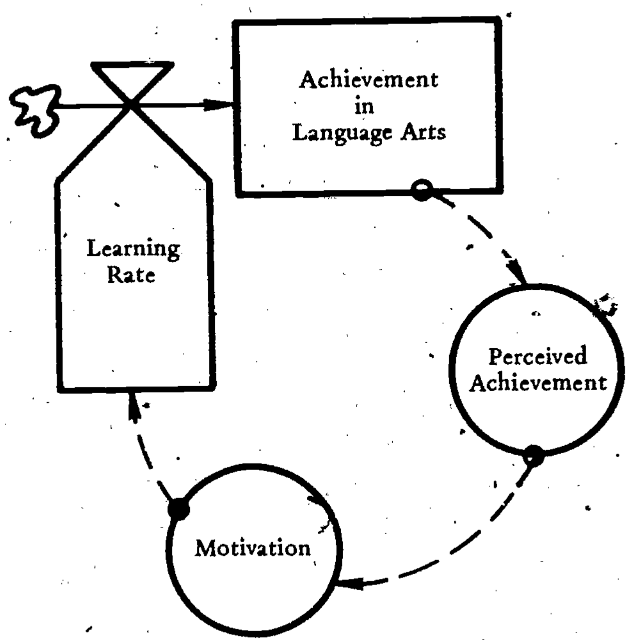


FIGURE 5: A Feedback Loop in a Simple Student Achievement Model

The Modeling Process

Once a feedback loop structure thought to explain the behavior of the social system under study has been developed, the model can be written as a computer program. The behavioral consequences of the structural model can be observed by using the program to simulate the model on a computer. A simulation represents the "time history" of a world in which all action occurs according to the structure of the model.

Often, considerable experimentation

with model simulation is required in order to understand the behavior characteristics of a model. A complex structure may exhibit "steersman-like" directive or goal-seeking behavior (termed negative feedback). A structure may give rise to divergence or growth (positive feedback) and pathologies such as information delays and distortion. "Policies" designed to bring about desirable system behavior can be tested by altering model structure; in many cases, experimental policies result in "worse-before-better" solutions.

Testing the validity of a simulation model is a difficult and ill-understood problem. A well formulated model creates a framework for the analysis of data. It suggests the kinds of empirical evidence required in order to monitor system behavior. Moreover, a good model, if it is correct, suggests the nature of the quantitative and qualitative relationships which should be observed in the data. Models are, therefore, important tools in the design of a management information system. A model can suggest which data should be collected and how the data should be analyzed.

At the same time, data obtained in a systematic information gathering project can help uncover shortcomings in a model. Errors can emerge in the original conceptualization of a model, in the particular structural representation, and in parameter choices. Models can be improved through continued logical analysis of the model conceptualization and structure and through repeated attempts to compare the model with empirical evidence.

It should perhaps be emphasized that there is no one "best" or "final" model. A model designed to answer specific questions about a system often tends to generate new questions, and these may require the development of new models. The model-building process may result in a sequence of models, each related in some way to the others in the sequence, but each with a special focus of concern. A useful information system must, therefore, be sufficiently flexible that new data can be entered and connected with existing data, and existing data can be interrelated in new ways.

The existence of a model, of course, does not insure that it will be employed by policy-makers. If a model is to be used in a government agency, model-builders must take into account organizational context — purposes, structure, and problems. The development of organizational self-consciousness is the essential and difficult beginning of any model-building process. Without knowledge of an organization's purposes and structure, little model usefulness can be expected.

The goals and structure of an organization as vast and complex as public education in America, however, are not easy to ascertain: in fact, the determination of the purposes of American education is a continuing part of the political process. In education, policies are a result of competition among diverse values and interests, and it is therefore unlikely that complete agreement on a single set of organizational goals can be reached.

Groups with alternative theories and values about education in America will necessarily come to different conclusions about policies and practices. Mathematical models are not substitutes for a rigorous analysis of values. On the contrary, the development of useful models in education can come only through intensive consideration and judgment of values, theory, and evidence.

The formulation of a system dynamics model is consequently a several stage process. Edward B. Roberts carefully argues that the entire procedure must be "deliberately and skillfully designed to produce implementable results, the desire to implement, and an environment that enables implementation." The stages in the system dynamics approach as summarized by Roberts are given below (Roberts, 1964):

1. Problem identification
2. Verbal description of the dynamic system theory affecting the problem
3. Mathematical model development
4. Computer simulation of the represented system
5. Analysis of results to determine model validity and factor sensitivity
6. Double-checking of, and data collection regarding, the sensitive areas of the model
7. Simulation experimentation to help identify improved system parameters and policies
8. Implementation of results of investigation in the real-world problem areas
9. Evaluation of the effectiveness of the changes, and return to the first term of the procedure for continuing improvement.

Poverty and Underemployment in Massachusetts: an Illustration

As part of MISOE, a system dynamics model of poverty and underemployment in Massachusetts is being developed. The primary purpose of the model is to demonstrate ways in which dynamic systems analysis can aid in education policy-making. The model is not yet complete, and many issues of empirical corroboration and analysis remain to be confronted. For this reason, conclusions concerning schooling and poverty developed from the model must, at this stage, be considered tentative. Nevertheless, the model provides insight into the system dynamics approach, and it is presented here as a case study.

Poverty, underemployment, and undesirable work are conditions of major social interest and importance. In 1966, over 18% of those Americans who wished to work could not find employment, were involuntarily only part-time employed, or were paid less than $1.68/hour – the hourly equivalent of the $3,500 1966 poverty line. Fully 33% of those who wished to work earned less than $2.65/hour in 1968 – the equivalent of the Bureau of Labor Statistics $5,500 Lower Level Urban Family Budget (Harrison, 1972).

In 1968, the mean earnings for full-time workers was $7,320. The mean for the top fifth of earners was $15,010, however, while that for the bottom fifth was $2,780. Thus, while workers in the top fifth earned 205% of the mean, those in the bottom fifth earned only 38% (Jencks, 1972).

Policies designed to reduce subemployment have been widely debated in both academic and political forums. Manpower training, educational reform, job creation, and urban renewal have all been proposed as possible solutions.

This system dynamics study attempts to address two issues:

1. What are the determinants and consequences of occupational and educational stratification in Massachusetts?
2. To what extent can extreme occupational inequalities be reduced by various purposeful social policies?

The study has been pursued in the belief that extremes of inequality in income and occupational well-being should be reduced. In America, many adults face menial work, job instability, and low wages; yet, in America, an individual's occupation is a major basis for self-respect and political power. For this reason, it is essential to understand the causes and consequences of occupational inequalities and the possible effects of public policies designed to reduce inequality.

In order to formulate a system dynamics model, it is essential to develop a precise statement of the policy problem the model is to illuminate: otherwise it is impossible to judge which factors should be included in the model and which should be omitted. For the study at hand, the "dual labor market" theory of poverty allows an extremely simple and insightful statement of the problem.

The dual labor market theory, which has developed directly from attempts to evaluate the effectiveness of manpower training and anti-poverty programs, distinguishes two categories of work, one characterized by high productivity and high wages, the other by low productivity and low wages (Gordon, 1972; Harrison, 1972; Doeringer, 1972; and Piore, 1969). In the primary labor market, high wages encourage employee stability and investment in training. Stability and training permit the efficient utilization of new technologies; and new technologies in turn result in high productivity and high wages. In general the market power of primary firms leads to high profits, permitting primary employers to invest both in modern capital equipment and, through on-the-job training, in the "human capital" of employees.

The secondary labor market is characterized by low productivity, antiquated physical capital, low wages, and employee instability. Few skills are required in secondary jobs, and consequently, secondary jobs attract casual laborers.

These features of the two markets create considerable barriers which prevent workers from moving from the secondary to the primary economy. Workers in the secondary market receive little investment in on-the-job training and have little incentive to learn stable job norms. Further, employers have come to value certain worker attitudes and demographic traits above others. Evidence indicates, for example, that federal manpower training programs have rarely been successful in placing workers with a history of secondary employment in primary jobs.

In the urban ghetto, the secondary labor market competes with "quasi-legal" activities such as "hustling" and illegal activity, for example, crime. Both crime and secondary employment share qualities of instability, risk and small opportunity for "advancement." In addition, the income derived from welfare compares favorably with wages in the secondary labor market; thus a member of the secondary labor force has little to lose by moving from work to welfare and back again.

The balance among primary and secondary jobs in the United States has apparently remained roughly constant since the Second World War, with perhaps two-thirds of the labor force in primary jobs and the remaining one-third in secondary employment. Because no explicit categorization of jobs according to the two markets has yet been completed, this estimate of relative primary and secondary shares is based on qualitative evidence and information on income distribution.

The dual labor market theory suggests the following policy problem:

What are the determinants of the relative sizes of the primary and secondary labor forces in Massachusetts, and to what extent can public policy alter the primary-secondary composition of the state's labor market.

This problem provides a focus for the model-building effort.

The most important stage in the development of a system dynamics model is the formulation of the system structure – the set of feedback relationships among system actions and conditions. In this study of poverty and underemployment, the system structure should account for the observed balance between primary and secondary jobs in Massachusetts over time.

There are a number of central feedback relationships in the two-market system.[1] The first concerns the primary-secondary job balance in the state and the educational attainment of adults. If educational attainment in the state is high, primary job growth is stimulated, causing the primary-secondary job balance to move in favor of primary jobs; and when the job balance favors primary jobs, highly educated people migrate to the state to take advantage of preferred employment. On the other hand, if the educational attainment in the state is low, primary employers leave the state to locate elsewhere, and the resulting unattractive job balance influences highly educated people to leave the state. This is a positive feedback loop (see figure 6) because a small increase (decrease) in the balance of primary jobs leads to continuing future increases (decreases).

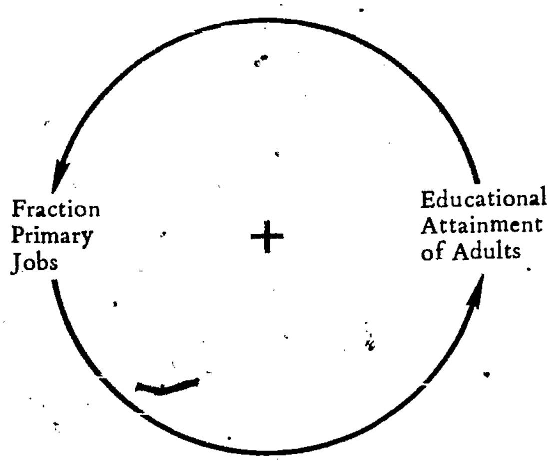


FIGURE 6: Job Composition-Educational Attainment Feedback Loop

The second principal feedback relationship in the system concerns the educational attainment of adults and children. When the average educational attainment of adults in the state is high, the average attainment of their children will be high. But the attainment of children in the state determines the future attainment of adults. Consequently, this also is a positive feedback loop (see figure 7).

The two positive feedback loops discussed above would result in sustained

[1] A complete description of the theory and evidence on which the model is based and a listing of all system equations can be found in Garet, 1973.

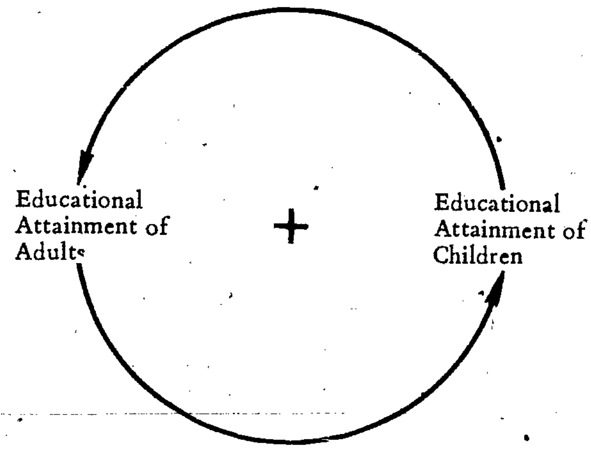


FIGURE 7: Educational Attainment Feedback Loop

growth in the fraction of primary jobs, or in sustained decline, were it not for several negative loops in the system involving unemployment and wages. These negative loops tend to preserve a balance of about two primary jobs for each secondary job in the state.

First, consider the wage structure. The rate of increase in the mean wage paid to primary job-holders is a function of the average wage in the state: when average wages are high, local costs of goods and services tend also to be high, resulting in strong wage demands (for example, in union negotiations). Since the primary wage is considerably higher than the secondary wage, the average wage tends to increase as the number of primary jobs rises, all else remaining constant. Thus an increase in the number of primary jobs

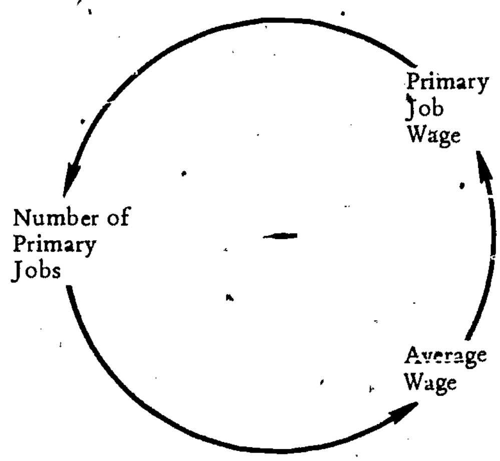


FIGURE 8: Primary Jobs Feedback Loop

causes an increase in the average wage, resulting in a rise in primary wages and a corresponding fall in the rate of growth of primary jobs, as firms move to take advantage of lower wages in other states. This is a negative feedback loop, which tends to preserve the number of primary jobs at a constant level (see figure 8).

A positive loop relates secondary jobs and wages: an increase in the number of secondary jobs causes a decline in the average wage, which results in a fall in secondary wages, causing an increase in the growth rate of secondary jobs (see figure 9).

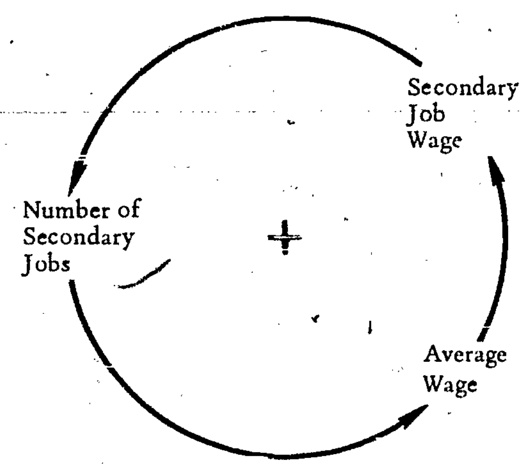


FIGURE 9: Secondary Jobs Feedback Loop

Because primary jobs are usually in high productivity, high profit industries, primary job growth is generally less sensitive to wage increases than is the growth of secondary jobs. Thus the positive loop in the secondary wage sector (figure 9) tends to dominate the negative loop in the primary wage sector (figure 8), and the two loops together behave as a single positive loop, relating wages and job balance. An increase in the primary job fraction increases the average wage, thus increasing both primary and secondary wages. Since these wage increases tend to depress secondary job growth more severely than primary job growth, the net outcome is an increase in the dominance of primary jobs (see figure 10), as well as a fall in the total number of jobs.

As the total number of jobs falls, unemployment must rise. Unemployment tends to increase the relative supply of labor for secondary employment, however, and this increase in labor supply results in a fall in the secondary wage. A decrease in wages, furthermore, tends to increase the growth rate of secondary jobs, increasing the total number of jobs, and limiting unemployment. This is a negative loop, shown in figure 11. Note that when secondary wages fall, the primary wage also drops, due to a decline in the average wage.

A final negative loop relates the size of the labor force to unemployment. If unemployment rises, population outmigration from the states tends to increase, causing the labor force to fall in

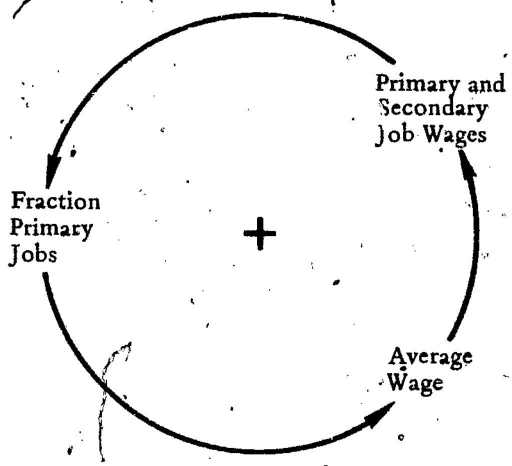


FIGURE 10: Job Composition Feedback Loop

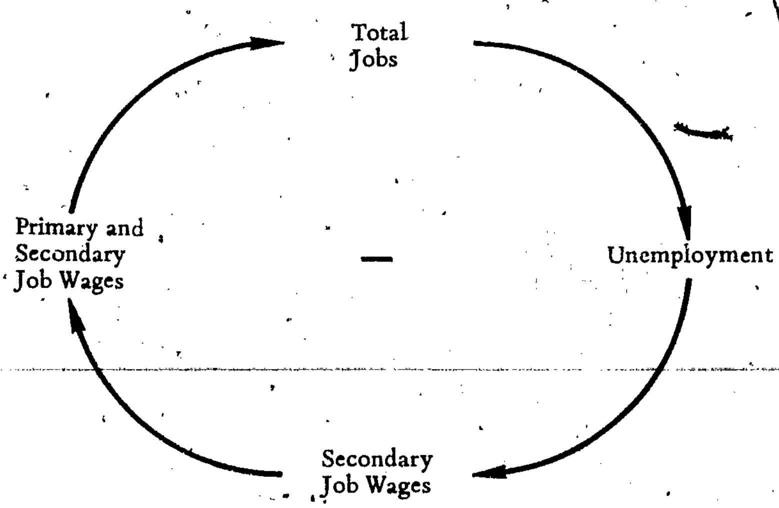


FIGURE 11: Secondary Job Wage Feedback Loop

size, decreasing unemployment, all else remaining equal (see figure 12).

The overall feedback loop structure of the dual labor market system in Massachusetts is represented in a level-rate flow diagram in figure 13. All feedback loops discussed earlier can be traced explicitly in the flow diagram, from the levels, through the information network, to the rates associated with the levels. A set of equations has been written, corresponding to this level rate formulation, and parameter values have been obtained, when possible, from census data. The equations are expressed in DYNAMO, a computer language designed for dynamic simulation (Pugh, 1970).

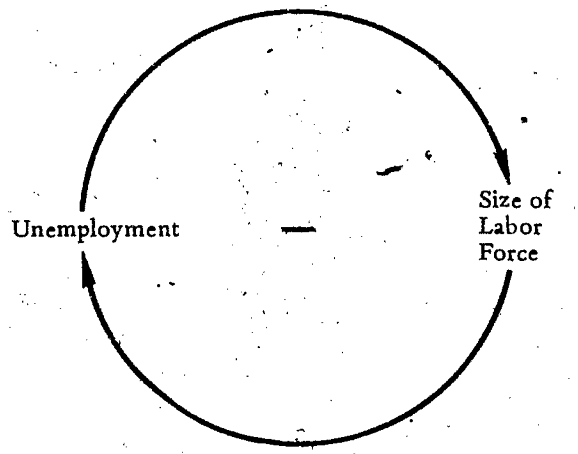


FIGURE 12: Unemployment Feedback Loop

In the model, the population is, for simplicity, disaggregated into four age groups:

- children (age 0-14)
- teenagers (age 15-19)
- adults (age 20-64)
- aging adults (age 65 and over)

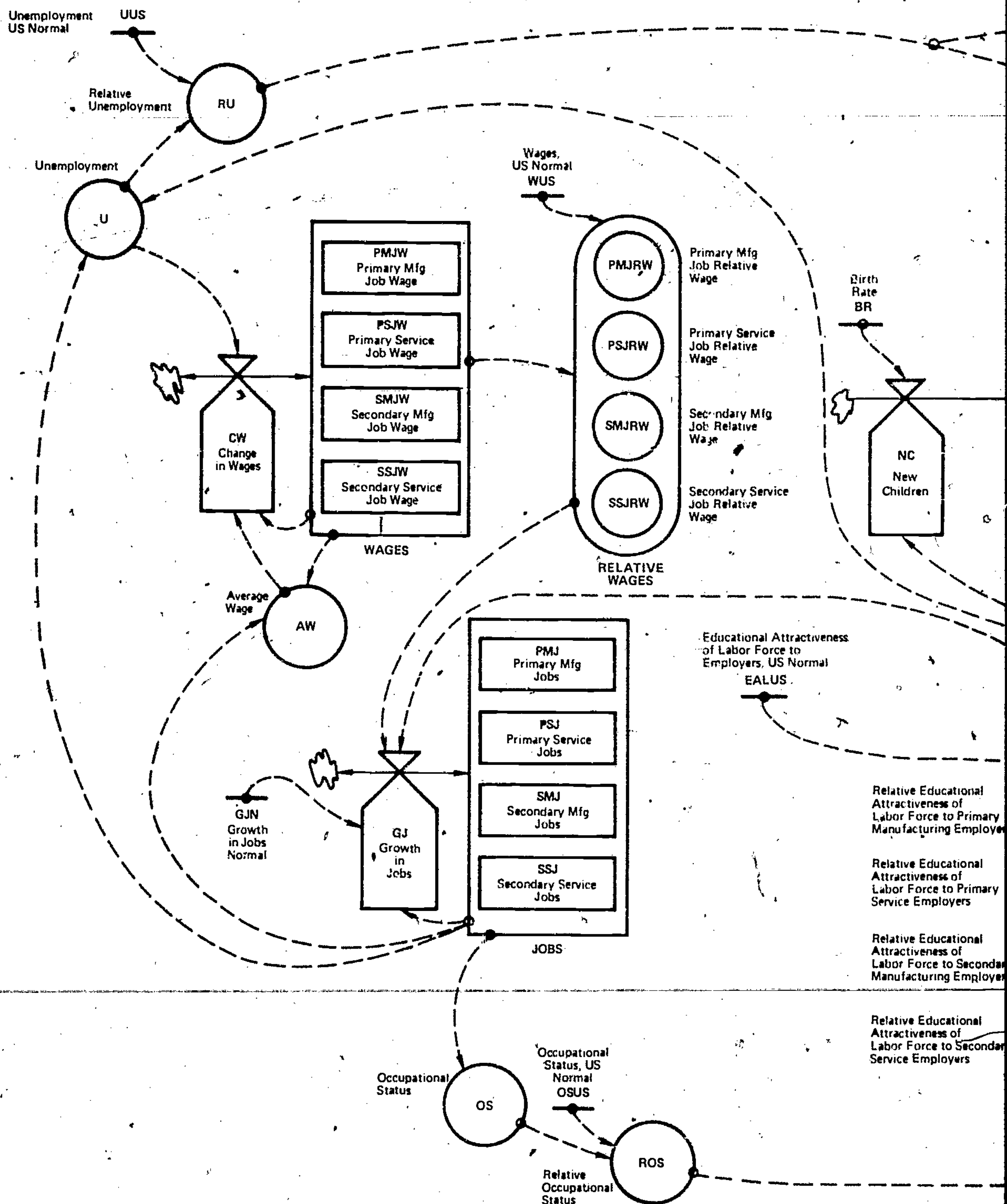
This division was selected primarily because labor force participation, fertility and migration characteristics differ significantly among the groups. In fact, of course, the groups are not completely homogeneous with respect to these characteristics; for example, women are more likely to bear children in the age period 20-44 than in the period 45-64.

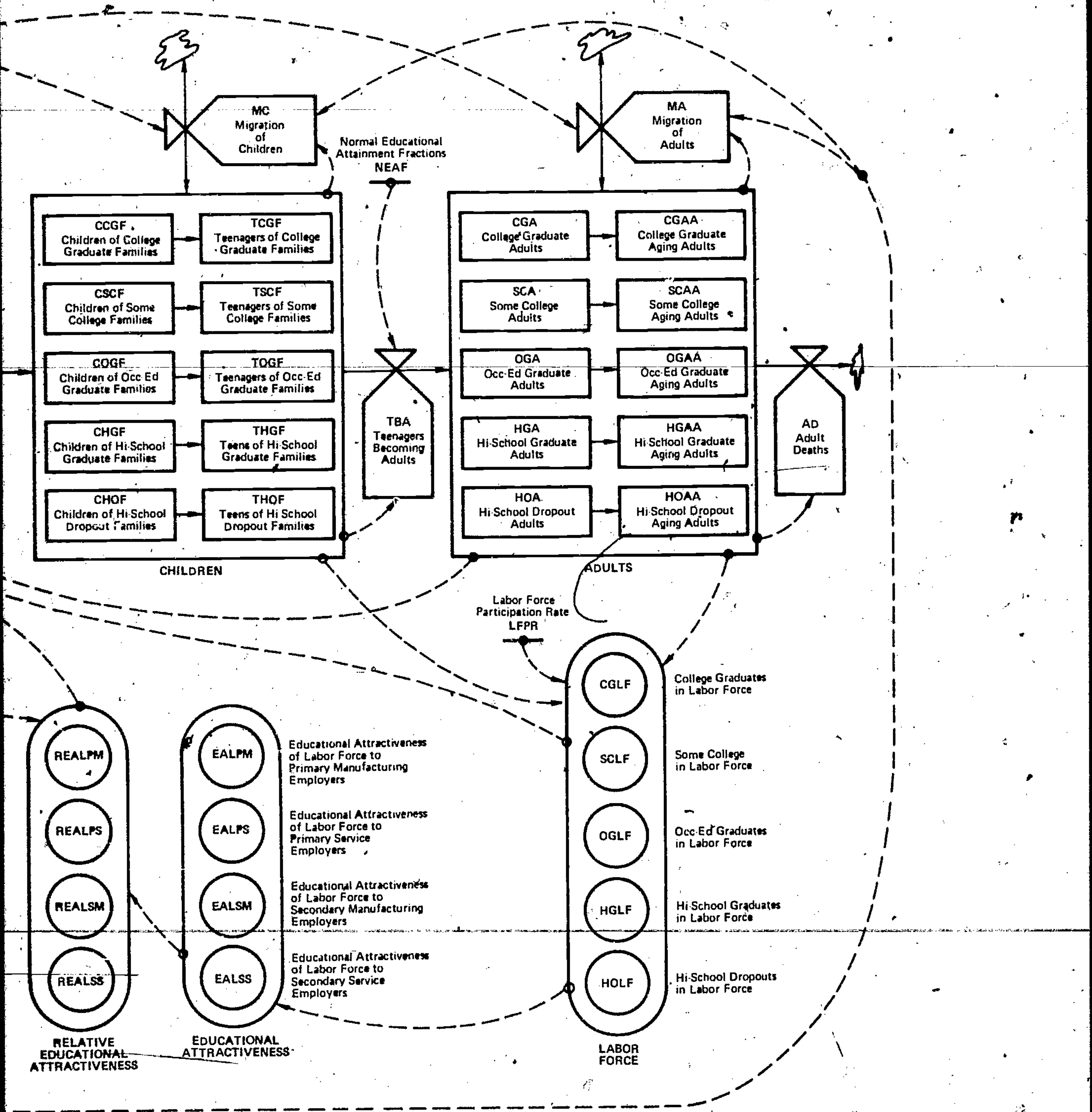
The adult and aging adult population is disaggregated into five educational attainment groups:

- highschool dropouts (0-11 years completed)
- highschool graduates (12 years completed)
- occupational education graduates (12 years completed)
- some college (13-15 years completed)
- college graduates (16 or more years completed)

Children and teenagers are grouped according to the educational attainment of the head-of-household of their family of origin.

In the flow diagram (figure 13), the large rectangles labelled "Children" and "Adults" each represent a set of level variables in the model. The large "valve" symbols represent related sets of rate variables.


Unemployment US Normal
UUS
Relative Unemployment
RU
Unemployment
U
Wages, US Normal
WUS
PMJW
Primary Mfg Job Wage
PSJW
Primary Service Job Wage
SMJW
Secondary Mfg Job Wage
SSJW
Secondary Service Job Wage
WAGES
CW
Change in Wages
PMJRW
PSJRW
SMJRW
SSJRW
Primary Mfg Job Relative Wage
Primary Service Job Relative Wage
Secondary Mfg Job Relative Wage
Secondary Service Job Relative Wage
RELATIVE WAGES
Birth Rate
BR
NC
New Children
Average Wage
AW
Educational Attractiveness of Labor Force to Employers, US Normal
EALUS
PMJ
Primary Mfg Jobs
PSJ
Primary Service Jobs
SMJ
Secondary Mfg Jobs
SSJ
Secondary Service Jobs
JOBS
GJN
Growth in Jobs Normal
GJ
Growth in Jobs
Relative Educational Attractiveness of Labor Force to Primary Manufacturing Employers
Relative Educational Attractiveness of Labor Force to Primary Service Employers
Relative Educational Attractiveness of Labor Force to Secondary Manufacturing Employers
Relative Educational Attractiveness of Labor Force to Secondary Service Employers
Occupational Status
OS
Occupational Status, US Normal
OSUS
ROS
Relative Occupational Status


MC
Migration of Children
Normal Educational Attainment Fractions
NEAF
MA
Migration of Adults
CCGF
Children of College Graduate Families
TCGF
Teenagers of College Graduate Families
CSCF
Children of Some College Families
TSCF
Teenagers of Some College Families
COGF
Children of Occ-Ed Graduate Families
TOGF
Teenagers of Occ-Ed Graduate Families
CHGF
Children of Hi-School Graduate Families
THGF
Teens of Hi-School Graduate Families
CHOF
Children of Hi-School Dropout Families
THOF
Teens of Hi-School Dropout Families
CHILDREN
TBA
Teenagers Becoming Adults
CGA
College Graduate Adults
CGAA
College Graduate Aging Adults
SCA
Some College Adults
SCAA
Some College Aging Adults
OGA
Occ-Ed Graduate Adults
OGAA
Occ-Ed Graduate Aging Adults
HGA
Hi-School Graduate Adults
HGAA
Hi-School Graduate Aging Adults
HOA
Hi-School Dropout Adults
HOAA
Hi-School Dropout Aging Adults
ADULTS
AD
Adult Deaths
Labor Force Participation Rate
LFPR
CGLF
College Graduates in Labor Force
SCLF
Some College in Labor Force
OGLF
Occ-Ed Graduates in Labor Force
HGLF
Hi-School Graduates in Labor Force
HOLF
Hi-School Dropouts in Labor Force
LABOR FORCE
REALPM
REALPS
REALSM
REALSS
RELATIVE EDUCATIONAL ATTRACTIVENESS
EALPM
Educational Attractiveness of Labor Force to Primary Manufacturing Employers
EALPS
Educational Attractiveness of Labor Force to Primary Service Employers
EALSM
Educational Attractiveness of Labor Force to Secondary Manufacturing Employers
EALSS
Educational Attractiveness of Labor Force to Secondary Service Employers
EDUCATIONAL ATTRACTIVENESS

The present version of the model includes four job markets:

primary manufacturing jobs
primary service jobs
secondary manufacturing jobs
secondary service jobs

In the flow diagram, the large rectangle labelled "Jobs" represents the set of four job level variables, and the valve symbol represents related rate variables.

To each job market category in the model corresponds a wage level, and the set of four wages is represented in the diagram by the large rectangle labelled "Wages." The large "valve" represents related wage change rate variables.

Each feedback structure in the model is represented as a closed loop formed of at least one level, an associated rate, and the information network connecting them. As an example, the feedback loop shown in figure 6, relating educational attainment and job composition, can be traced in the general flow diagram beginning with the "Jobs" level variables. The loop continues from the "Jobs" levels through the "Occupational Status" and "Relative Occupational Status" information auxiliaries, to the "Migration of Adults" rate variables. In the model, the "Occupational Status" auxiliary represents the occupational quality of the state, in terms of the primary-secondary job balance; "Relative Occupational Status" represents the job quality in the state relative to the average in the United States as a whole. The feedback loop continues through the "Adults" level variables and the "Labor Force," "Educational Attractiveness," and "Relative Educational Attractiveness" auxiliaries. The "Labor Force" auxiliaries represent the numbers of people with different amounts of education participating in the labor force. The "Educational Attractiveness" variables are indicators of the degree to which the skills, training and attitudes of members of the labor force, as reflected in their educational attainment, correspond to those desired by employers. Finally, the feedback loop continues from the "Relative Educational Attractiveness" auxiliaries, to the "Growth in Jobs" rates, returning to the "Jobs" levels. Thus, the loop is closed. Job composition affects occupational status, which influences migration, altering the educational attainment of adults. The attainment of adults influences the educational attractiveness of the labor force, which in turn determines job growth, affecting job composition. The feedback relationships shown in figures 7 through 12 can be traced in the flow diagram similarly.

The purpose of formulating a mathematical model is to gain understanding of the behavior associated with a structure. This model of the two labor market system in Massachusetts generates a forty year time history. During the simulation, the period 1960-2000 is traversed in one-year intervals, beginning with given initial conditions. The values of the system levels at the beginning of an interval determine the values taken by the system rates during the interval. The values of the rates during one interval, in turn, determine the changes in the values of the levels from that interval to the next. It should be emphasized once again that all changes in system levels are determined by rates, and that all rates are determined by system levels: the model is "self-regulating."

The curves in the figures which follow were prepared from computer plots showing the behavior of selected system variables as generated through time by the simulation model. The horizontal axis is a time scale, starting with the year 1960 and continuing for the next forty years. The vertical scales at the left of each plot are marked at the top with the plotting symbols to which they apply.

The computer plots for the standard model simulation are given in figures 14 and 15. The behavior is rather straightforward: primary and secondary jobs rise throughout the 40 year period, maintaining their relative shares of the labor market. The population grows at a slowing rate. The relative wage, educational attractiveness, and occupational status variables all persist approximately equal to unity, and the unemployment rate falls slightly.

This fall in unemployment rate is due to the population migration formulation. As the empirical evidence indicates, there is a net out-migration from states experiencing unemployment rates equal to the national mean. The initial 1960 unemployment rate in Massachusetts was set equal to .05 in the model, and it drifts down to about .04 as the out-migration diminishes the size of the labor force. The small variations in the relative wages are due to these changes in the unemployment rate (see the feedback structure in figure 11).

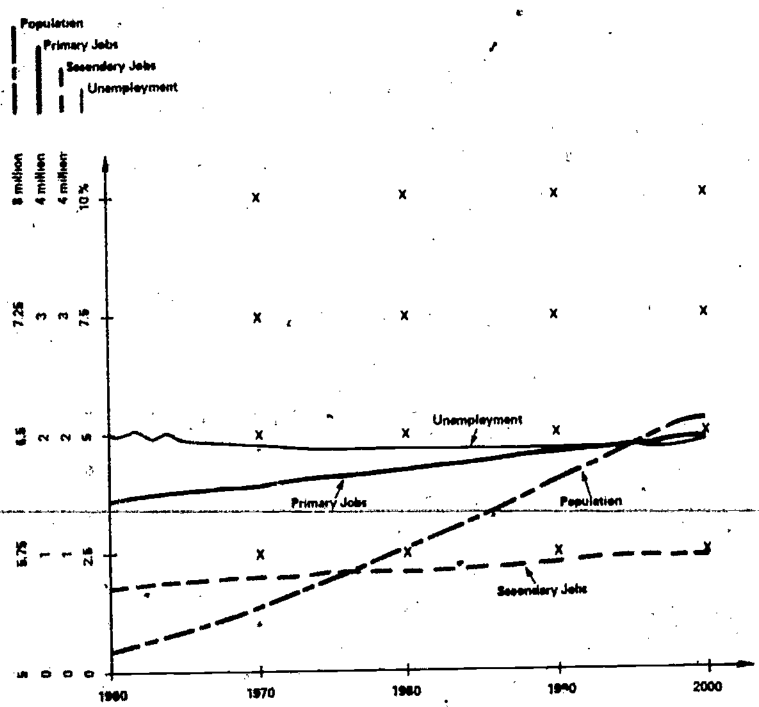


FIGURE 14: Standard Model Simulation

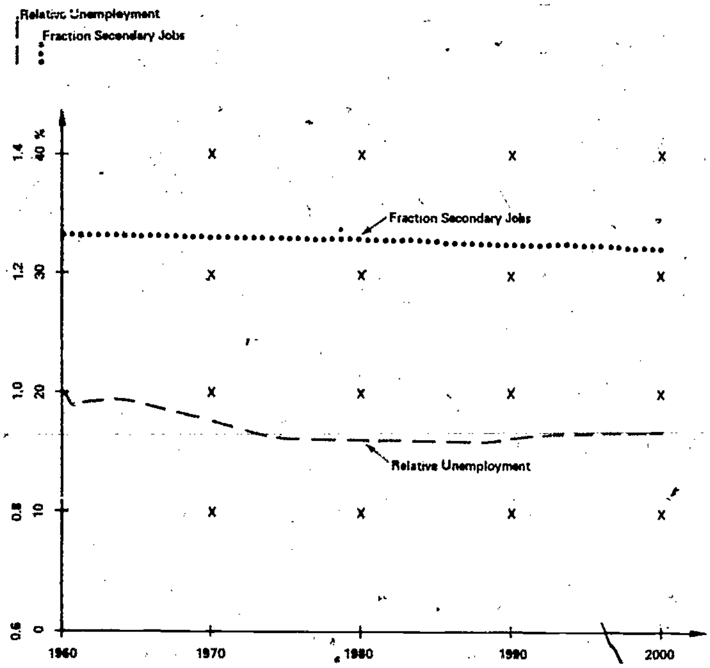


FIGURE 15: Standard Model Simulation

The standard run is, of course, unsurprising – the model was constructed in such a way that the primary and secondary markets grow evenly.

Several model experiments have been conducted, by altering the normal growth rate parameters of one job sector so that the normal primary and secondary growth rates are no longer equal. Compensating changes in unemployment, wages, and population migration (see the feedback loops in figures 11 and 12), however, tend over time to counteract the alterations in normal growth rates. Altogether, the results of these experiments are not too different from the basic run – indicating that a rather substantial change in the normal primary or secondary job growth rates does not have a very significant effect on the characteristics of the labor market.

The model can be used to test the effects of experimental policies on labor market composition. The first policy tested is an occupational education program which provides one-third of the normal high school dropouts with an occupational school education each year. This, of course, would be a difficult and perhaps costly program to implement; for purposes of this test, however, it is assumed that the program is implemented in 1965 and that it is effective in providing potential dropouts with an occupational school education.

As figures 16 and 17 indicate, the program has a significant but not dramatic beneficial effect on labor market composition. By the year 2000, the primary job share has risen from 66% to 74%, and the secondary share has fallen from 33% to 26%. Interestingly, the program has

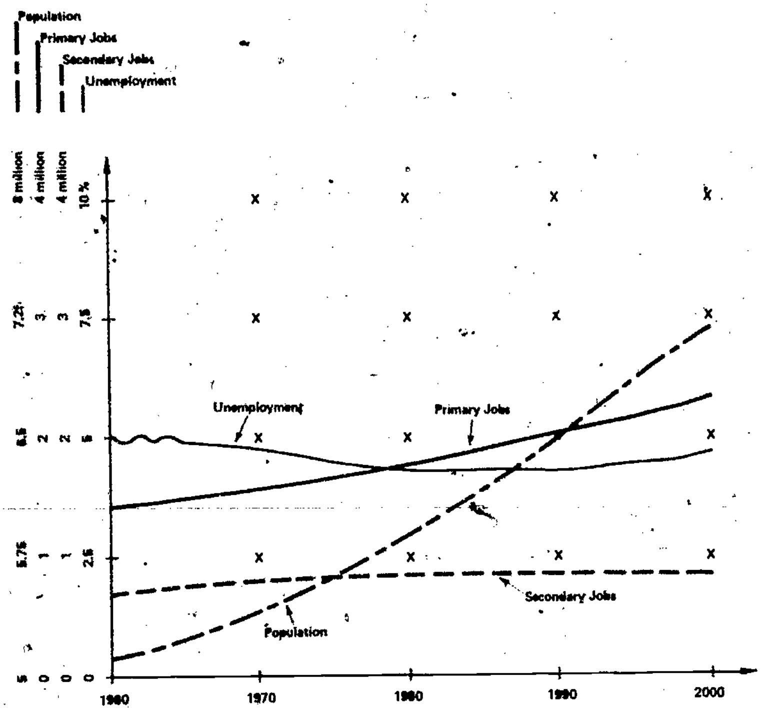


FIGURE 16: Occupational Education Policy Test

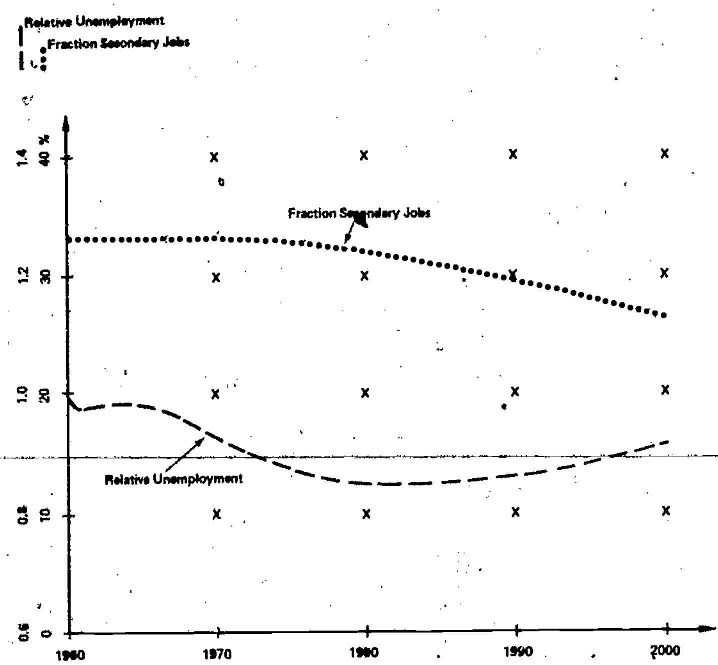


FIGURE 17: Occupational Education Policy Test

almost no effect on job composition whatever until 1974, nearly ten years after it is implemented, and it has no real effect until the late 1980's. This is due to the fact that the educational attractiveness of the population influences the number of primary jobs through the *rate* of primary job growth. An improved primary job growth rate must persist for quite a few years before the increase is felt as a significant change in the primary-secondary job balance.

It is also interesting that the total population in the experiment grows to over 7 million by the year 2000 – a figure over 500,000 greater than the total in the standard run. This is due to the improved relative occupational status and favorable unemployment rate (see the feedback loops in figures 6 and 12). The possible detrimental effects of crowding are not included in this model; any consideration of social policy, however, would have to take such effects into account.

The outcome of the occupational education experiment suggests that a favorable policy might also require direct intervention in the labor market, in an effort to work with employers and workers, through on-the-job training and reorganization of work, to convert secondary to primary jobs. This policy has been proposed by a number of dual market theorists. The policy has been

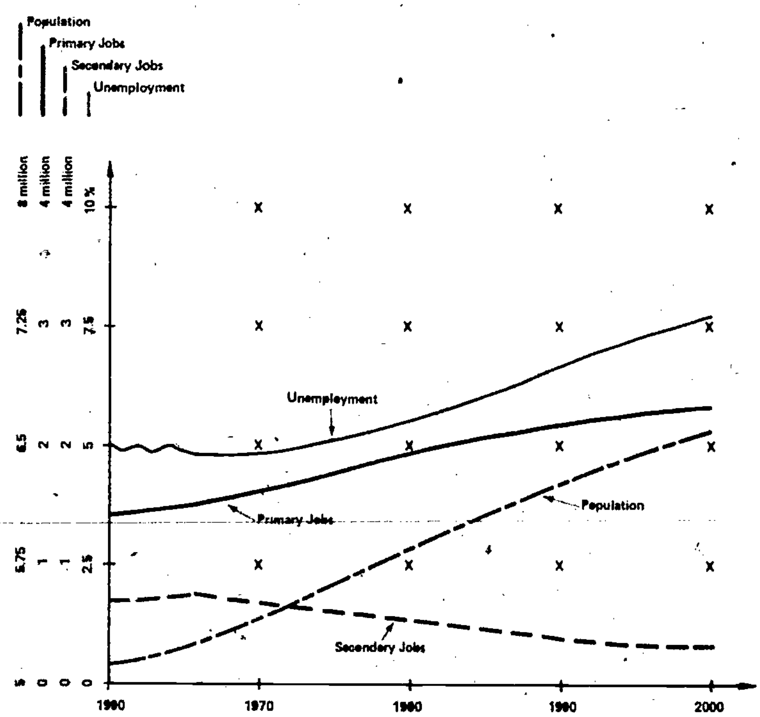


FIGURE 18: Job Program Policy Test

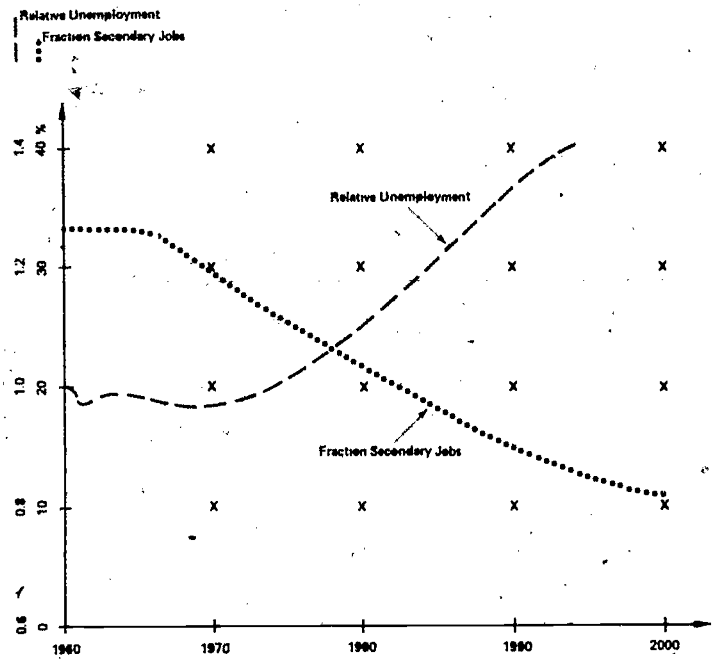


FIGURE 19: Job Program Policy Test

tested in the model by moving 3% per year of the jobs in the secondary sector to the primary sector, beginning in 1965. This would no doubt be an extremely difficult policy to implement. Here, a test is made of such a policy's effects on the assumption that it can be successfully carried out. Figures 18 and 19 indicate the results of the experiment.

As can be seen, by the year 2000, the job share of the primary market is about 90%, while that of the secondary market is about 10%. This is indeed a dramatic improvement. The unemployment rate rises somewhat in the process, and this has the effect of reducing the population in-migration that would otherwise occur due to the improved occupational situation. The improved occupational status does increase the in-migration of highly educated adults, which enhances the relative attractiveness of the labor force to primary employers, somewhat compensating for the rise in wages which is the consequence of the changing job mix (see the feedback loops in figures 6 and 9).

A final policy experiment combines a 1% per year direct conversion of secondary to primary jobs with the occupational education program discussed earlier. The results are indicated in figures 20 and 21.

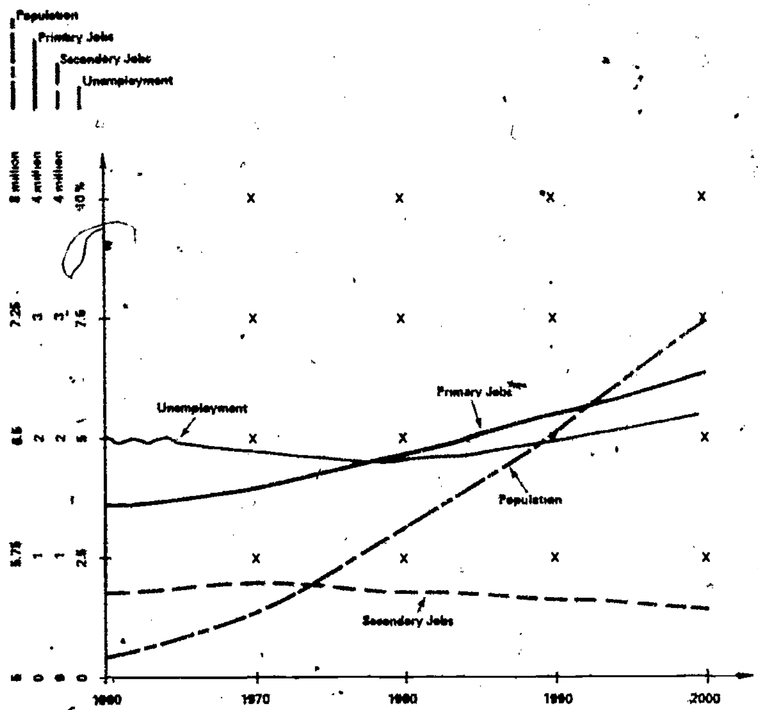


FIGURE 20: Combination Program Policy Test

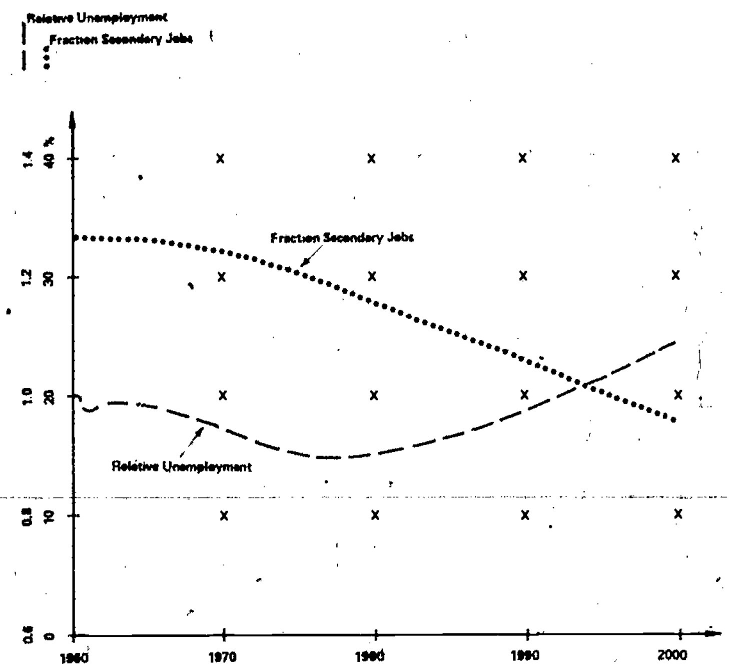


FIGURE 21: Combination Program Policy Test

These policy tests should be considered as model experiments. They are not recommendations for action. At this stage, the model is a laboratory in which hypotheses can be tested. Many model experiments must be evaluated; evidence must be compared with model behavior; important parameters must be revised to conform more nearly to the developing empirical theory. These are matters considered in the concluding section of this chapter.

System Dynamics and Management Information Systems

John Little writes that, "the big problem with management science models is that managers practically never use them" (Little, 1970). Political rationality and responsibility in education are not served by the production of data few people use or the development of models few people understand. To be used, information should meet the kinds of criteria Wilensky has suggested: it must be clear, timely, reliable, valid, adequate, and wide-ranging.

The development of information with these qualities is necessarily an evolutionary process. The particular evidence collected for an information system – the variables measured, the instruments used, the errors tolerated – will depend upon the values and theories held by the investigators. To the extent that these values are unexamined or the theories are incomplete or ill-formed, the evidence collected will likely suffer from empirical and conceptual inadequacies: it will be unclear, untimely, unreliable and invalid.

In short, empirical evidence, if it is to be used as a scientific base for decisions, must be collected with a clear human purpose in mind. The formulation of dynamic system models is one way to attempt to make values and theories explicit: In developing a model, assumptions are often clarified, and the consequences of multiple assumptions, taken together, can be examined.

Of course, a model, once formulated, must be compared with the evidence provided by the "concrete" system under study. Thus a model suggests not only what should be measured, but also what should be expected in the data collected. As data is observed, of course, models will necessarily be altered and new sources of evidence will be demanded.

The labor market model described above focuses attention on issues for which new evidence is required: for example, to what extent is job growth in a state sensitive to the educational composition of the labor force? To what extent is population migration sensitive to occupational status? How important are wages in industrial location? Some evidence is available to, answer these questions, but more information is needed.

The primary value of a dynamic model, such as the labor market model discussed earlier, does not lie in the precise policy recommendations which emerge. Most important is the model formulation process itself, which provides a means of visualizing actions and their interrelations in a complex system. Long term consequences of actions and unexpected secondary effects gain clarity when viewed in a system simulation context. Further, the possibility of real and difficult value choices is often suggested in a system study. For example, in the labor market model, it appears that policies which improve the primary-secondary job composition of a state may, at the same time, increase the unemployment rate.

Amital Etzioni has argued that the important issue in social action is similar to the dilemma posed by Freud in individual conduct: how is society guided and what activities extend or curtail societal self-control (Etzioni, 1968). The study of social policy in dynamic system terms is directed toward an increased understanding of the social guidance process. Perhaps the use of dynamic systems analysis is also a program in the direction of a new social self-consciousness.

CHAPTER 10
AN ASSESSMENT OF MISOE

The assessment responses by Charles H. Buzzell, David V. Tiedeman and Jacob J. Kaufman are offered to provide the reader with reference points for determining the usefulness of MISOE. Each assessor responds from a professional perspective: Buzzell as a chief state manager for occupational education in Massachusetts; Tiedeman as an educational researcher and Kaufman as an economist. It was the editorial intention to provide a range of responses as a stimulus for a broad-based evaluation. To a large extent, this seems to have been accomplished. Charles Buzzell's piece rings of "under the gun" management realities, Dave Tiedeman's discussion deals with scope, structure and value and Jack Kaufman's assessment sounds just like an economist, as it should. Together, these responses could be helpful to the reader who has surrendered some of his nonreplaceable time to consider and judge MISOE.

A MANAGER'S RESPONSE TO MISOE

Charles H. Buzzell
Associate Commissioner
Division of Occupational Education
Massachusetts Department of Education

When one reviews the "state of the art" relative to rational decision-making by educational managers, it should become obvious why MISOE has captured the imagination of administrators not only in Massachusetts, but nationwide. There lies within this highly complex and scientific information system the potential of freeing educational managers from the hazards of making budget and programmatic decisions in a veritable vacuum, too often devoid of valid data. To harness the full potential of MISOE requires a new level of decision-making sophistication be achieved. This sophistication is not an exercise to become academically "hip", but, rather involves the development of important new skills and understandings. The need for improved management techniques is a clear alternative to a management strategy which is based upon emotional pleas for increased tax dollars to "help children." This tactic will no longer suffice.

The level of taxpayer concern (the essential employer of educators) has reached such a crescendo in many places that it has triggered direct responses by legislative bodies, rather than educators. As these responses develop, the real danger of noneducators assuming the professional educator's role becomes a reality which may have dire consequences for professionals. In short, MISOE is a necessity in the face of this reality, not just another "academic" exercise.

Accountability, that much bandied about expression, is upon us. Rather than placidly sitting back, in the hopes of seeing it fade away, managers who recog-

Dr. Buzzell would like to thank the following members of his staff for their assistance in organizing this response: Carol Cataldo, Vincent P. Lamo.

nize the importance of the concept are in a pro-active stance, gathering their forces in order to be in the vanguard of educational response to the cry for accountability.

MISOE provides administrators with a rational system for the implementation of an accountability process. Fundamentally, it addresses itself to the substantive question of: given limited resources and unlimited demands, how can I make decisions which will result in resource allocations achieving maximum cost/benefit ratios?

In Massachusetts, which has some 325,000 secondary students, more than $190,000,000 is spent annually on occupational education. It is the efficient distribution of these funds in a way to maximize benefits to society and students that constitutes the core of MISOE's contribution to rational management.

In a society composed of a variety of sub-systems competing for essentially the same dollars, the success or failure of the educational sub-system will rise or fall on the results of the decisions educational managers make. These decisions will not only affect education, but upon implementation, can affect other political and economic sub-systems. In this light, the blueprint of MISOE has incalculable value. It should be stressed, however, that MISOE can be effective as a tool for management only if it functions in a close relationship with the local educational agency, the State Department of Education, and appropriate legislative and fiscal bodies.

Impact Statements

Given MISOE as a system to assist in decision-making, the manager is able to relate input to product, as well as to impact. For some it is essential in decision-making not to focus on product statements, but impact statements. Let us presume that education wishes to contribute its share to increasing the tax revenue available to the state. It might be assumed that increased occupational education could lead to increased state revenue by virtue of increasing the tax base.

In an attempt to achieve this goal, the occupational educational manager must determine where to distribute his dollars. He may choose to invest in one or more of the following in order to maximize his benefits, i.e., increase the tax base, expand facilities, expand and/or improve curriculum, focus on professional improvement (pre-service, in-service), expand remedial skills in the academic sector.

However, more often than not he finds that the data on which he bases his allocation(s) are incomplete, without validity or reliability. Just where among the competing alternatives does he allocate money? One thing is certain, he will allocate. Often in the absence of fact he relies on "gut" feelings. He may have a "feeling" for what is best, but he does not *know* what is best.

Hypothetically, a manager may feel that the key to increasing the tax base lies in enticing new industry into the state, using the lure of a skilled work force which could be trained. An industry may be a logical choice because manpower opportunities are high and the training costs low. However, this decision, based on lack of sufficient data, could have long range effects counter-productive to the goal of increasing the tax base. For instance, new industry and employment prospects may cause an increase in migratory flow from other localities. In essence, the pay off of dollars invested in occupational education may be jeopardized by an outside, experienced work force which supplants local labor. In addition, greater burdens may also be placed upon the state, city, and/or town for supplementary services (police, fire, education, sanitation, highways, etc.) by the new industry, as well as by the new population group. Thus, the demand for service dollars may far exceed the new tax dollars produced by the industry.

Hence, in the absence of sufficient information, what appears logical to a manager can be subverted by previously unconsidered variables. Without a relevant management system, using only the data and tools presently available, the educational manager cannot accurately estimate present program benefits or the far reaching effects of his decision on other systems. The occupational education manager needs a process to help him measure what he received for past performance, and therefore a more accurate measure of what alternatives are open to him now. MISOE can provide this process. MISOE can relate to managers, not only information, but alternatives for action, their variations, and possible consequences.

However, it must be emphatically stressed that MISOE will not make a decision for a manager. MISOE must not be looked upon as a substitute for the decision-making process. It can only display alternatives for us, as any management system can. MISOE cannot act alone, it is man who humanizes and interprets for implementation. This personalized conception is vital; he is ultimately the decision-making process. Admittedly, we do not as yet have all elements isolated or factored out. But we do have, with MISOE, more than we have currently. MISOE will also enable us to take a great percentage of the risk out of our decision-making.

Evaluation

To test the validity of MISOE, its concepts were arrayed before a group of state and federal administrators at varying levels of the occupational education hierarchy.[1] General concensus of opinion was that MISOE can make a valuable contribution to education, and in turn, to society as a whole.

The evaluators supported the notion of expanding the current state of the art in making rational decisions from competing alternatives. However, they also stressed the need for implementation tactics. MISOE will deliver its benefits to a variety of sectors, but these sectors must know their benefits as well as their responsibilities. It is crucial that managers understand that benefits can only result from their input.

With this beginning, MISOE begins Phase II. We are now taking the blueprint off the drawing board and fabricating the tactical strategies to implement it. We would hope that the strategies resultant from Phase II will help realize decisions which are more cost beneficial.

Only when these strategies can be proven successful by MISOE will educators begin to relinquish the ambiguities, and ambivalence of the past, and begin to assume the posture which is theirs, a posture which will allow them to come forth and present to "the essential employer" the kinds of budgetary and programmatic decisions which that employer is demanding.

The tool, MISOE, is in place. What is needed now is the determination to pick up that tool and use it to its fullest potential. Frankly, education has no choice.

[1] See appendix, this chapter

APPENDIX

The following is a list of people who attended the National Invitational conference of September 13 and 14, 1973 to offer judgment upon MISOE.

Mrs. Evelyn Blewett
Editor
Journal of Research and Development in Education
Room 219
175 W. Wieuca Road, N.E.
Atlanta, Georgia 30305

Miss Barbara Carraway
Division of Occupational Education
Department of Public Instruction
Raleigh, North Carolina 27611

Dr. John A. Creager
Research Associate
Office of Research
American Council on Education
One DuPont Circle
Washington, D.C. 20036

Dr. Ernest Feleppa
Division of Occupational Education Planning
99 Washington Avenue
Albany, New York 12210

Mrs. Ernestine H. Frazier
Asst. Dir. Program Evaluation
Division of Occupational Education
Department of Public Instruction
Raleigh, North Carolina 27611

Dr. Jack Gutilla
Vocational Education
Room 612, Ohio Departments Building
65 South Front Street
Columbus, Ohio 43215

Dr. Howard Hjelm
Adult, Vocational & Technical Education
Department of Health, Education & Welfare
Office of Education
Washington, D.C.

Dr. Jacob J. Kaufman
Director & Professor of Economics
Pennsylvania State University
Institute for Research on Human Resources
407 Graduate Building
University Park, Pennsylvania 16802

Dr. Michael Kozma, Supervisor
Division of Occupational Education Planning
State Education Department
99 Washington Avenue
Albany, New York 12210

Dr. Charles J. Law, Jr., State Director
Division of Occupational Education
Department of Public Instruction
Raleigh, North Carolina 27611

Mrs. Mae E. Murphy, Consultant
Program Evaluation
Division of Occupational Education
Department of Public Instruction
Raleigh, North Carolina 27611

Dr. Urwin Rowntree, Director
Adult, Vocational & Technical Education
Room 1309-A
J. F. Kennedy Federal Building
Boston, Massachusetts 02203

Mr. Robert Russell, Director
Chief of Data Processing – Vocational Division
225 West State Street
Trenton, New Jersey 08625

Mr. Harold Seltzer, Director
Occupational Research & Development
225 West State Street
Trenton, New Jersey 08625

Dr. Stephen Sworen, Chief
Administrative and Planning Services Division
Department of Education
P.O. Box 911
Harrisburg, Pennsylvania 17126

Professor David V. Tiedeman
College of Education – Gurler 204
Northern Illinois University
DeKalb, Illinois 60115

Mr. Robert Trombly
Twin State Educational Information Director
State Department of Education
105 Loudon Road
Concord, New Hampshire 03301

Dr. Robert M. Worthington
Associate Commissioner (former)
Adult, Vocational & Technical Education
Department of Health, Education and Welfare
Office of Education
Washington, D.C. 20202

Dr. Garth Yeager
Division of Vocational & Technical Education
Board of Vocational Education & Rehabilitation
1035 Outer Park Drive
Springfield, Illinois 62706

A RESEARCHER'S RESPONSE TO MISOE BECOMING AN OPERATIONAL MANAGEMENT INFORMATION SYSTEM FOR OCCUPATIONAL EDUCATION

David V. Tiedeman
Professor
College of Education
Northern Illinois University

A Model of MISOE's Past Growth

I had the pleasure of advising the Associate Commissioner, Division of Occupational Education, Commonwealth of Massachusetts to support construction of MISOE (Management Information System for Occupational Information) when, in the Spring of 1971, he was entertaining a proposal for its inception. I considered the potential value of MISOE to be evident even during insemination.

As MISOE entered the gestation of implementative planning in the ensuing 28 months, Dr. William Conroy kept the promise of MISOE's potential before me by reporting to me and consulting me from time to time. I was first pleased with Dr. Conroy's vision of the many uses and users of MISOE. Dr. Conroy dreamed large dreams for the child he was conceiving. I was next particularly delighted by his choice in that dream to have the acronym MISOE represent a Management, not just a Massachusetts Information System for Occupational Education. Although the samples which would actually go into a MISOE supported by the Commonwealth's Associate Commissioner for Occupational Education would be those dictated by the boundaries of his Commonwealth and specific duties, MISOE's conception is as applicable to Massachusetts' 49 sister states as it is to herself.

The MISOE is in one sense born with publication of this *Journal*. MISOE's implementative planning is concluded. The child is born. It remains for those who must decide either to accept and nurture or to reject and ignore the MISOE to determine whether this baby will have a childhood or not. I personally hope that the baby will be given a childhood. The baby is born healthy. The potential of the baby is great, just as its promise was in Spring, 1971. It currently remains for those of us who will benefit from its adulthood to decide to invest the money still needed to give it a childhood. Hence, it's important for us who have read what MISOE can be about to pause now and assess whether we wish to help it achieve its potential or not.

Reckoning What MISOE Currently Is

The reader is cautioned that MISOE presently exists only in potential, not in reality. Like the baby it is, MISOE is a corpus, capable of existence with further nurturing, but doomed to death without developmental financial nurturance in its immediate future. The articles provided by Dr. Conroy and his staff indicate in exquisite detail what MISOE can do, provided someone is now willing to invest in the data assembly and data analyses which are required to turn proposed, adjuvant, interactive-computational form into the needed reality. Dr. Conroy and his staff have taken all the steps needed to give the Commonwealth of Massachusetts the following capability:

1. A census of a few data for all schools including those offering occupational education within the Commonwealth (only very broad data will be collected in the census, but the census defines the population of schools which will be represented in the sample of schools);
2. Representative samples of schools which, because of the fine detail of their data, will permit extensive IPPI (input, process, product and impact) studies of occupational education in the Commonwealth of Massachusetts and its contrast with non-occupational education;
3. Cost data which will permit IPPI studies of occupational and non-occupational education to be undertaken with full attention to costs, benefits and relative effectiveness; and
4. An extremely powerful interactive computational system which gives a user flexible specification of (a) target groups, (b) the analyses he wants performed, and (c) the formats in which he wants his data reported.

In addition, Ms. Weinberger, Dr. Conroy and Mr. Garet have illustrated the versatility of the adjuvant, interactive computational facility which MISOE can be. Ms. Weinberger has given several rather clever examples of reports which an administrator will be able to get from an operating MISOE. Any administrator with technical leanings could not help but admire the reporting power which MISOE could put at his command.

Dr. Conroy went on and presented an advanced example of how an administrator can locate a problem among the data of his reports and cleverly query the system in order to find a path more likely to achieve what he wants within costs more reasonable for the elected procedure than for others. An educational researcher cannot help but admire the scientific method and technique which Dr. Conroy exemplified. MISOE invites administrators and policy makers to be applied scientists of the art of managing occupational education.

Finally, Mr. Garet has illustrated the quite considerable power which is envisioned for MISOE, namely inclusion of Forester's system of dynamic analysis. Dynamic analysis is not common in educational research or policy making and deserves a few extra words as a result. Most of what is investigated in educational research and policy making occurs within fairly closed and a priori systems. The result is that most of our investigations are more convergent than divergent. We lack inclination toward divergent thinking and its rewards of discovery. Yet we are day by day, year by year, gaining more evidence that more divergent than convergent thinking is needed in education. Old assumptions need the revitalization of new assumptions, as it day by day becomes more and more evident that old solutions are not up to new demands in education. Dynamic analysis offers visionary administrators the power to think divergently with a system that converges in its limits. This power stems from the fact that the administrator has to operate on his variables in dynamic analysis in order to move effects from a state which is not desired into another state which is desired. This requires that the administrator not alone think relationally as those of us in educational research have so far taught him to do, he must think functionally as well. He must chain effects into sub-systems in which *a* causes *b* and *b* causes *c*, etc. Means lead to ends but in the end the administrator will find that in reality one end merely becomes the means to a larger end, etc. Furthermore, he must begin to estimate rates in order to see how long it will take *a* to become *b*, etc., under his assumptions. Administrators who allow themselves time to become familiar with such technique and thinking will find that they can chart quite considerable pathways into the future with quite strong feelings that they know what is likely to happen within relatively narrow time spans, provided certain conditions can be made to exist. The effects which MISOE seek to cause in administrators would allow them to play with its capability for dynamic analysis in the same way which an insurance agent trys to influence his customers, namely to look into the future and its potential, relatively certain that consequences which are sufficiently detailed and clear will give the customer the personal conviction that he must act now, in such and such ways, to get what he seeks by "x" years from now. Dynamic analysis can build the consciences of occupational education's administrators to such a point that they become more rational guides, not the somewhat irrational guides they are, and will remain, in the absence of dynamic analysis in MISOE.

Although I intentionally accord MISOE great potential, I am realist enough to anticipate problems for MISOE as well. In order for MISOE to work, it must have data, not enormous sets of missing observations. It must be open to all users, not closed to many users. It must be consultative, not dictatorial. It must be synergistic, not competitive. Such conditions will not easily materialize. Some of the difficulties now readily discernible are as follows:

1. Local schools and the Commonwealth's Department of Education itself must all agree to participate in MISOE for it to work;
2. There are rather high implementative costs which must be borne to collect MISOE's data, maintain its data files, and operate it as a consultative, adjuvant, interactive-computational facility;
3. There are computational and display difficulties of high magnitude which must be worked through before the adjuvant, interactive-computational facility will become as commonplace and reliable as the telephone; and
4. The difficulties which naive users will at first experience will cause the near sighted to argue that a state facility ought to do the computation for a user, not provide the adjuvant, interactive, computational-capacity in which any Tom, Dick and Harry who thinks he can decide better than a legislator, the Commonwealth's Associate Commissioner for Occupational Education, or a local system's director of occupational education can actually test his assumptions.

Alternatives and a Recommendation

Since MISOE is funded annually, its continuation or discontinuation will be the major decision which has to be reached now that implementative planning is almost finished and implementation itself is becoming necessary, if the planning is to be given value. In this decision, immediate full or a phased implementation are alternative pathways which can be followed, should implementation be elected. My recommendation is by all means for implementation, but I suggest a phased rather than an immediate full implementation. Why?

Rationale for Recommendation of a Phased Implementation

Readers experienced in operating data files within the context of an adjuvant, interactive, computational capability can readily understand why I recommend a phased implementation of the MISOE. At the present time MISOE's data files do not exist, except as examples. In addition, MISOE's computational routines appear so far to have been exercised merely in terms of the examples reported by Ms. Weinberger, Dr. Conroy and Mr. Garet above. Actual data and computational routines have yet to meet each other. Those experienced with computer operations know that many difficult hours lie ahead for those who would make an adjuvant, interactive, computational-facility out of that meeting. There is a need for as yet unwritten editing routines for both the data files and the output programs. Despite such programs, inevitable errors in data files and output routines creep through even the most rigorous editing routines and will cause difficulties for awhile. Intermediate applications programs will be needed to approximate optimization of data recovery and use in the various forms of problems which will be attacked. In addition, educational researchers and educational policy makers are not very experienced in asking product and impact questions simultaneously in a system of input and process data as well. Experience will therefore have to emerge in the handling of cost data in relation to output data. These conditions together suggest that at least 12 months of intensive trial effort in the operation of the adjuvant, interactive, computational-faciltiy will be necessary.

Although the need for more trial and experience with the operation of an interactive computational facility seems self evident at this time, it is still necessary to make a positive overall implementation decision at this time. The big problem for MISOE is initiation of its data file. This requires the Division of Occupational Education in the Commonwealth of Massachusetts resolutely to direct acquisitions of the data called for in MISOE's detailed implementative plan. Both local school systems and the Commonwealth's Department of Education itself will be sources of the required data. Hence cooperation of these groups will be needed and should be obtained as early as possible in coordination with the further development of the adjuvant, interactive, computational-facility. There will be no reason for the latter in the absence of the former.

The genius of the MISOE plan lies in the expectation that it will operate as a network. Data are to be assembled at local and Commonwealth levels. Computational power is being arranged to address questions in local program invention and operation, in Commonwealth program invention and operation and in legislative policy making. There are fortunately no present plans to restrict address of any part of the system to any class of user. This means that in addition to the questions appropriate to the level at which each works, local program administrators can ask Commonwealth and legislative questions, Commonwealth administrators can ask local and legislative questions, and legislators can ask local and Commonwealth questions. In contradistinction to present suspicions which currently limit each group to the questions at only its own level, MISOE can therefore materially increase communication and understanding among local and Commonwealth administrators and legislators. Through MISOE each can satisfy himself that the other is doing the best he can or else generate data publicly transmissable which ought to convince the party in need of change of the bases on which that change ought to be predicated and pursued.

The creation and operation of a network requires leadership and finesse. MISOE as a network intends to operate as a consortium. Funds will have to come from both local and Commonwealth sources for data collection, filing and analysis and for the continual consultation with users which is required in operation of an adjuvant, interactive, computational-facility. The Federal government, additionally, has to be interested in generalizing MISOE to the several United States, thereby creating a fourth level at which MISOE can operate. However, Federal participation should not be expected other than in development at the moment. The Commonwealth and its local systems will have to lift themselves by their own bootstraps in the actual operation of their consortium for awhile before the Feds are likely to become convinced that MISOE is a good valuable to Massachusetts' sister states as well.

With annual renewal of funding being the momentary situation, the Division of Occupational Education has to address the problem of leadership in MISOE with considerable care. Effective and efficient operation of MISOE requires the ability, interest and dedication currently exhibited by those who conceived and planned it. However, personnel of such quality are not likely to remain interested in a project in which the Commonwealth annually wavers in its support. Hence the present key to MISOE's childhood principally rests with the Division of Occupational Education and its resolve to press forward, despite the difficulties which can now be foreseen and will inevitably arise, even though all are not now foreseen.

The Division of Occupational Education would do well to separate kinds of costs in planning for a phased implementation of MISOE. Data collection will require a considerable initial investment in forms and training. Some of these costs need to be borne by local school districts. They will be receiving advantages by securing such data and addressing questions to them which are relevant to local school operation. There will be other data which the Division of Occupational Education will have to provide as well. Hence data collection costs will be at the Commonwealth as well as the local level.

The machine reading and inputting of data into MISOE will be a continuing cost which needs to be borne by the Commonwealth. Local systems will benefit from their own data, but the Commonwealth's benefits need to be borne both by school and for the Commonwealth as a whole.

The creation of master files of data and the provision of a capacity to process the files when analyses are desired will be costs which the Commonwealth will also need to support. There may well be questions which individual users ask that are sufficiently esoteric to assess data processing and analysis costs directly upon them. However, the Commonwealth will have to provide some general money in support both of data processing and of empowering users to ask and get questions answered without having to secure special grants in aid every time a use is anticipated. Nothing will bring about the demise of MISOE faster than a premature use-by-use fee which must be paid in order to secure use. The policy matters which can be addressed by MISOE are currently sufficiently unfamiliar to most educational administrators to require a period of general support to provide the education which will permit them to know what useful questions they can get answered and to make those personal decisions which give local school funds in support of worthy questions they want to address to MISOE with some regularity.

Finally, continual system improvement will have to be provided for MISOE. A data file deteriorates without continual care and improvement, just like a library deteriorates from lack of use and attention. The current plan is that the interactive, computational-facility will expand as individual uses are programmed and serviced. This represents good financial planning; the system is not over-programmed in the beginning and the programs which are developed are those for which use can be anticipated. However, the problem with case-by-case construction of a system is that it quickly becomes a non-system. That is, if each case is not programmed with some larger system in mind each time, the case remains an example, it does not become a capacity which can be used later with greater generality. Thought and attention must therefore continually be given to computational facilities in which examples are to become general cases of computational functions rather than singular computations. Costs of this attention is what is meant by the improvement costs which MISOE needs to anticipate and secure.

Problems will also arise in the operational management of improvement in MISOE. Programmers in their selection, writing and operation of established programs with new sets of data are ordinarily inclined to insert small improvements gratuitously. Such improvements are fine when they operate correctly the first time. However, difficulty frequently arises from small errors in modifying established but less efficient programs and production and accuracy tend to suffer. The result is that data files operated in conjunction with an adjuvant interactive computational facility can quickly become so confusing to everyday operation that production drops off. The workable answer to this condition so far derived has been ruthlessly to separate production runs from developmental runs and to incorporate well proven and tested developmental programs into the main stream programs only from time to time. Management decisions such as this lie over the near horizon for MISOE, should it become a regularly producing system.

Administrators are likely to use MISOE as they might a chauffered automobile, namely to have someone drive MISOE for them. This will defeat the ultimate purpose of MISOE, which is to have all administrators interactively lend their minds to MISOE so that administrators might together improve education by improving the game of educational decision-making. MISOE will therefore have to anticipate that fear of the unfamiliar will circumvent its main purpose and must do whatever is within its power at all times to disspell that fear and encourage familiarity.

A Model for MISOE's Future Growth

I began this comment by presenting a model of MISOE's growth. The model I elected to use was that of human conception and development. Within the model of human growth and development I assessed MISOE's current state representing it as that of the new born child, a bundle of high potential and great need for a financial environment in which that potential can be realized. I then went on to challenge the local schools of the Commonwealth of Massachusetts and those who might help financially in further development from the Federal level to provide that environment. However, the Associate Commissioner's Office of the Division of Occupational Education in the Commonwealth currently faces the dilemma of honoring its paternity and continuing to nurture the bundle of potential it has so far brought to the wonderous state of visibility in the world or not. I have recommended that the Associate Commissioner of Occupational Education elect the course of undertaking MISOE's implementation, but that he do so in a phased program, not an all out program starting immediately. MISOE needs to start collecting data. But MISOE also needs 12 months of intensive testing of its basic paradigms and programs, using live rather than contrived data, before it represents itself as an operating interactive, computational-facility.

Should MISOE be given a childhood as I recommend, MISOE's parents can very well later expect some of the pains of adolescence to follow the joys of MISOE's childhood. As MISOE grows it will demand new things of those who have so far served the System on terms they attributed to it, not terms which a young and boisterous MISOE can and might later demand. These will be the times when administrators who prefer to administer without developed and used personal skills in numerical analysis of education and societal data will receive their trial by fire, the trial of either changing themselves to operate with new power because of added adjuvant, interactive, computational-capability, or to wither without daring to change.

MISOE holds considerable potential for good in our common development of an Educating Research Machine Game. Let's help MISOE to have a childhood and face the trials and tribulations of its adolescence when they arrive a decade from now. Doing well later by doing good now is greatly to be desired.

AN ECONOMIST'S RESPONSE TO MISOE

Dr. Jacob J. Kaufman
Director and Professor of Economics
Institute for Research on Human Resources
The Pennsylvania State University

The Massachusetts Information System for Occupational Education (MISOE) has certain basic characteristics which are essential for decision-making in a society which is confronted with limited resources and virtually unlimited social needs. It is the purpose of this article (1) to describe these characteristics; (2) to review and discuss briefly some of the alleged limitations of such an approach; (3) to indicate the potential value of such an information system.

Characteristics of MISOE

Rationality. The basic characteristic of MISOE is its rationality. By rationality is meant that decisions to allocate resources are consistent with the objectives which the decision-maker wants to achieve. This requires the presentation of alternatives to the decision-maker, each of which describes the resulting social benefits and costs.

Computerization. The information obtained by MISOE is computerized in a manner which allows the decision-maker to interact with the computer as he pursues a series of questions designed to produce answers which will assist him in making a decision, in the form of alternative lines of action.

Cost Effectiveness. MISOE is organized in such a manner as to provide information not only on outcomes but also on costs, operating on the principle that no outcome is "good" unless related to costs, and no action is "cheap" unless related to outcomes.

Trade-Offs. The emphasis of MISOE is that there are always alternative lines of action and that each line of action has both advantages and disadvantages. Therefore, the decision-maker is confronted with the problem of "trade-offs", namely, what is he willing to give up in order to obtain a certain outcome. The system will not yield this particular answer but will provide the information to the decision-maker who can then make the judgment.

Planning. MISOE provides the basic ingredients for planning. In the past, planning in education usually involved the making of projections in such areas as enrollments, teachers, building construction, etc. Under MISOE planning involves more than this. It attempts to predict the outcomes or consequences — favorable or unfavorable — of certain lines of action. Such an approach involves the development of a theoretical model which permits such predictions. Such a model is required because decision-makers usually fail to take into account the large number of variables or the complex interaction of the variables on each other.

Alleged Limitations of the MISOE Approach

Any attempt to introduce an information system that involves the application of rationality to decision-making frequently results in the misinterpretation or misconception of the processes involved. Several of these can be discussed.

The Pass-Fail Phobia. Any information system designed to determine outcomes and costs is looked upon by those affected as a method by which they will be held "accountable." Actually, although "accountability" is involved, MISOE is primarily a system which provides a feedback mechanism by which corrective actions can be taken in order to produce better the desired outcomes. Thus, it permits the decision-maker to make better decisions and by "better" one means to achieve better results.

Difficulty of Quantification. One of the most common criticisms is that certain "things" cannot be quantified. If this criticism can be changed to certain things are difficult to quantify, the criticism is legitimate. The only response is every effort must be made to quantify certain qualitative outcomes. This can be done by the development of new instruments or obtaining "proxies" for certain outcomes.

Inadequacy of Data. In the development of any management information system, it is usually found that the data which heretofore has been submitted for legislative and fiscal accountability are not satisfactory for decision-making purposes. Frequently, concern is expressed over the "added burdens" of submitting additional information. A solution to this problem would be (a) to determine what kinds of data currently being submitted can be eliminated; and (b) to utilize sampling techniques for certain types of data. Despite this concern, the willingness to submit additional data will depend on the usefulness to the recipients of the various reports generated by the system.

Potential Value of MISOE

From an economist's point of view, given limited resources available, it is essential that a given amount of resources should achieve maximum outcomes or given outcomes should be achieved at the least possible costs. MISOE is designed to achieve this goal. As indicated previously, given the virtual array of unlimited social needs, it is incumbent on each decision-maker to utilize this process. As social needs increase, each decision-maker will be facing increasing competition for resources. The failure to develop a management system along the lines indicated by MISOE might well result in the curtailment of a particular social program, if the administrator cannot account for the outcomes of his program.

REFERENCES

Alker, Hayward R., Jr., and Christensen, C. From Casual Modelling to Artificial Intelligence: The Evolution of UN Peace Making Simulation. In. J. LaPonce and P. Smoker (ed). *Experimentation and Simulation in Political Science.* Toronto: University of Toronto Press, 1972.

Astin, Alexander. *Link System for Longitudinal Research,* American Council on Education, Washington, D.C., (Technical Report), 1969.

Astin, Alexander and Molm, Linda. *Correcting for Non-Response Bias in Follow-up Surveys, Unpublished Manuscript,* American Council on Education, One DuPont Circle, Washington, D.C., 1972.

Bellman, Richard. Mathematics and the Human Sciences. In John Willenson *et al. The Dynamic Programming of Human Systems.* New York: Center for the Study of Democratic Institutions, 1973.

Biderman, Albert D. Social Indicators and Goals. In Raymond A. Bauer (ed). *Social Indicators.* Cambridge: The MIT Press, 1966, 68-153.

Bisco, Ralph. *Data Bases, Computers and the Social Sciences.* John Wiley, New York, 1970.

Brunner, Ronald D., and Brewer, Garry D. *Organized Complexity: Empirical Theories of Pollitical Development.* New York: The Free Press, 1971.

Buros, O. K. *Mental Measurement Yearbook.* New Jersey: The Gryphon Press, 1965.

Coleman, James, *et al. Equality of Educational Opportunity.* U.S. Department of Health, Education and Welfare, U.S. Government Printing Office, 1966.

Corazzini, A. J. The Decisions to Invest in Vocational Education: An Analysis of Cost and Benefits, *Journal of Human Resources,* Vol. 3 (Supplement, 1968), 88-120.

Data Base Management Software Systems, Models: 202, 204, Computer Corporation of America, 575 Technology Square, Cambridge, Massachusetts, 1972.

Denison, E. *The Sources of Economic Growth in the United States,* (Committee for Economic Development), 1962.

Deutsch, Karl W. *The Nerves of Government: Models of Political Communication and Control.* New York: The Free Press, 1966.

Doeringer, Peter B. Low Income Labor Markets and Urban Manpower Programs: A Critical Assessment. *Research and Development Findings,* No. 12, U.S. Department of Labor, Manpower Administration, 1972.

Downey, G. F. *Cost-Benefit Study of Vocational Education in the Haverhill, Massachusetts School System, Doctoral Dissertation,* University of Michigan, Microfilm, June, 1971.

Downey, G. F. *Survey of Information Status of Occupational Education in the Commonwealth of Massachusetts,* publication of the Research Coordinating Unit, Massachusetts Department of Education, June, 1971.

Eckstein, O. *Public Finance,* Prentice-Hall, Inc., 1967, 8-10.

Emshell, James R. and Sisson, Dale L. *Design and Use of Computer Simulation Models.* New York: Macmillan Company, 1970.

Etzioni, Amital. *The Active Society: A Theory of Societal and Political Processes.* New York: The Free Press, 1968.

Forrester, Jay W. *Urban Dynamics.* Cambridge: The MIT Press, 1969.

Forrester, Jay W. The Counterintuitive Behavior of Social Systems. *Technology Review,* 1971, 73(3), 52-68.

Forrester, Jay W. *World Dynamics.* Cambridge: Wright-Allen Press, 1971.

Fox, Karl L. *Economic Analysis for Educational Planning,* Maryland: John Hopkins University Press, 1972.

Garet, Michael S. *Occupational Life in Massachusetts.* Unpublished. Available from Management Information System for Occupational Education, Division of Occupational Education, Department of Education, Commonwealth of Massachusetts, 1973.

Gordon, David M. *Theories of Poverty and Underemployment: Orthodox, Radical, and Dual Labor Market Perspectives.* Lexington, Massachusetts: Lexington Books, 1972.

Harrison, Bennett. Employment, Unemployment and Structure of the Urban Market. *Wharton Quarterly,* VI (3), Spring, 1972.

Hirshleifer, J., *et al. Water Supply – Economics, Technology, and Policy.* University of Chicago Press, 1960, 1958-59.

Jencks, Christopher, *et al. Inequality: A Reassessment of the Effect of Family and Schooling in America,* New York: Basic Books, 1972.

Little, John D. C. Models and Managers: The Concept of a Decision Calculus. *Management Science,* 16(8), 1970.

Nie, Norman, Bent, Dale and Hull, C. Hodlas. *Statistical Packages for the Social Sciences.* New York: McGraw Hill Book Company, 1970.

Piore, Michael J. On-the-Job Training of Disadvantaged Workers. In Arnold R. Weber *et al. Public-Private Manpower Policies.* Industrial Relations Research Association, 1969, 101-132.

Pugh, Alexander L. III. *Dynamo User's Manual.* Cambridge: The MIT Press, 1970.

Roberts, Edward B. *The Dynamics of Research and Development.* New York: Harper and Row, 1964.

Roberts, Edward B. *Program-Client Interaction in Education.* Unpublished. Alfred P. Sloan School of Management, Massachusetts Institute of Technology, 1972.

Schultz, T. Investment in Human Capital, *American Economic Review,* Vol. LI, p. 16, March, 1961.

Systems Analysis for Educational Planning, Organization for Economic Cooperation and Development, Paris, France, 1969.

Travers, William. *Introduction to Educational Research.* New York: Macmillan Company, 1969.

U.S. Department of Health, Education and Welfare, Office of Education, and U.S. Department of Labor Manpower Administration, *Vocational Education and Occupations,* U.S. Government Printing Office, Washington, D.C. 1969.

U.S. Employment Service, Division of Employment. *Dictionary of Occupational Titles,* U.S. Government Printing Office, Washington, D.C., 1949. (regularly updated).

Weisbrod, B. A. *External Benefits of Public Education.* Industrial Relations Section, Princeton University, 1964, p. 18.

Wilensky, Harold L. *Organizational Intelligence: Knowledge and Policy in Government and Industry.* New York: Basic Books, 1967.

Wilile, Douglas J. and Beightlen, Charles. *Formulation of Optimization.* New Jersey: Prentice Hall, 1967.

XSTAT Statistical System, Dynamics Associates, 44 Brattle Street, Cambridge, Massachusetts, 1970.

Yourdon, Edward. *Design of On-Line Computer Systems.* New Jersey: Prentice Hall, 1972.

BRIEF NOTES ABOUT CONTRIBUTORS

Martin P. Breslow is Research Associate, Project MISOE, Division of Occupational Education, Commonwealth of Massachusetts. (MISOE computer system design, co-developer MISOE-CDS) He received the B.A. from Queens College, City University of New York. He received the M.S. from Tufts University and is presently working toward the Ph.D. in Experimental Psychology. Before becoming a part of Project MISOE he had a NDEA title IV fellowship; was Teaching Assistant at Tufts University; and also served as a Research Assistant in Visual Perception at Tufts University. He has authored and co-authored several papers.

Charles H. Buzzell is Associate Commissioner, Division of Occupational Education, Massachusetts State Department of Education. He received the B.S. in Industrial Arts from Teachers College of Connecticut, New Britton, Connecticut; the M.A. in Guidance and Psychology from University of Connecticut, Storrs, Connecticut; and the Ed.D. in Vocational Education from Rutgers University, New Brunswick, New Jersey. Prior to his current position, he served as Director, Bureau of Professional Services, Division of Vocational Education, New Jersey Department of Education; co-ordinator, National Leadership Training Institute; Assistant Director of COPE, Rutgers University Graduate School of Education, Department of Vocational-Technical Education; and as Instructor of Industrial Education Department for Central Connecticut State College, New Britton, Connecticut. In addition, he has also served as a counselor and teacher in various high schools. Before becoming an educational professional, Dr. Buzzell had several years of industrial experience and also holds an Honorable Discharge from the United States Coast Guard. With one invention to his credit, Dr. Buzzell has served in the role of principal researcher for a number of very important projects. He is author and co-author of many articles in the field of vocational education.

William G. Conroy, Jr. is Principal Investigator of Management Information Systems for Occupational Education (MISOE), Division of Occupational Education, Massachusetts Department of Education. He received the B.A. from American International College and the M.Ed. and Doctorate from the University of Massachusetts. Before becoming Principal Investigator for MISOE, Dr. Conroy was Director, Research Co-ordinating Unit, Massachusetts Department of Education, and Principal of New Salem Academy, New Salem, Massachusetts. He has also served as a teacher in several high schools in the state of Massachusetts. He has served as consultant to the U.S. Office of Education on Evaluation of Occupational Education; as Advisory Council Member of the Educational Leadership Development Program for the University of Connecticut; and as discussion leader at several important conferences. Dr. Conroy is the author of many papers and articles which have been published in various technical and vocational journals, both in the United States and abroad.

John A. Creager is Division Director, Division of Educational Statistics, American Council on Education, Washington, D.C. He received a B.S. in Chemistry from Rutgers University, and an M.S. and Ph.D. in Psychology from Purdue University. He was Research Associate, Office of Research, American Council of Education, Washington, D.C., prior to being appointed Division Director for that same Council. He has served as Research Psychologist in charge of Fellowship Selection Research, Office of Scientific Personnel, National Academy of Science, Washington, D.C., as Research Psychologist, Personnel Research Laboratory, Lackland Air Force Base Texas; Teaching Assistant and Research Assistant at Purdue University; Research Assistant, the Squibb Institute for Medical Research; and Research Assistant U.S. Naval Research Laboratories, Bellevue, D.C. Dr. Creager served as consulting editor for the Journal of Experimental Education from 1967-72. He has a total of seventy-nine publications to his credit, excluding a number of special reports, notes, working papers, and presentations at professional meetings.

Gerald F. Downey is a consultant to the Department of Education, Division of Occupational Education, Massachusetts State Department of Education. He received a B.S. in Business from Northeastern University; an M.B.A. from Northeastern University; and an M.A. and Ph.D. in Economics from Boston College. Dr. Downey is an Assistant Professor of Economics and Management at Lowell Technological Institute, Lowell, Massachusetts. He has also served as Instructor at Northeastern University, Boston, Massachusetts. He is the author of several papers and articles, as well as technical reports, and co-author of several technical reports. He also has one book to his credit.

Michael S. Garet is a resident consultant to the Management Information System for Occupational Education, Division of Occupational Education, Massachusetts Department of Education. He received a B.S. in Mathematics from California Institute of Technology, and is presently working toward a Doctorate at the Sloan School of Management, Massachusetts Institute of Technology. He was a member of the research staff evaluating the National Assessment of Educational Progress, Center for Educational Policy Research, Harvard Graduate School of Education and has been involved in numerous research programs at various universities in the United States. He is author of three articles, and co-author of another, all of which have been published.

Jacob J. Kaufman is Professor of Economics and Director of the Institute for Research on Human Resources, Pennsylvania State University. He received the A.B. from Brooklyn College, the M.S. from Columbia University, and the Ph.D. from Columbia University. He served as a lecturer for the New York State School of

Industrial and Labor Relations, Cornell University; as Assistant Professor of Economics at the University of Buffalo; and as Statistician and Economist for the Federal Government in the Resettlement Administration National Resources Committee, Securities and Exchange Commission, National Labor Relations Board, Farm Security Administrations, and War Assets Administrations. Dr. Kaufman is the editor of many books and articles in the fields of unemployment, labor training and retraining, and related subjects. A great many of his publications are involved with vocational-technical education, and the role it plays in teacher education plans.

William Kyros is Project Officer, Product Data System, Management Information System for Occupational Education, Division of Occupational Education, Massachusetts Department of Education. He received a B.S. from Lowell Technological Institute, Lowell, Massachusetts, and the S.M. from Massachusetts Institute of Technology, Cambridge, Massachusetts. He was previously Head Administrative Assistant, Bureau of Financial Management, Division of State and Federal Assistance, Massachusetts Department of Education; Supervisor in Education, Office of Trade and Industry, Division of Occupational Education, Massachusetts Department of Education; Senior Staff Engineer for AVCO Corporation and Instructor at the Lowell Technological Institute.

David V. Tiedeman is Professor of Education, Department of Education, Northern Illinois University, DeKalb, Illinois. He received his A.B. from Union College; an A.M. from the University of Rochester; and the Ed.M. and Ed.D. from Harvard University. He previously served as Director for Project TALENT and the Institute for Research in Education, as well as Assistant Director of the Palo Alto Office, American Institute for Research. Dr. Tiedeman was Chairman of the Executive Committee, Harvard NEEDS-Newton Information System for Vocational Decisions, Graduate School of Education, Harvard University, as well as Associate Director for the Center of Research and Careers, Graduate School of Education, Harvard University. He was Professor of Education at the Graduate School of Education, Harvard University and prior to that was an Associate Professor in that same institution. He has also been a lecturer and an instructor for Harvard University. Dr. Tiedeman has been widely published in various educational and technical journals, both as author and co-author.

Elizabeth Weinberger is Research Associate for Project MISOE, Division of Occupational Education, Massachusetts Department of Education. She received a B.A. from Queens College, Flushing, New York, and an M.S. from Tufts University, Meadford, Massachusetts. She served as Research Assistant at Boston State Hospital and as a Teaching Assistant at Tufts University in the Psychology Department. She has been involved in many research projects and had papers published in connection with those projects.