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ABSTRACT

Any state-level postsecondary education agency could perform its job more effectively through discriminate use of the available technology of informational and analytic planning approaches. The paper attempts to increase an awareness of how data, analytic techniques, and their product information should be used to assist state-level academic planning. An introduction is offered to the available products for collecting and structuring data and to three general levels of analytic capability. Some of the shortcomings of those approaches are also identified, and suggestions for amelioration are made. (MSE)

Orwig

# ANALYTIC AND INFORMATIONAL SUPPORT FOR STATE-LEVEL ACADEMIC PLANNING

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## I. Introduction

### A. Purposes of This Paper

This session of the seminar was established for at least three distinct reasons. The primary purpose is to present an overview of the applications of analytic techniques and management information in the performance of academic planning in state-level postsecondary education agencies. To this end, this paper heroically attempts the impossible. It is designed to be responsive to the needs of a variety of academic planners, including both those with little previous exposure to analytic and informational approaches as well as those who are at the cutting edge in the development of such approaches. The paper also is designed to acquaint the practitioner with these various techniques in a generic sense and to provide information about specific products or tools which are currently available. Owing nothing to their generic nature, but rather deriving from the locus of the authors, particular (and perhaps undue) emphasis will be given to those products available through the National Center for Higher Education Management Systems.

A second reason for this session concerns the evaluation of the available technology. While the paper includes some evaluative comment, we are anxious for members of the audience to share their experiences with, and their assessments of, the various approaches which we will discuss.

The final purpose of this session is to provide a forum for the discussion of needed development in these areas. Our paper will describe the results of a recent NCHEMS assessment of developmental needs, both in terms of requirements for new types of products as well as the desirability of reorientation of existing tools. As with the evaluation theme previously discussed, it is hoped that our comments will provide a springboard for audience discussion on product development.

B. Relationships Between the Conference Theme and the Topic of This Paper

Most of us will recognize that the conference theme, "The Maintenance of Academic Quality in a Time of Uncertainty", is a most timely one. Several key words in this conference theme are useful in relating the purposes of this particular session to that of the overall conference. The term "maintenance" implies managing on an ongoing basis. In turn, this suggests that monitoring would be a common activity toward this end. The process of monitoring requires the acquisition and analysis of information to determine that the planned course is being maintained.

"Quality" suggests assessing or measuring against some predetermined or desired standard. Quality frequently has been measured with operational data, e.g., student teacher ratios, although more recently there has been a trend toward the collection and analysis of information about the outcomes of academic programs rather than focusing exclusively on operational characteristics.

The "time of uncertainty" term is both the key phrase in the conference theme and offers the strongest link to this particular session. The term implicitly suggests the acknowledgement of an unknown future. Those who wish to manage and prepare (maintain quality) for this uncertain fate must develop projections of the alternative futures possible and analyze the state of the enterprise under many various assumptions. Generally, data and information are used to describe these future conditions and analytic techniques such as the use of simulation models to understand the relationships of various emerging trends. Thus, we believe our topic is of the utmost relevance to those who wish to aggressively pursue "the maintenance of academic quality in a time of uncertainty".

C. Characteristics of State-Level Academic Planning Which Require Information and Analysis

Compared to academic administration at other levels, there are several characteristics unique to the state level which require a greater reliance on informational and analytic techniques in academic planning. For instance, any academic department chairman is able to make many decisions based on a first hand knowledge and observation of the operation. Through personal contact, the chairman knows how many students are graduating, how many are expected in the new class, how many faculty are planning retirement or transfer, and how much salary to pay faculty to remain competitive in the field. The state-level academic planner possesses few, if any, of these personal insights due to the sheer volume of the operation alone.

Instead, the state-level planner must rely on impersonal, comparative data to monitor and to assess activities in these same areas unless he can build networks among the users and providers of information.[1]

Most state agencies usually are expected to treat constituent institutions on an objective basis. While peer review has been employed in certain types of decisions, and perhaps most frequently to provide for qualitative assessments, generally the drive for objectivity translates into decision making based on quantitative criteria. Such quantitative information takes many forms ranging from the use of raw data to the application of analytic techniques.

Finally, the state-level postsecondary education agency is expected to perform a dual role. While for many purposes it is considered part of the academy, its other role, that of being an agency of state government, generally requires it to integrate postsecondary education activity with that from other governmental programs. This usually is accomplished by translating postsecondary education information into much more general formats which are descriptive of overall governmental purposes. This, in effect, allows the governor and other state government officials to treat the various state agencies with the same objectivity that the state postsecondary education agency attempts to employ in its relationships with the academic institutions.

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[1] Hefferlin and Phillips made a similar point in their discussion of the administrative problems resulting from inadequate information in rapidly growing institutions (Hefferlin and Phillips, pp. 2-3).

D. Changing Trends in State-Level Academic Planning

The last decade has seen significant shifts in the types of activities engaged in by state-level academic planners.[2] Only ten years ago most of us were concerned with understanding and responding to growth. Planning topics included opening new institutions, expanding degree offerings within existing institutions, and building new facilities. Although different states are encountering somewhat different trends, most of us do not experience such situations currently. Instead, the emphasis responds to the economic concept of scarcity--whether it is the scarcity of funds or the scarcity of students.[3] This recognition has led to more thorough evaluative activities and to a greater emphasis on articulating institutional purpose. Most would agree these new varieties of planning activities are much more difficult from both the technological and the human behavior perspectives.

Just as the emphasis in academic planning has shifted, so have the trends in informational and analytic techniques. A decade ago the relevant topics were enrollment projection models, facilities construction models, and procedures to evaluate the readiness of new degree programs. Newer

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[2]Millett discusses these trends in terms of the demands being placed upon chief executive officers of state boards (Millett, pp. 67-68).

[3]An interesting parallel, described by Orlans, is the attempt of a prestigious commission to plan for the year 2000. The Commission's initial work was premised on a vision of an expanding economy which did not evolve. Thus, the efforts to optimally invest the "fiscal dividend" that derives from economic growth were not helpful when the problems were recession, inflation, energy shortages and the fiscal burdens of established social programs (Orlans, pp. 30-36).

techniques are also concerned with many of these same topics, but the approaches are now much more complex and sopisticated. Enrollment models are expected to be much more precise, more responsive to a wider variety of predictive factors, and more specific at greater levels of detail in projecting future students. Program review techniques now encompass the assessment of existing programs with the results of such studies frequently leading to program consolidation and, in some cases, even closure.[4] As in the enrollment projection example, the information needed to determine the desirability of closing an academic program is expected to be much more accurate and in much greater detail than that which was used for deciding on program expansion. Modeling techniques have grown from simulation approaches to optimization methods where the planner is trying to achieve a maximal outcome with limited resources.

Changes in informational approaches to decision making are resulting not only from the changing requirements of state-level academic planning, but also from changes in information technology itself. Indeed, as a recent IBM advertisement notes, we are now entering the information age.

> "Human history has long been described in terms of ages whose names reflect the stages of development through which mankind has passed: the Stone Age, the Bronze Age, the Iron Age and so on--down to the Industrial Age, which established the foundation of our modern society.
>
> Today, there is growing agreement that we have entered a new era, a post-industrial stage of development in which the ability to put information to use has become critical, not only to the essential production of goods, but to efforts to provide a better life to the individual, as well.

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[4] Callan suggests that program review activities will need to be especially rigorous to provide justification to the legislative and executive branches (Callan, p. 18).

This new era is being referred to with increasing frequency as the Information Age.

Changes in our perception of information itself--its nature as well as its scope--have accompanied this profound shift of emphasis in our society". (Saturday Review, June 11, 1977, pp. 22-23.)

In this paper we will attempt to discuss these trends in informational support for academic planning in more specific terms and to focus on the direction of changes to come.

E. A Framework for Analysis of Informational Techniques

As the previous paragraphs implied, application of informational and analytic techniques has been and continues to experience stages of development. For purposes of this paper, it is useful to consider information to be comprised of at least two distinct parts. First, there is the raw data itself. For the academic planner, such raw data might include such data elements as the number of students, the number of student credit hours taught, the number of faculty, faculty salary expenditures, the number of library volumes, or the number of degree programs. For a limited number of purposes, data alone are sufficient for the planning need.

Data, however, can increase in utility through the application of analytic techniques, the second component of our framework. Analytic techniques can vary according to their complexity and sophistication. At the lower end of this continuum, such analyses as average faculty salaries, average student loads, student/teacher ratios, and other descriptive, statistical relationships between data elements are common as measures of phenomenon

considered relevant to different decisions. The middle range of sophistication or complexity is characterized by such activities as faculty activity analysis, induced workload matrices, and facilities utilization studies where the planner seeks to analyze the operations of the institutions and the academic programs in the institutions. Among the more complex types of analyses are simulation studies, where many types of data and analytic techniques are brought together to examine their interrelationships, and optimization studies which employ linear programming, goal programming, and other advanced mathematical techniques. It is important to note that a third component of information exists, namely opinions, values, and other subjective assessments. While this paper does not deal directly with this category of information, the underlying premise of this paper is that quantitative information and analysis is effective to the extent that it supports, rather than supplants, the use of judgement in decision-making.

In the next two sections we will attempt to provide brief summaries about (1) types of data and data structuring conventions, and (2) the various levels of analytic activity. As part of each summarization, we will discuss both current and planned NCHEMS activities related to the particular topic and the better known products developed by other researchers.

## II. Data and Data Structures for Academic Planning

### A. Issues Concerning Data Collection

The planner who engages in data collection faces a number of issues concerning what data to collect and how to collect it. These issues

include technical considerations, analytic considerations, and concerns for the relative roles of the agencies and institutions involved.[5] The identification of what information to collect for planning and how to collect it rests fundamentally upon some explicit or implicit conception of a planning process and of the role that information will plan in such a process. There are various trade offs to be considered in data collection and analysis that impose different costs on both the providers and users of information. This is perhaps the least well developed and most frequently ignored step in planning for the collection and use of information.[6]

Most statewide planners find that "snapshot" data is sufficient for their purposes. Such point in time data, e.g., enrollment as of October 1, as compared to on-line operating data, is often considerably cheaper to obtain and is reasonably accurate since institutions tend to have much the same characteristics for a semester, or even a year, at a time. An issue where state agencies are more divided concerns the collection of summary versus individual-specific data. Proponents of individual-specific collection (individual student enrollment data, individual faculty salary and activity data, etc.) cite the advantages of not being confined to any particular data structure and being able to reorganize the data for any

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[5] Wellman provides a good discussion of problems in developing state-level management information systems (Wellman, pp. 114-115).

[6] For an example of an initial attempt at articulating the assumptions underlying the development of an information base and for a description of refinements that are still required in individual states, the reader may wish to review Chapters I, II, and III of (Jones, et. al., 1977).

policy issue that arises. Proponents of summary data collection frequently mention that this approach prevents the state agency from assuming institutional management perogatives and the cost of data collection is minimized.

Another set of related data collection issues pertains to the quality of the data. Data quality concerns include validity, reliability, accuracy, and comparability. The validity question focuses on whether the data element measures what it was intended to describe. The accuracy issue is concerned with the correctness and precision of the data. For data to be reliable, one would expect that if the same data were sought more than once, the answer would be the same each time. Finally, the concerns for data comparability address an issue which is especially important at the state level, namely when collecting data from two different sources, does it describe a similar subject in a similar way? Given these data quality objectives, there are several steps which can be taken. In attempting to collect data, the planner should attempt to provide definitions which are mutually exclusive, do not require significant judgement by the data provider, and have been agreed to by the collectors and providers.

Another major issue in data collection for the state-level academic planner concerns the timeliness of the information. While data can be a particularly valuable resource in planning, its utility is greatest when it is available at the time when it is needed. The planner may enhance the probability of receiving timely information if he establishes

data collection plans and schedules which enable integration of data reporting systems with operational management systems and/or planning systems and allow providers to anticipate needs with sufficient lead time.[7]

Finally, an issue of major importance concerns the cost of the data collection effort. The planner must ask himself if the cost of the data collection effort that is incurred by both the collector and the provider is warranted by the potential use. Data collection costs are minimized when the data collection plan remains stable over a reasonably long period of time and the collection plan is integrated with other data collection efforts. Not incidentally, use of these same criteria generally increases the accuracy of the data collected.

B. Types of Data Useful to the Academic Planner

As we noted in the previous section, the data required for academic planning is derivative of the specific process that is used. Nevertheless, it might be possible to generalize that data for academic planning can be collected in two different ways. On the one hand, data can be collected as part of a specific planning process or activity such as program review--i.e., for each program proposed, there is a typical set of data that the program proposer is required to provide. On the other hand, many states have on-going data collection processes, often centralized in a specific

[7] The importance of a management information systems master plan and insuring the potential for success is noted in a recent paper from the Management Information Systems Research Center (Schroeder, 1975, pp. 15-17).

office, with such data being used to support a variety of state-level planning and financing activities, among them being academic planning.

There usually are similarities between the generic kinds of data collected through these two different processes, but the specifics of the data often differ. Although the criteria for program review are stated differently from state to state, generally they deal with issues related to the need for the programs, the extent to which the need can be fulfilled in other programs existing in the state, the anticipated costs for initiating or carrying out the program--measured both in terms of opportunities forgone, as well as program specific costs, and an indication of the purposes (benefits) to be served by the program. To this end, information in specific new program proposals is typically requested that would reveal how many students might enroll, what courses are required for the program, what faculty will be used in the program, what equipment is required and its availability documentation of the relationship of the program to other programs in the institution and to the overall institutional mission, the sources of funds available to support the program, and so forth.

On a broader level, information is, or might be systematically collected by the agency that would support the program review and their academic planning processes. One attempt to conceptualize such a generalized information base has been initiated by NCHEMS. It is called the State Level Information Base Project (SLIB) and is currently beginning the third

year of a four year project.[8] Organized around four issues relevant to state-level postsecondary education planning--What is the need/demand for postsecondary education in a state? What programs are required to meet this need? What resources are available to supply these programs? How should these resources be financed?--the project identifies a prototypical set of information that a state, adapting it to its own environmental circumstances and statutory responsibilities, might wish to collect on an on-going basis. Aspects of this information set that might be relevant to the academic planner are data about students, faculty, academic programs, academic support, and institutional finances.

Students are described in various ways. The planner frequently has a need to know how many students are full-time versus how many are part-time. He usually wants to know the major field of study of the student and the degree sought. For many planning purposes, such student descriptive data as his age, sex, and race are important. It is often helpful to know the geographic and institutional sources of the student body and the successes and/or failures which the students experience after their educational preparations. Similarly, faculty also may be described in terms of the extent of their effort and their personal characteristics. Additionally, it is useful to know their tenure status, their educational attainment, their disciplines of expertise, their current assignment, and their salary and rank.

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[8] Funded by the W. K. Kellogg Foundation and the National Center for Education Statistics, information that has been identified as useful for state level planning is currently being pilot tested in California, Hawaii, Illinois, Kentucky, New Jersey, New York, South Carolina and Virginia. For additional information about this project, see McCoy (1977) for an overview of the project, and Jones, et. al. (1977) for a detailed discussion.

Program data are included that provide both descriptive measures and quantity indicators. Data elements suggested to describe programs include program inventory information (by student degree level and discipline for instruction, by discipline only for research and public service activities). Program information to describe activity level includes the number of credit hours taught in each discipline and the number of degrees awarded. Frequently, academic support data also are useful for planning purposes. Data about the library collection, audio-visual and computer equipment utilization, and laboratory capabilities add an important dimension to many academic plans.

Because financial information increasingly is becoming a concern of the academic planner in assessment and resource allocation, the financial data about salary levels, instructional costs and tuition in SLIB might also be relevant. Financial data associated with many of the academic support programs is also included.

A frequently overlooked aspect in data collection for academic planning concerns those data which do not describe the individual institutions but rather describe the state or region at large. In performing access studies, information about the state's population including the number by region, by age, by sex, and educational level are important. Needs assessment studies require not only population data, but also information depicting manpower trends. As a counterpart to the institutional finance data which is important to the academic planner, information concerning the state's wealth is also important. Typical data collected for this purpose includes tax base, income distributions, and income trends.

C. Sources of Data

The same framework for describing types of data (institutional and non-institutional) will be used to suggest where the academic planner might obtain information. Institutional data may be acquired either directly or indirectly. In turn, direct data collection from the institutions can be on either a recurring or non-recurring, special study basis. Many states, with an interest in reducing data collection costs, are turning to more indirect methods of data collection. This is accomplished in the development of the data collection plan by recognizing that the institutions already have to report data to other agencies. Many state agencies now automatically receive copies of institutional Higher Education General Information Survey (HEGIS) reports[9] and survey responses to the studies conducted by the American Association of University Professors, the National Association of State Universities and Land Grant Colleges, and other similar organizations and agencies. When timeliness is not a concern, the planner also can obtain data from the National Center for Education Statistics after they have processed, edited, and published the HEGIS reports or prepared the EDSTAT data base.

The sources for non-institutional data are as varied as the type of data sought. Within state government, such agencies as the State Planning Division, the State Economist's Office, or the Bureau of Business and Economic Research are likely sources of needed data. At the federal level,

[9] For the 1976-77 HEGIS Submission, institutional responses were coordinated at the state level in 32 states. Ten additional states experienced partial state-level coordination. (See NCES, "Requirements and Specifications Manual", pp. 1-18.)

the U.S. Department of Commerce's Bureau of the Census collects and reports considerable data concerning the nation's population. Census reports describe the population by location, race, sex, income level, educational attainment, and the many combinations thereof. Also the Census Bureau collects much information about state and local governmental finance. In the U.S. Department of Labor, the Bureau of Labor Statistics is a source of much manpower information which is useful for those performing needs assessment studies and enrollment projections.

D. Existing Standardized Conventions for Organizing Data for Academic Planning and Analysis

Data frequently is collected along organizational lines, and for many purposes this is an appropriate approach. However, there are other occasions when standardized conventions are more useful. This is frequently the case when program planning or data comparison is the object of the activity. In this section, we will describe standard data collection conventions for institutional activities (and academic programs in particular), for finances, for manpower, for facilities, for institutional environment, for institutional goals, and for student outcomes.

The Program Classification Structure(PCS) was developed by NCHEMS (Gulko, 1972) in the early 1970's to facilitate planning and financing on a programmatic rather than organizational basis. The PCS is now undergoing field review for its second edition (Collier, 1976) and describes institutional activities in eight broad programmatic areas: instruction, organized

research, public service, academic support, student services, institutional support, student access, and independent operations. Additionally, there are conventions for categorizing data at the sub-program level within each of these seven programs. The academic programs (instruction, research, and service) may further be described through the use of the HEGIS Discipline Taxonomy (Huff and Chandler, 1970). The HEGIS Taxonomy includes over 300 disciplines which can be aggregated into 30 discipline categories. The Program Classification Structure incorporates the HEGIS Discipline Taxonomy at the data element level.

The "bible" for financial data collection is the report of the Joint Accounting Group. Members of the Joint Accounting Group (JAG) represented the National Association of College and University Business Officers, the American Institute for Certified Public Accountants, and NCHEMS. In 1974, the Joint Accounting Group issued a report (Collier, 1974) endorsing conventions for the collection and reporting of financial data based both on the program considerations reflected in the program classification structure and on the fiduciary concerns of business officers and auditors. Additionally, each organization issued their own report focused on the unique needs of their constituencies (Committee on College and University Accounting, 1973; NACUBO, 1974; Collier, 1975). Each of these separate publications is consistent with the principles developed by JAG.

Although higher education generally is acknowledged to be a labor intensive industry, a standard convention for reporting manpower information has not existed until recently. A National Center for Education Statistics publication, A Manual for Budgeting and Accounting for Manpower Resources in

Postsecondary Education (Jones and Drews, 1975), has been developed in recent years under contract with NCHEMS. Fortunately, there is more standardization in reporting on other institutional resources. The Higher Education Facilities and Inventory Classification Manual (Romney, 1972), developed by NCHEMS, serves as a reference for reporting facilities data to the Federal Government through HEGIS.

The Educational Testing Service has been heavily involved in developing conventions for collecting data on institutional environment and institutional goals. Their Student Reactions to College (Warren and Roelfs, 1972), Institutional Functioning Inventory (Peterson, et. al., 1970), and Institutional Goals Inventory (Peterson, 1970) are suggested for the planner with these interests. Similarly, the American College Testing Program has developed a product called the Institutional Self Study Service that addresses many of these topics (Lenning, 1970).

The past five years have seen increased interest in learning more about student outcomes. NCHEMS has done extensive developmental work in this area and has published the Outcomes Measurement and Procedures Manual (Micek, et. al., 1975) which enabled planners to select outcome measures appropriate to the particular planning purpose. Based on experience gained with the Manual and from additional work, NCHEMS currently is developing a set of student outcomes questionnaires targeted for specific institutional sector audiences to facilitate longitudinal outcome studies. In the context of the SLIB project, two states (Hawaii and Rhode Island)

are focusing on the use of outcomes information in state-level planning. The Hawaii pilot test is investigating how outcomes information might be used to allocate budgets to institutions, and Rhode Island is exploring the use of outcomes information to measure progress in achieving state postsecondary education objectives.

Three more recent projects currently are underway, each of which is likely to have significant impact on the structure of data to be collected at the state level. These are the Subject Matter Taxonomy project conducted by Educational Management Services (EMS) of Minneapolis, and the Adult and Continuing Education Taxonomy project and the State-Level Information Base project which are both underway at NCHEMS. As compared to the HEGIS Taxonomy of Student Major Programs, the EMS project is designed to develop a structure for describing subject matter. This project has been underway for several years and intends to develop a taxonomy for all levels of education. The final report of the project is due to be submitted to its fundor, the National Center for Education Statistics, in late July, 1977.

As the Federal Government and state agencies broadened their perspectives from higher education to include all of postsecondary education, they became aware that there was no convenient way to categorize much of the data relating to adult and/or continuing education. Under contract with NCES, NCHEMS has recently developed a first draft of such a structure and currently is conducting an extensive series of field reviews in various sections of the country. The W. K. Kellogg Foundation has funded another

NCHEMS project to develop principles and procedures for assembling a State-Level Information Base (SLIB). While SLIB (Jones, et. al., 1977) is being designed to respond specifically to planning issues at the state level, it is built from many previous NCHEMS projects, most of which have been described above. The Program Classification Structure, the HEGIS Taxonomy, the report of the Joint Actounting Group, the Manpower and Facilities manuals are all used to describe SLIB.

Two other federally funded activities underway concerning data collection are important to note. The National Center for Education Statistics, under contract with NCHEMS and in cooperation with the W. K. Kellogg Foundation, is funding a Federal Component of the State-Level Information Base project. This component extends beyond the basic SLIB activity in its focus on problems of data collection for outcomes and adult and continuing education. The Federal SLIB project also is concerned with coordinating federal needs for postsecondary education data with those at the state level. Inherent in this project is the belief that data collection efforts might be minimized through such coordination. NCES also has entered into contract with the State Higher Education Executive Officers (SHEEO) Association. The purpose of this contract is to develop a network of state-level data providers. This network and its steering committee, the Postsecondary Education Policy Committee on Information (PEPCI), is or will be addressing such matters as state-level data collection and editing before transmittal to the Federal Government.

F. Summary

The purpose of this section has been to describe the issues surrounding data collection which face the academic planner, the types of data available and their usual sources, and the conventions most frequently used in organizing data for reporting and analysis. As such, this section provides the basics of the data half of the information equation. The next section will address the many analytic techniques available to the state-level planner for translating data into information for policy-making.

## III. Analytic Techniques Used by State-Level Planners

### A. Hierarchy of Analytic Approaches

As discussed in an earlier section, the analytic approaches used by academic planners at the state level in postsecondary education range from the comparatively simple to the highly complex. For the purposes of this paper, it is useful to consider three levels of a developmental hierarchy of analytic techniques. For discussion purposes, they have been designated as (1) basic, (2) intermediate, and (3) complex analytic techniques. It is important to note further that there are no rigid criteria to distinguish between techniques at any intersection of the hierarchial levels, but rather these divisions suggest ranges along a continuum.

B. Basic procedures are characterized by their tendency toward descriptive statistics. Usually the analysis is performed within the construct of an analytic framework designed to provide insight to some problem or policy area. At the basic analytic level, various items of raw data are arranged together mathematically (ratios, products, sums, or differences) within the framework. Usually, the emphasis at the basic level is on comparative analysis either across similar organizational units or for single units over a period of time.

Perhaps the best example of NCHEMS work at this level is the report of the Statewide Analysis Project entitled State and Local Financial Support of Higher Education, 1973-74 (McCoy, 1976). In this publication, attention was directed toward comparing the level of support for postsecondary education across the fifty states, both in aggregate and by institutional sector. Additionally, further analysis was directed toward understanding reasons for the variation in state support and for using different measures to examine state support. Included are demand variations as suggested by the age distribution of the population and by the ability of the state to support public services as suggested by state wealth measures. Much of the information reported in State and Local Support has been updated for inclusion in the State Postsecondary Education Profiles Handbook (ECS, et. al., 1977). In addition to the statistical reports, Profiles contains sections on state structure for postsecondary education and on current publications and reports.

Another project just beginning at NCHEMS has tentatively been named the Indicators project. Through this activity, efforts will be focused on further development of an analytic framework for describing the status of

postsecondary education within a state. Primary effort will be directed toward developing consensus on a set of measures which might be used over a period of time and will gain wide recognition by policy makers. Useful analogies for the potential utility of postsecondary education indicators are the Gross National Product, the unemployment rate, and the inflation rate which are used to describe the status of key aspects of the economy and to evaluate the possible consequences of different policy proposals.[10]

C. Intermediate Techniques

As the transition is made from the lower end of the continuum toward the middle, the types of analysis shift from displaying previously available data toward conducting special studies to understand additional aspects of the operation. Such "operations analysis" may involve special data collection efforts on an ad hoc basis or the development of recurring data collection activities. It might be said that intermediate analytic techniques focus on the "why" and the "how" of the enterprise.

Several NCHEMS activities serve as examples of such mid-range analysis. First, the Induced Course Load Matrix (ICLM) and the Induced Work Load Matrix (IWLM) represent a step beyond the typical tally of enrollment information (Haight and Manning, 1972). In these matrices, one can analyze which disciplines contribute support to student major programs and, conversely, which programs consume student credit hours from each

[10] For additional information about possible uses and developmental problems associated with the development of postsecondary education indicators, see Collier (1973), Orwig and Jones (1977), and Van Alstyne and Coldren (1976).

discipline. This type of analysis reveals many interrelationships among academic programs and course offerings which are invaluable in program planning.

Two NCHEMS projects have led toward developing special data collection and analysis procedures. One project, labeled the Faculty Activity Analysis project, developed a framework for describing the ways in which a faculty member might spend his or her time and developed instruments for collecting this information. Recommendations are reported in Faculty Activity Analysis Procedures Manual (Manning and Romney, 1973), and Faculty Activity Analysis: Interpretation and Uses of Data (Romney and Manning, 1974). As a labor intensive industry, knowledge of how the faculty effort is expended is of extreme importance to the academic planner. As a result of the NCHEMS Outcomes program, the Outcomes Measurement and Procedures Manual (Micek, et. al., 1975) has been developed. Through use of these techniques, the academic planner can gain a better understanding of the effectiveness of the various programs offered by the institutions.

During the past several years, state agency activity in academic program review has experienced a resurgence of interest, particularly as such analysis has expanded to include the consideration of existing programs. Within our framework, much of the program review activity would fit the upper range of the intermediate level of analysis. The more successful approaches in state-level program review include attempts to understand interrelationships among academic programs, to indicate the quality of the faculty and to describe how they spend their time, and to measure the student outcomes of the programs.

D. Complex Analytic Techniques

At the upper end of the analysis continuum are those procedures which attempt to interrelate many aspects of the program or the institution. Frequent objectives in the more complex types of analyses are determination of cost benefit ratios, estimation of future conditions, and the allocation or distribution of resources. Among the more complex types of analyses are those which attempt to simulate the life of the organizational unit under study and those which strive to find the optimal mix between the resources and demands for the program. Due to the complexity of the analysis and the massiveness of the data, computer models are frequently used in performing such higher order types of analysis.

For purposes of describing the products available to perform such complex analysis, it is useful to think in terms of three basic types: costing, simulation, and optimization. NCHEMS has perhaps done as much work as any agency in developing costing procedures for postsecondary education. Early procedural developments were part of a Cost Finding Principles project (Topping, 1974); and widespread implementation was seen through the Information Exchange Procedures project (Johnson and Huff, 1975). These efforts are being expended through the Major Research Universities Component of the Information Exchange Procedures project where attention is addressed toward the unique problems experienced by large complex institutions in deriving cost information. Whereas the earlier efforts focused on defining, through simple conventions, the average cost per student credit hour (and in turn FTE student), further developmental work is beginning to consider the more difficult issues of marginal

costs and jointly incurred cost. The latter situation occurs when one expenditure of resources results in more than one valued outcome. An example is a joint faculty-student research activity, which has value both as graduate credit for instruction and as research per se. Additional costing work has been done in the health field, mostly by the Association of American Medical Colleges (1971), and the Institute of Medicine (1974). These approaches are similar to the cost finding principles approaches in determining average costs, although they are more focused to the peculiarities of the medical school setting.

Many different vendors have computer simulation products available. Among this group are NCHEMS with its Resource Requirements Prediction Model (RRPM) (Gulko, 1971), the Systems Research Group with their CAMPUS Model (Judy, 1969), Peat Marwick and Mitchell with their SEARCH Model (Keane and Daniel, 1970), and the Midwest Research Institute with their HELP/PLANTRAN Model (McKelvey, 1970). Generally speaking, each of these models builds from some type of costing methodology to project the impact of future decisions. A frequent criticism of these approaches is that they force the planner to make assumptions that the future will continue much as the present in terms of operational relationship of the production function.[11] Nevertheless, each of these models is useful in allowing the state planner to estimate the impact of current decisions at a macro level.

[11] A more complete description of the criticism of simulation models is provided by Schroeder (Schroeder, 1975, pp. 701-702).

Over the past several years increasing attention has been given to applying mathematical programming techniques, and particularly linear programming and goal programming, to the management problems in post-secondary education. As a rule, these approaches recognize a broader range of available options and constraints facing the academic planner than do simulation models and they permit the planner to adjust the relative quantities of input resources such that the optimal level of output might be obtained. Appraoches developed by Weathersby (1970), Wagner and Weathersby (1971), Wallhaus (1971), Lee and Clayton (1972), Turksen and Holzman (1970), and Andrew and Collins (1971) are representative efforts in this field.[12] To facilitate the implementation of these approaches at the state level, NCHEMS has developed a State Planning System (SPS) which was previously known as the State Postsecondary Education Planning Model (SPEPM). SPS (Bassett, et. al., 1977) is a software package which allows the state-level planner to establish design equations which describe the activity under study. Then, the planner can call upon a broad range of mathematical approaches including linear programming to assess, and in some cases, optimize in a mathematical sense, the relationships among the many variables. Other NCHEMS activities include the State Nursing Model (Sauer, et. al., 1977) and the Efficient Surfaces Model (Gray, forthcoming). The former assists in evaluation of alternative training strategies for fulfilling a state's manpower needs in nursing while the latter seeks to identify the optimal mix of academic resources in fulfilling a mission.

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[12] Schroeder has provided a more complete description of mathematical programming approaches (Schroeder, 1973, pp. 900-902).

E. Summary of Analytic Techniques

In this section of the paper we have attempted to provide a sampling of the many analytic approaches available to the state-level academic planner. While our listings are in no way exhaustive, they do provide an introduction to the types of capabilities which currently are available. The approaches were presented in a hierarchial framework ranging from the more basic applications to those which are of considerable mathematical complexity and require large computer systems. Depending on the types of problems under analysis, the commitment of the agency to the analytic process, and the size and level of expertise of the planning staff, the appropriate procedure can be identified.

## IV. Summary and Implications for Future Development

### A. Overview

A summary of the various uses of informational and analytic techniques in state-level postsecondary education planning requires comments along two dimensions: the types of techniques in use and the degree of their utilization. Product development to date has followed a somewhat predictable pattern. A good portion of the efforts thus far have been to develop a "communications base"--a standard language in the form of information standards for planning and management. Without this necessary framework for relating phenomenon and the specification and definition of data elements, the overall analytic process would be hollow. Although the planner is usually concerned with both the efficiency and the effectiveness

of the constituent institutions, most of the developmental work thus far has been focused on the former criterion. This is due in large part to the fact that cost determination and related issues are easier to address than those effectiveness measures which require value judgements.

The utilization of informational and analytic techniques vary widely from state to state, and in some cases among agencies within a state. Although little systematic effort has been directed toward understanding this utilization thus far, it is believed that utilization varies in accordance to the legal role of the state-level agency, the size and capability of the agency staff, and the political forces operative within the state.[13] Not only has the extent of utilization varied by state, but also the degree of success in the use of these approaches has differed widely. Success patterns may be explained by the utilization factors just mentioned, the readiness of the state to apply a particular approach in an evolutionary sense (cost studies without an adequate communications base), and the appropriateness of the tool for the context in which it is applied.

The state of the art can be summarized through observing that the most advanced tools available to industrial management (costing, simulation, optimizing) are also available in some form to higher education administration. However, even the most advanced state agencies fall short in

[13] The differences and responsibilities in orientation between coordinating boards and governing boards has been noted in Millett, pp. 62-66).

applying the available technology. Furthermore, most state agencies lag significantly behind the forefront of developmental efforts in their readiness and willingness to utilize such techniques.

B. Needed Developmental Activities

Although some needed technical advances can be identified, most of the important developmental work over the next few years is likely to incorporate a behavioral science approach to understanding the limitations in the uses of these techniques for state-level academic planning. As suggested in the previous paragraphs, no state agency is employing the full technology, and the vast majority of such agencies fall significantly short in their utilization of informational and analytic planning approaches. While it would be convenient to ascribe the situation to the lack of adequate staffing in the state-level agencies, it probably is more realistic to believe that many of the available approaches fail to satisfy significant dimensions of need of the state-level planner.[14] In the coming years, much greater attention is likely to be placed on matching the available technologies with the different contexts and problems in existence at the state level. Such modifications could recognize the difference in function of the state-level agency (governing, coordinating, community college, etc.), the relative degree of rigor to which the planning approach must satisfy, and other environmental variation.

[14]This issue will be addressed in greater detail in a forthcoming NCHEMS staff paper (Caruthers, 1977).

From a technical perspective the most needed advance in efficiency analysis are the requirements to assess more accurately incremental costs[15] and to find ways to link costs to outcomes. The limited value of average cost information is becoming more apparent with each successive application. The more qualitative aspects of planning (e.g., outcomes measurement and environmental measurement) also need further technical advance. We are only beginning to understand how to collect, measure, and analyze data in this arena.[16]

C. Summary

Informational and analytic approaches have much to offer the state-level academic planner. While such approaches do not yet reach perfection, the evidence of our experiences to date suggests that any state-level post-secondary education agency could perform its job more effectively through discriminate use of the available technology. Through this paper we have attempted to increase an awareness of how data, analytic techniques, and their product information should be used to assist in state-level academic planning. Further, we have offered an introduction to the available

[15] This contention is supported by the results of a survey conducted during the NACUBO Costing Conference held in Miami, Florida during January, 1977. The topic, "Determination of Cost and Revenue Behavior", was ranked highest among eleven topics identified as potential areas for investigation through NACUBO and NCHEMS joint costing efforts.

[16] Evidence for these assertions can be found in the analysis of the questionnaires sent to participants of this seminar. Program Review and Academic Quality headed the list of 23 areas of interest to state-level academic officers.

products for collecting and structuring data and to three general levels of analytic capability. Finally, we have attempted to identify some of the shortcomings in the current approaches that we have identified, and we have suggested how these shortcomings might be ameliorated in the coming years.

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