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ABSTRACT

The underlying assumptions and the structure of the enrollment analysis matrix (EAM) concept are discussed. EAM is a component of the Strategic Planning Project of the National Center for Higher Education Management Systems. EAM relates changes in the population of potential students external to the institution to the impacts that might result internally within the institution. Responses to upcoming changes can be studied by using the EAM to understand the differential changes that can be expected due to changes in an institution's environment. Examples of potential applications of EAM in postsecondary education planning and management are included, along with implementation guidelines and information on methods. Alternative applications of EAMs include: differential impact of demographic changes, costing, student-flow analysis, analysis of equity concerns, retention/attrition studies, curricular analysis, market segmentation for recruitment strategies, and student aid analysis. Included is a review of the literature on demographic changes affecting the college student populations in the 1980s and 1990s. Historical background on the EAM concept is also included, and some data elements and categories that might be included in EAMs are presented. Limitations and applicability of the EAM are identified, and basic report formats and possible software tools are discussed. A 44-item bibliography is appended. (SW)

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The

Enrollment Analysis Matrix

Concept

by

Mark Chisholm

February 1981

NCHEMS

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<u>Contents</u>

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Preface

This document was prepared as part of a project at NCHEMS to promote better planning and management methods and techniques in postsecondary education. This project, the Strategic Planning Project, contains many separate components, but the enrollment analysis matrix (or EAM) concept is a central and archetypical example of the strategic planning approach. This is because the central idea behind an EAM is the interrelationship between the environment and the internal organizational units of an institution. An EAM can be used as a tool to help an institutional manager understand the differential changes that can be expected due to changes in an institution's environment, and also as a tool to help in testing and formulating strategies for coping with those changes.

However, the EAM concept can stand on its own, as a useful planning and analysis tool for institutional management, without being tied directly to strategic planning. It is this independent stance that is emphasized in this document. The EAM is presented as a tool of immediate and important relevance to postsecondary education, especially in the upcoming decades of population and environmental changes. The underlying assumptions and structure of the EAM are thoroughly discussed, and numerous examples are given of potential applications of the EAM in postsecondary education planning and management.

Acknowledgements

Much of the inspiration for this document comes from Dennis Jones and Douglas Collier of NCHEMS. They provided many of the key concepts and ideas presented in this document and their encouragement, advice, and careful review are chiefly responsible for its completion. Dennis Jones, in particular, conceptualized many of the ways that a traditional induced course load matrix could be expanded to support the applications described in this document. Richard Allen of NCHEMS also contributed several important ideas during his careful review of the document.

Conversations with many people outside NCHEMS were also very helpful in formulating the enrollment analysis matrix concept. It is not feasible to list everyone who contributed, but four individuals stand out because of the quality of their ideas and because of the time they spent. They are:

Michael Young, Director, Office of Planning Studies, Ohio State University

Michael Haight, Consultant, Ohio State University

Jeffrey Cribbs, Budget Director, Virginia Commonwealth University

and, William Gleason, Consultant, Virginia Commonwealth University

This document would never have been completed without the dedication and extra hours put in by Caroline Andree, who entered most of the document into a word processing system, made the numerous changes required for each draft, and prepared most of the figures and diagrams used throughout the text. Also assisting in the document preparation were Linda Crooms, who edited and typed the bibliography, and the editorial and publication staff at NCHEMS who oversaw the final production process.

Any mistakes or omissions in this document, of course, are the responsibility of the author, and are not attributable to any of the above individuals.

Chapter I

Introduction

Postsecondary education is moving into an era where enrollments are expected to decline and where other drastic demographic shifts are expected in the student population. Institutional managers have been bombarded with warnings about these impending changes, but except for some studies that describe regional differences or that categorize types of institutions into "safe" and "threatened" categories, there is little information available to help managers assess what impacts are expected at their own institution. This document is about a concept that addresses this problem, the enrollment analysis matrix.

An enrollment analysis matrix (EAM) relates changes in the population of potential students external to the institution to the impacts that might result internally within the institution. Such analyses are vital because what is true in general may not be true for a particular institution. The nature and distribution of the student body at an institution may be such that the school does not follow the trends that might be expected within the school's region or among other schools of the same type. For example, an institution with a larger than average percentage of adult students might be less affected by a drop in the number of 18-year-olds than a school that depends almost entirely on recent high-school graduates.

Even more important, however, are the possible differential changes within an institution. One set of programs or departments may be declining while another part of the institution is growing. Such differences should be analyzed in terms of the nature of the student body within each area since these differences may further enhance the impact of

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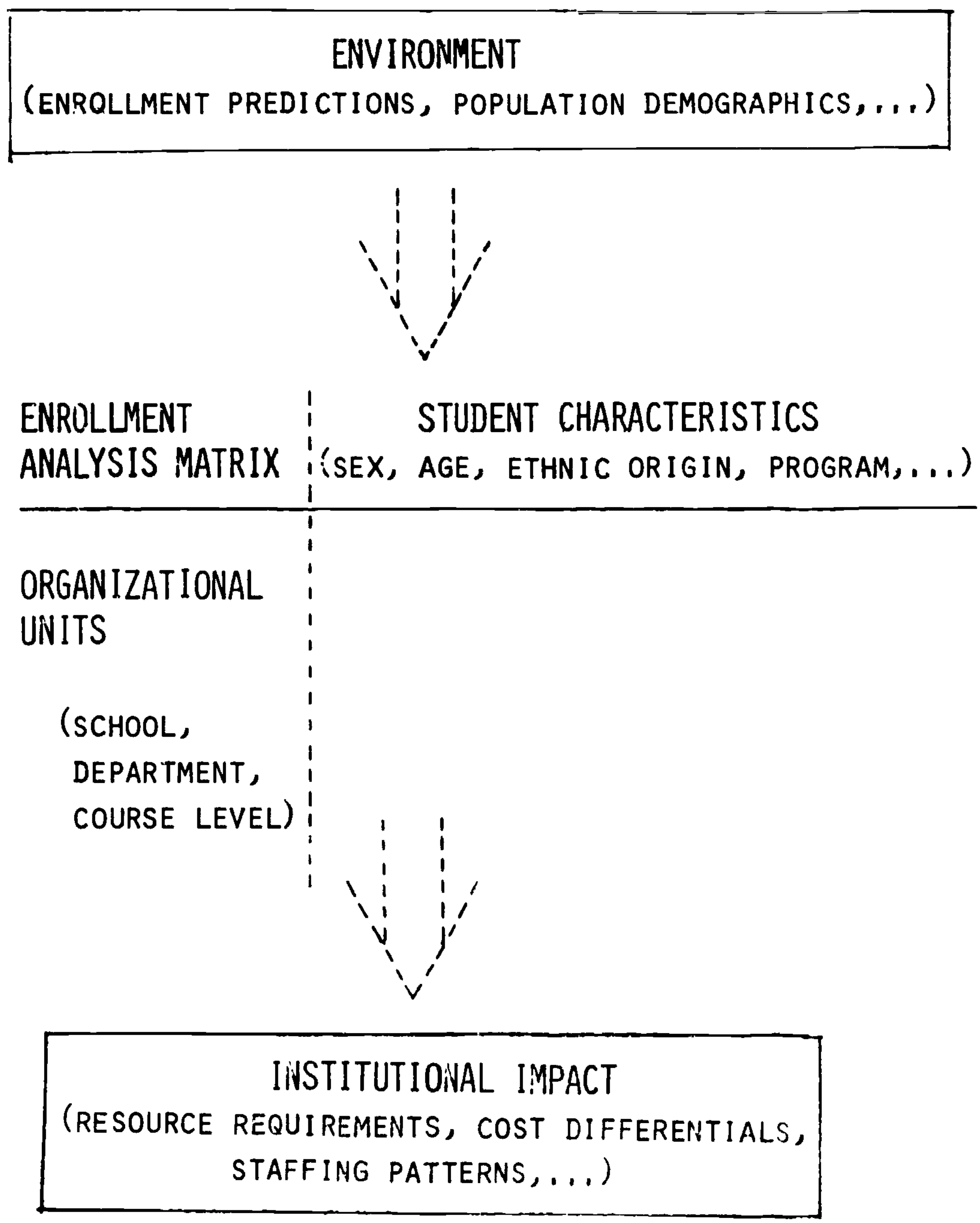
changes in student demographics. It is the possibility of uneven enrollment changes within an institution that makes it critical that institutional managers understand their own student's characteristics and how those characteristics relate to conditions in their institution's market.

An EAM, therefore, is a tool that lies on the interface between an institution and its environment. It describes the interaction between the student body and the organizational units of the institution and thereby allows one to relate potential changes in the environment to their probable impacts within the institution. A generalized schematic diagram of an EAM is given in Figure 1.1. The choice of student characteristics and organizational units to be included in a particular EAM is dependent on the environmental changes being studied and the institutional impacts to be measured, but the basic framework remains the same. Most of this document will discuss these issues, showing how the actual details of any EAM study may vary while still using the same approach and methodology.

It is this unified approach that is the key element in the EAM concept. Matrices that relate two or more variables to each other are very common and are surely not an original contribution of the EAM concept. Many examples of their use in institutional planning exist and several of these previous applications will be discussed in later chapters. But in most of the literature, a matrix of student and institutional data is presented for a very specific purpose, such as for program costing or for enrollment projection. The matrix is built for that application, but the approach and technique is not generalized. In addition, the matrix developed for a typical analysis is usually used in a very predetermined manner and not as a tool for helping to determine what

FIGURE I.1

THE GENERAL SCHEMA FOR AN
ENROLLMENT ANALYSIS MATRIX



should be done about a potential problem. The focus of the EAM concept is on pointing someone in the right direction to look for a solution, or at least in helping one "decide what needs to be decided." Another advantage of the EAM concept is that once an institution has developed a capability for performing a specific EAM analysis (by creating appropriate data elements and analytical tools) it then has in place all the tools necessary to carry out many other studies. A very important side benefit of this is that the users of EAM reports within the institution have a chance to become familiar with a standard reporting format and approach, so that new analyses are more readily understood and accepted.

The main thrust of the EAM is not forecasting (though later discussion will show that it can be of help in that task as well) but in the analysis of student patterns within an institution and the differential impacts that may result when enrollments change. Referring back to Figure I.1, the environmental changes are assumed to be given a priori in an EAM analysis, and the EAM is used as a tool for relating those changes to the impacts on the institution. Responses to up coming changes can be studied by using the EAM to evaluate how different policies by the institution are likely to turn out. In addition, the EAM can be used to measure the impact of a variety of environmental changes when the exact nature of those upcoming changes are uncertain. Therefore, an EAM can be used both to "play out" policies under varying assumptions and as an analytical tool to investigate current relationships.

The rest of this document describes the basic ideas behind the enrollment analysis matrix concept in much more detail, suggests several possible applications, and discusses implementation guidelines and methods. The level of presentation is kept on a very general level. The

ERIC

purpose of this document is to generate ideas and to explain the approach--not to be a technical workbook of step-by-step instructions. The final chapter on implementation guidelines does, by its very nature, use more technical language that assumes a basic familiarity with institutional data and data processing, but the most important points of the EAM concept and its applications are covered in Chapters III and IV.

First, however, Chapter II provides a brief review of the literature that describes the demographic changes that are expected in the student population of colleges and universities in the 1980s and 90s. In particular, it gives evidence of the differential impact of the upcoming changes in different regions of the country and on different types of institutions. It also describes some efforts that are underway to help an institution or state determine the impact it should expect, based on the characteristics of its current student population and the corresponding changes in the population as a whole.

Chapter III moves on to a discussion of the EAM concept, giving some historical background and working through a detailed example to explain the basic ideas more fully. Some of the data elements and categories that might be included in EAMs are presented and the chapter ends with some caveats regarding the limitations and applicability of the EAM. These caveats are important; the EAM is potentially a very powerful and useful tool. but like any tool, it can be misused, and there are some things it cannot and should not be expected to do. Chapter IV presents eight different EAM applications that are appropriate uses of this technique. considered. Some of these are quite familiar while others are fairly original, but they all use the same basic approach. This chapter is intended to stimulte the reader into thinking of ways to apply the EAM--it

11

is a not list of all possible applications or a detailed "cookbook" of how to put a study together. The final chapter, Chapter V, does go into more detail and some technical guidelines for implementing an EAM analysis are presented and some basic report formats and possible software tools that can be used are discussed. This chapter is intended to start potential users off on the right track and to at least point them in the right direction for developing an initial EAM capability.

Chapter II

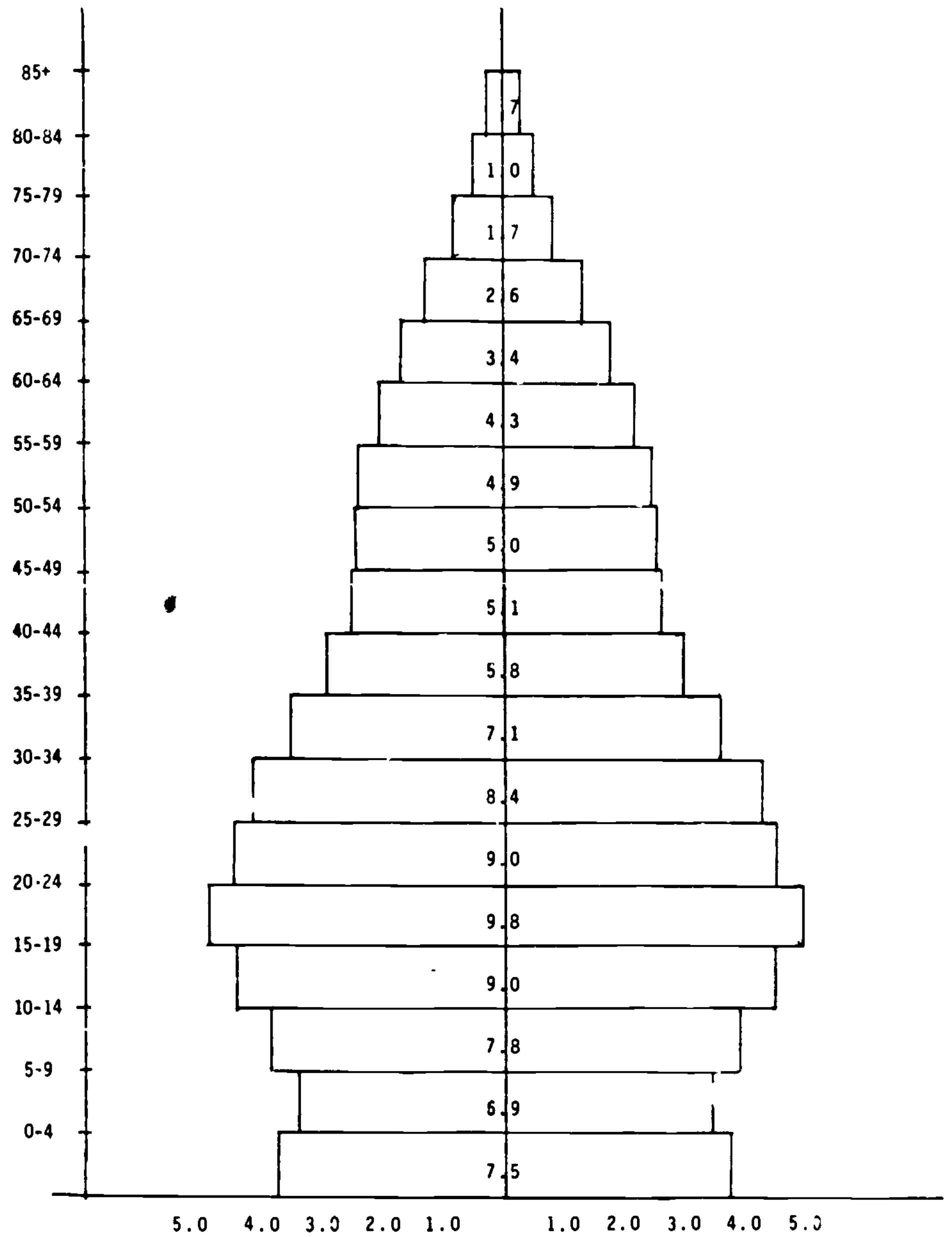
Why Is the EAM Important Now

Most everyone is aware by now that higher education is facing a potential crisis in the 1980s, resulting from the upcoming decrease in the number of eighteen year olds. The exact effect of this decrease on the total national college enrollment is a point of much debate, but the actual number of eighteen year olds in each of the next eighteen years is predetermined since those people have already been born. For example, the pattern of age distributions in the current national population is illustrated in Figure II.1. An examination of the figure will show that as the five to nine year-old age group reaches eighteen (from 1990 to 1994) there will be about a twenty-five percent drop in the number of eighteen year olds in the population. Of course, this type of general information, while frightening to institutional managers in a vague sort of way, is not very helpful in terms of identifying the specific enrollment and institutional impacts that they should expect. The national level of student information is too general, and it is easy to just assume that "the decline won't affect us because we are somehow special or unique."

It is one of the purposes of this paper to show how the EAM can help institutional managers to identify what the impact of changes in the student population is likely to mean to them, for it is the differential impact of changes in the student population that poses one of the most difficult institutional planning problems of the 1980s. This problem is beginning to be addressed quite frequently in the literature from the perspective of how different institutions or different types of institutions (varying by geographic region, prestige, program offerings,

FIGURE II.1

NATIONAL POPULATION PERCENTAGES
BY AGE GROUPS FOR 1981



*THE EFFECTS OF TUITION INCREASES ON VIRGINIA COMMUNITY COLLEGE ENROLLMENTS, VIRGINIA STATE DEPARTMENT OF COMMUNITY COLLEGES, RICHMOND. MARCH 1979. ERIC DOCUMENT: ED 184 622 etc.) are affected by changes in the student population. In other words, researchers are asking the question depicted in Figure II.2: What is the differential impact on institutions of major changes in the student population?

With the EAM, we are more interested in the differential impacts within different subdivisions of individual institutions, but there are some strong parallels between the inter- and intra-institutional levels, and a review of some of that literature is worthwhile and will be helpful in our later discussions of EAM applications.

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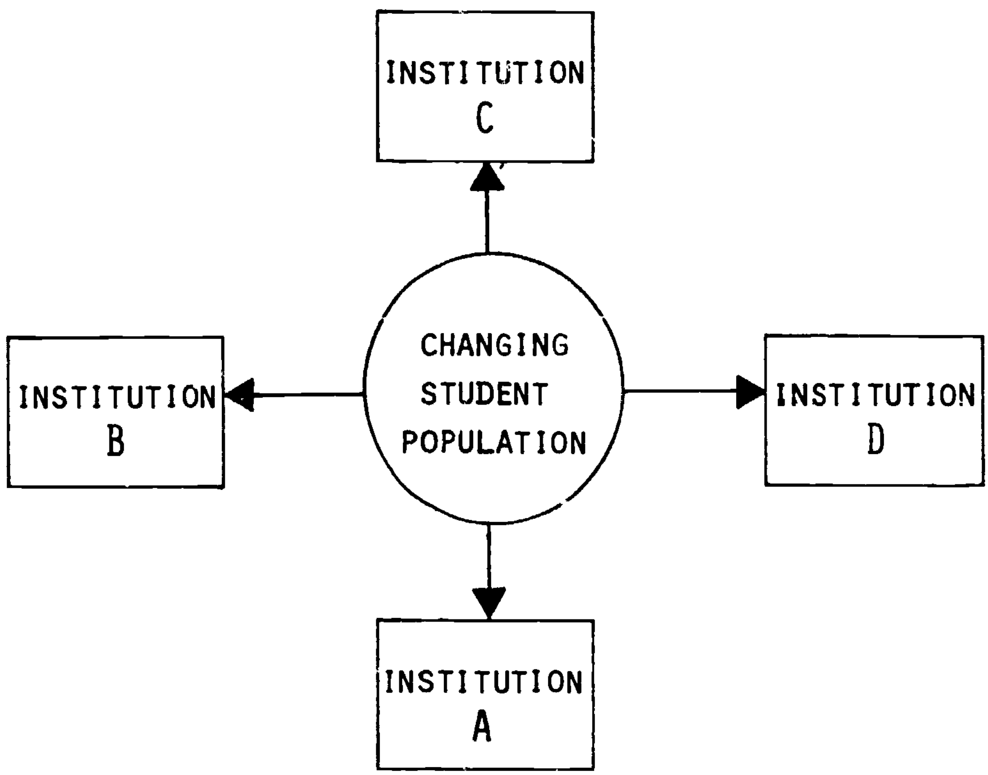
FIGURE II.2

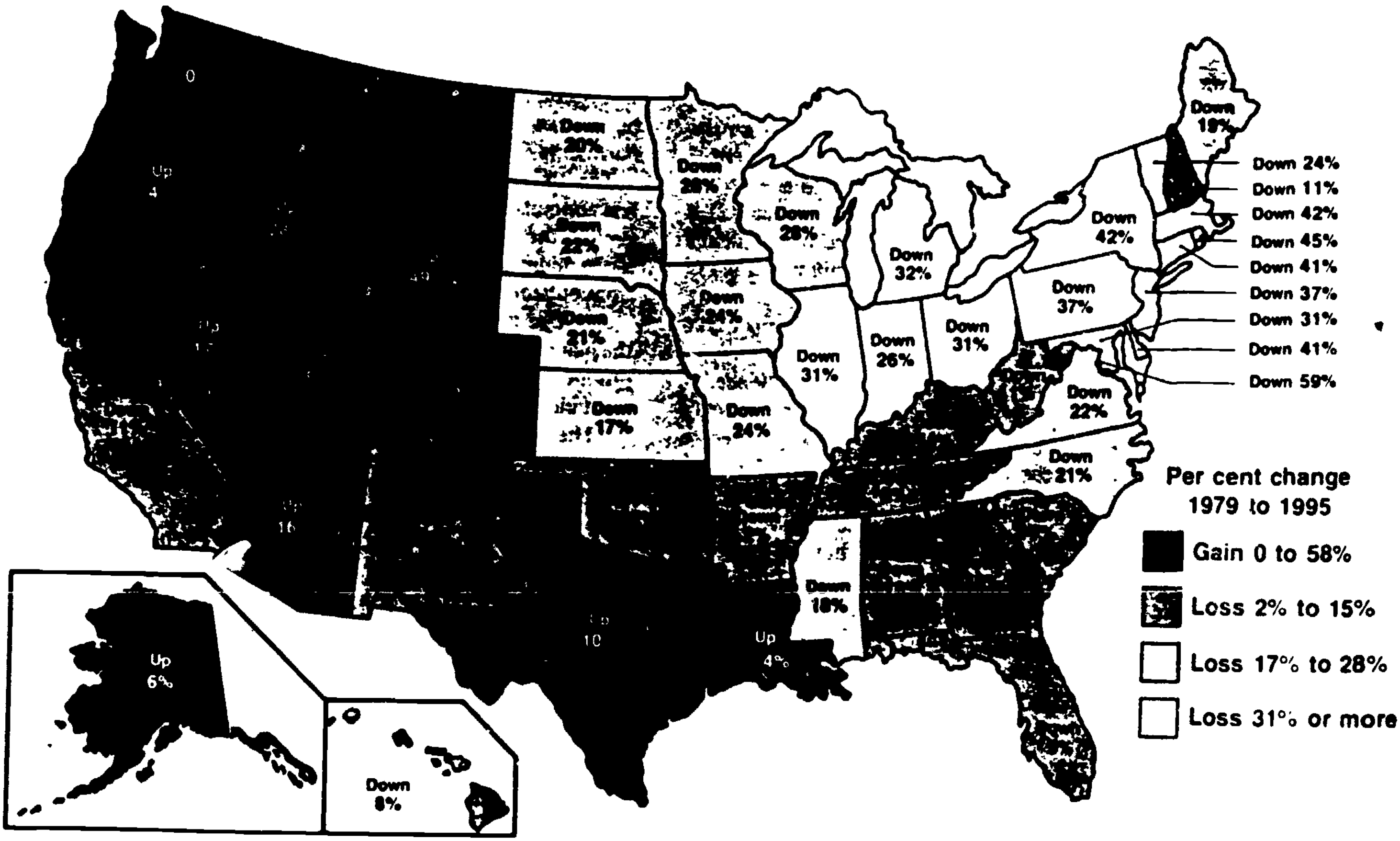
WHAT IS THE DIFFERENTIAL IMPACT ON INSTITUTIONS OF MAJOR CHANGES IN THE STUDENT POPULATION?



16

FIGURE II.3

CHANGING NUMBERS IN HIGH-SCHOOL GRADUATING CLASSES BETWEEN 1979 AND 1995*



*PICTURE FROM CHRONICLE OF HIGHER EDUCATION "FACT FILE", JANUARY 7, 1980, P.8.

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Figure II.1 illustrated the national distribution of age groupings, but any serious study of changing enrollments would have to at least start with state or regional enrollment projections. Differences in state growth patterns and interstate migrations can lead to quite different projections for different parts of the country. A recent report (WICHE 1979) computes state-by-state projections of high school graduating classes through 1995. These are summarized in Figure II.3. A quick examination of this figure reveals, for example, that institutions in the northeast are likely to be facing very different kinds of enrollment pressures than those in the southwest--states such as New York may have declines up to 42 percent, while others, such as Arizona, may even have increases.

So far, we have mostly talked about changing populatione characteristics in terms of the number of eighteen year olds in different parts of the country, but the problem, of course, is much more complicated than that. It is the entire composition of the population and the changing preferences of students that must be attended to if the impact on institutions is to be properly measured. A good example of the changing preferences of students is shown by the different patterns of part-time enrollment, especially in public two-year institutions. The chart in Figure II.4 illustrates the changes in part-time enrollment since 1968 and shows that different types of institutions have experienced this impact in varying amounts. Such changes in the future can have a huge impact on the actual enrollment and number of credit hours at an institution, regardless of changes in high-school graduates. Of course, a complete EAM analysis of part-time enrollments at an institution should also take into account such student characteristics as sex, age, and the programs the students

ERIC

are taking. For example, part-time enrollment patterns vary significantly by age: one-third of 18-24 year-old students are part-time, while two-thirds of all adult students are part-time (Frances 1980, page 62).

Student behavior factors other than full-time/part-time are also important, such as the different educational interests of adult versus traditional-aged students. These differences are investigated in a recent study by Hyde (1980). He reports that the likelihood of enrolling in a particular program is much higher for adults when the program is offered in the evening, but that youths will tend to avoid evening courses. Hyde looks at many other variables, much as tuition and financing considerations, types of instruction and programs, and delivery mechanisms. He concludes that there are significant differences in all these areas between the preferences of adults and youths, and that these issues need to be considered before the responses of various groups of prospective students to changes in educational services, costs, and means of delivery can be properly measured.

There are several recent studies that focus on the changings demographics of the potential student population and of how those changes may impact on postsecondary education. One such study, by John Centra (1980), reviews the many recently published projections of college enrollments in the 1980s and focuses on their similarities and differences. He does an excellent job explaining how factors such as participation rates, region of the country, and type of institution can play an important role. For example, he discusses how institutional qualities such as financial condition, reputation, size, and loction can influence an institution's ability to attract more students. Centra concludes with a discussion of the differences of enrollment behavior

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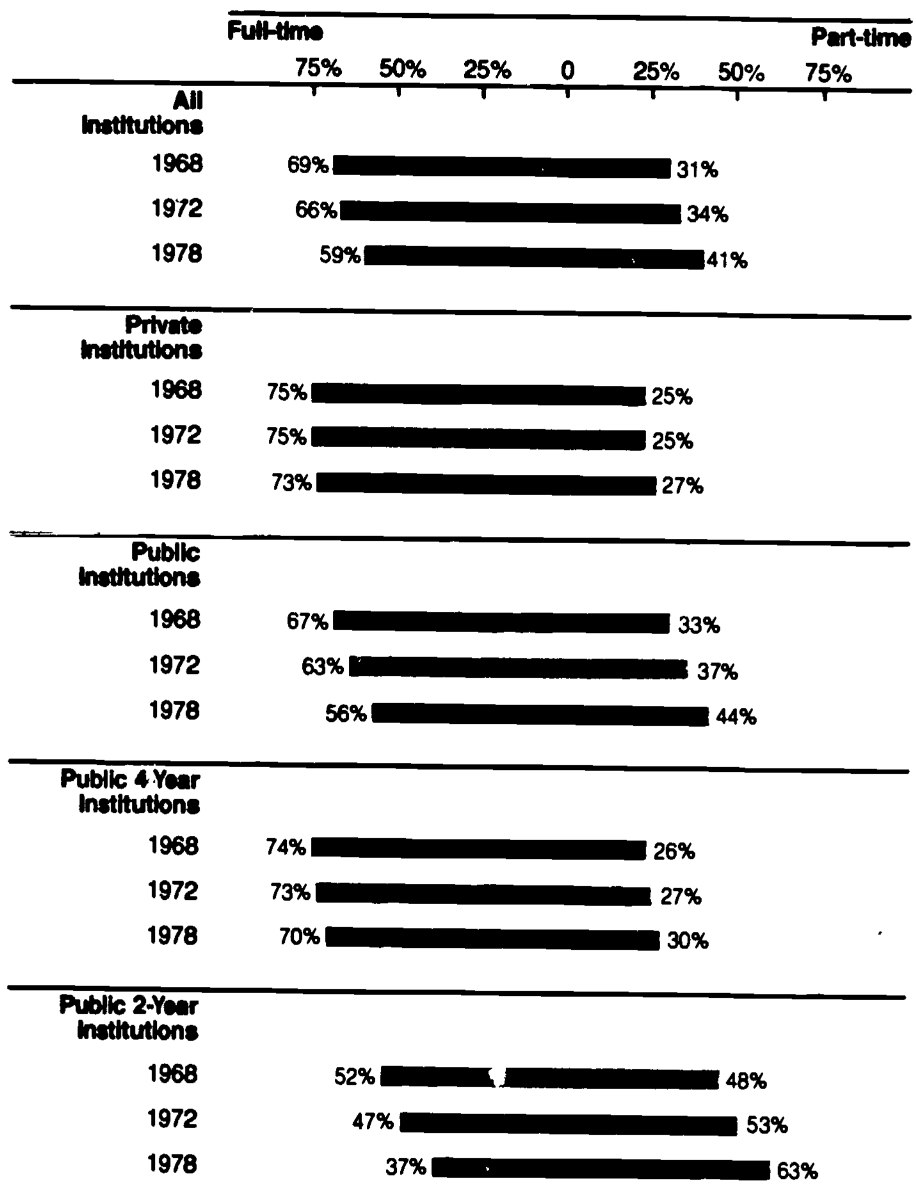
FIGURE II.4

ENROLLMENT, PART-TIME AND FULL-TIME, BY TYPE AND CONTROL OF INSTITUTION, 1968, 1972, 1978



SOURCE National Center for Education Statistics' Higher Education General Information Surveys (HEGIS), 1968, 1972, 1978

FROM <u>EDUCATIONAL RECORD</u>, WINTER 1980, P.47

between adults, women, and minority students. His evidence shows that the growth of the participation rate for adult students will probably slow, that women exhibit different retention rates than men once they are enrolled, and that the rate of population growth for minorities is higher than the national growth rate, but that they are still underrepresented in colleges and universities.

A study by Henderson and Plummer (1978), provides state-by-state comparisons of population shifts in terms of variables such as sex, or the proportion of the population that are Black or of Spanish origin. Another report, by the Carnegie Council on Policy Studies (1980), summarizes many of these same demographic trends and draws conclusions about the impacts to be expected over the next twenty years in different parts of the country and on different types of institutions. Their conclusions in this area are similar to those of Lyman Glenny (1980). Glenny also examines demographic issues and confirms many of the conclusions reported by Centra and others. One part of Glenny's paper that is particularly relevant to this discussion is his explanation of the differential impacts to be expected in different categories of colleges and universities. He divides institutions into three broad groups, from least to most vulnerable:

1. Least vulnerable--the main campuses of research universities and prestigious four-year private colleges.
2. Among those that should hold their own--the public community colleges that stay attuned to local needs and desires and that offer short-term occupation courses leading to job entry.
3. And most vulnerable--the denominational-related private colleges, state colleges and universities, and emerging public and private universities.

All of the above papers, especially the ones by Centra and Glenny, provide a good overview of the problem, but none of them offers any advice to an institution about how to predict what their actual enrollments will be or about what they can do about it. Carol Frances (1980), however, does address this problem. She first reports on current enrollment trends and contrasts them with the "conventional wisdom" of what has been happening. She shows that some common assumptions, such as that total enrollment is already down and that the less selective private liberal arts colleges are down in enrollment, are false. She argues that one cannot make assumptions about what will happen, but must instead look at actual data. But the most valuable part of her paper is the framework she provides for assessing the potentials that are available for offsetting the projected decline in college enrollments. For example, she points out that while it is true that there will be a 4.3 million decline in 18-24 year-olds by 1990, the adult population during the same period will increase by 22.8 million--providing a new market for institutions. Other factors, such as participation rates and retention can also help offset enrollment declines. Her framework lists twelve of these potential offsetting factors (page 40):

- Increased "high-school graduation" rates of students who would otherwise drop out
- Increased credentialing by testing of high school dropouts
- Increased enrollment of low- and middle-income students
- Increased enrollment of minority youths
- Increased enrollment of traditional college-age students
- Increased retention of current students

- increased enrollment of adults
- increased enrollment of women 20-34
- increased enrollment of men 35-64
- increased enrollment of graduate students
- increased enrollment of persons currently being served by industry
- increased enrollment of foreign students

She then goes through calculations, using national data, to show how much difference each of the above factors could make on a national level and she provides a blank worksheet to be used to assess these factors at a more local level. Therefore, she does not provide a new enrollment projection, but instead, she focuses on strategies and their possible outcomes.

Some researchers do provide specific enrollment-projection-tools for use at the institutional level that take into account changes in the institution's environment. Two such papers are by Zemsky, Shannon, and Berberich (1980) and Zemsky and Associates (1980). Both Zemsky et al. papers report on different aspects of work by the Higher Education Finance Research Institute, in cooperation with the College Board, to develop a model that allows colleges and universities to assess their enrollment potentials over the next several years. The Zemsky, Shannon, and Berberich paper gives details of a pilot test of their model in three counties in Pennsylvania, while the Zemsky and Associates paper describes a model designed to serve institutions in any of the nation's 200 regional admissions markets. Both models are based on the observation that most schools compete against a fairly small group of peer institutions that have similar levels of prestige. The main population market for a competing group is determined by using College Board data (such as SAT

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questionnaires). Then historical attendance patterns to the institutions are matched against projections of the student market, which is decomposed by population, socioeconomic background, and academic aptitude and aspirations. A quote from their pilot study in Pennsylvania provides a good justification for their approach:

> Individualized characteristics--high school performance, SAT scores, family tradition, and disposable family income--combine to help students choose among a relatively narrow range of options. The actual structuring of those options, however, as defined by the geographic horizons of the students' aspirations, is the function of community-held values and experiences. . . . While states with declining eighteen-year-old populations will send fewer students to college, how that pattern of decline translates into likely enrollments for specific institutions will be a function of the mechanism distributing students among market segments (Zemsky, Shannon, and Berberich 1980 [p. 371]).

The Zemsky approach is not dissimilar to an EAM analysis (though it is not referred to in that way in his papers). The level of analysis is on the whole institution, rather than on units within the institutions, but student data, categorized into relevant dimensions, is used as the means of relating changes in the environment to institutional impacts (similar to the generic diagram in Figure 1.1). Another approach to a state-level analysis of student enrollment is currently being started by NCHEMS (Allen 1981) that will build on the basic EAM concept.

And it is this EAM concept, of course, that is the main focus of the rest of this document. The above review of the literature was provided to present some evidence of the major changes in student demographics and in student attendance patterns that are soon to be forthcoming. The cited articles also predict that different regions of the country and different types of institutions will be differentially impacted by these changes. Managers at each institution must evaluate for themselves what these changes may mean to their institution, and they must also identify strategies and policies that may be effective in coping with the changes. Also, since these changes are only predictions, they need to be able to measure the range of changes that might be experienced. Analyses of past student-behavior patterns have been shown to be useful ways to approach the above problems (Frances, Zemsky, et.al.). Such analyses are really just different ways of applying the EAM concept. The next chapters will explain this concept in detail and give many examples of possible applications at the institutional level.

Chapter III

The EAM Concept

The most critical aspect of the enrollment analysis matrix concept is its focus on the uses that can be made of this type of data, rather than an emphasis on the data matrix itself. Researchers have been producing matrices, such as induced course load matrices, for a number of years, but all too often the reports they produce are too complex for anyone but the most sophisticated user to comprehend. Any attempts by institutional management to use those matrices as a tool to better understand their institution or to evaluate alternative policies are often foiled by the incomprehensibility of the reports and the difficulty of interpreting the interrelationships of the variables. In addition, there is often no way of easily producing additional analyses that include different variables or that reflect different underlying assumptions.

This is unfortunate since enrollment data can be very valuable. As Shirey and Kissel (1978) point out:

> "Enrollment data, in essence, tell whom the institution has served in the past, whom it is serving at present, and whom it will serve in the future." [p. 39]

An inability to easily access enrollment information, therefore, limits the extent to which managers can adequately understand the problems facing their instituion and the courses of action available to them when searching for solutions.

As a consequence, the main points of emphasis in the EAM concept are that (1) the enrollment matrix can be used to identify the key student and institutional variables of importance in a particular policy analysis, and (2) that it can be used to evaluate different strategies in dealing with

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upcoming problems and to help determine which ones are most likely to lead to solutions. To further those objectives, the researcher building the matrices must concentrate on the different variables that might need to be included, on the readability and clarity of the reports that are produced, and on the development of a system capable of producing a large variety of different reports easily and quickly.

History of EAM Analysis

While the term "EAM" is original with this document, several examples of what we call an EAM analysis have been around for a long time. The most familiar is the induced course load matrix, or ICLM. The ICLM was first introduced by Sidney Suslow at Berkeley in 1957 (Suslow 1976), though he feels the term "academic matrix" is better than ICLM. A basic ICLM relates student information (by major and student level) to institutional information (by discipline and course level). An example of a simple ICLM is given in Figure III.1. The contents of the cells vary, according to the use to be made of the ICLM. The most common value is ratio of course credits per student. For example, the value in the uppermost cell of Figure III.1 might be the average number of student credit hours in undergraduate biology taken by the typical undergraduate with a major in biochemistry.

Suslow made several early uses of the ICLM at Berkeley. He used it as an aid to building and space planners, as a tool to help planners at Berkeley convert from a semester to a quarter system, to develop full-time equivalency counts and properly assign full-time loads to departments, and to assess the impact of program changes, such as when the College of Letters and Science dropped its language requirement.

FIGURE III.1

EXAMPLE OF A TYPICAL ICLM

DISCIPLINES	DEGREE PROGRAMS: BIOCHEMIST UNDERGRAD	BIOCHEMIST GRADUATE	ENGLISH UNDERGRAD	ENGLISH GRADUATE	PSYCHOLOGY UNDERGRAD	PSYCHOLOGY GRADUATE
UG BIOLOGY						
GR BIOLOGY						
UG ENGLISH						
GR ENGLISH						
UG MATH						
GR MATH						
UG CHEMISTRY						
GR CHEMISTRY						

The most extensive use of ICLMs has come from the development at NCHEMS of program costing tools such as RRPM (Gamso 1977), CADMS (Haight and Martin 1975), and the Information Exchange Procedures (Gamso and Service 1976). All of these tools use an ICLM to apportion departmental costs across degree programs at an institution (a section in Chapter IV will further elaborate on these methods). In all the NCHEMS publications and previous applications, the dimensions of the ICLM are always degree program by discipline, as in Figure III.1. (In fact, one of the chief purposes of the first Program Classification Structure (Collier 1978) was to provide a standard set of program codes for the degree-program axis of ICLMs to be used in cost studies.)

However, the choice of dimensions used in those NCHEMS products was determined by the purposes to be made of the ICLMs. As Gamso and Service (1976) point out:

> "An ICLM can be developed for purposes other than IEP, in which case the definitions necessary for IEP might not apply. The 'PROGRAM' dimension, for example, might represent another grouping of students. The ICLM would then show the different course 'consumption' patterns for each grouping. Different student groupings might include full/part-time students, day/night students, male/female students, resident/nonresident students, and so forth." [pp. 73,74]

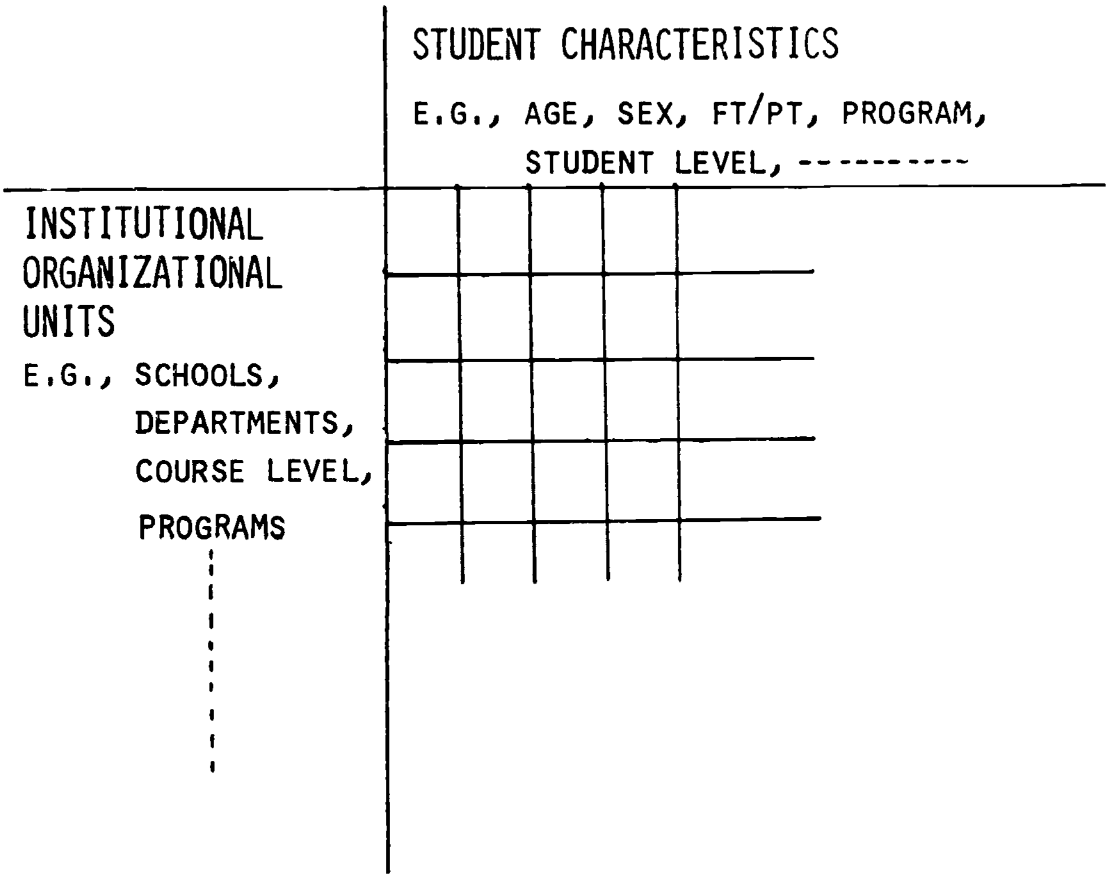
Example EAMs

A ICLM, therefore, is simply a specific application of an enrollment analysis matrix. A general schematic for an EAM is given in Figure III.2. A matrix is constructed by choosing the appropriate student and institutional characteristics and then filling the cells with data that reflects the basic underlying relationship that is being studied. The ICLM uses program and student level for studen characteristics, departments and course level for institutional characteristics, and the ratio of course credits per student as the data elements. Other variables might be chosen for other purposes. One thing to note about the dimensions of an EAM is that some variables, such as program, cannot be easily categorized as only students or only institutional characteristics. For example, in one sense program is a discription of the major being pursued by a student, but on the other hand, programs also describe the offerings of an institution in a way different from a list of course offerings. Some of the example applications in Chapter IV illustrate the use of program on more than one dimension of a matrix.

One example that arrays a student characteristic by program could occur if a school wished to investigate the effect of changing participation rates and of different career choices by women. The natural EAM to construct would array sex by program. A matrix of students by sex in each academic program could be computed to indicate the proportions of total students by sex in each program. Figure III.3 illustrates an example of such an EAM. Additional EAMs would then be generated for as many years (or semesters) as there are data. Trends could then be identified, showing changes in preference for different majors. These could be combined with estimates of changing participation rates of men

FIGURE III.2

THE GENERAL COMPONENTS OF AN EAM



and women in the population to arrive at institutional estimates of the impact on different programs in the institution. These estimates could then be used as input to another EAM analysis, such as to an ICLM, to estimate enrollment in departments, or even in some large course sections. Of course, this example is slightly simplified. Rather than headcount enrollments a school might prefer to look at student credit hours or full-time equivalencies. Other factors, such as day or night student or age of student might also be important.

The above example does point out that the actual data elements to be entered in a cell of an EAM is dependent on the questions being asked. In Figure III.3, the data elements are total students, and the proportion of students of each sex in a given program. Other analyses might work with total student credit hours, number of full-time equivalent students (FTE), proportions of students in a given program in each student category (that is, dividing each cell by the total program enrollment rather than the total enrollment by sex in Figure III.3), or by any other feasible measurement.

In each case, the matrix is constructed from student registration information. This will be discussed more thoroughly in Chapter V, but a brief example will be given here. Referring back to Figure III.3, the original counts of headcount enrollment in each cell would be arrived at by first starting with a record of student registration information that included information about each student's major and sex. A counting procedure would then be gone through to accumulate the total number of students in each cell of the matrix. Such a procedure is illustrated in Figure III.4.

FIGURE III.3

EAM OF STUDENTS BY SEX AND PROGRAM*

	HEADCOUNT/ PROPORTION	SEX: MALE	FEMALE	TOTAL BY PROGRAM
DEGREE PROGRAM	MATH	20/.14	10/.07	30/.21
	HISTORY	15/.11	35/.25	50/.35
	BIOLOGY	30/.21	30/.21	60/.43
	TOTAL BY SEX	65/.46	75/.54	140/1.00

*THE ELEMENTS IN EACH CELL REPRESENT THE TOTAL NUMBER OF STUDENTS IN THAT CATEGORY ABOVE THE SLASH, AND THE PROPORTION OF MALE OR FEMALE STUDENTS IN THAT PROGRAM BELOW THE SLASH.

ERIC

FIGURE III.4

CONSTRUCTION OF AN EAM FROM STUDENT REGISTRATION DATA

PART OF A STUDENT REGISTRATION DATA BASE:

STUDENT I.D.	NAME	STUDENT'S MAJOR	STUDENT'S SEX	-----
12345	BOB JONES	MATH	MALE	
21435	MARY SMITH	BIOLOGY	FEMALE	
45213	BILL THOMAS	HISTORY	MALE	
51234	FRED ABBOTT	BIOLOGY	MALE	
52143	JOHN SMITH	HISTORY	MALE	
53412	SUSAN DOE	MATH	FEMALE	
⋮	⋮	⋮	⋮	

ACCUMULATION OF STUDENTS BY CATEGORY:

	MALE	FEMALE
MATH	1	1
HISTORY	2	0
BIOLOGY	1	1

However, the actual construction of an EAM is not of as much importance to an institutional planner as the uses that can be made of the matrix once it is available. The next example will work through the steps of a simple analysis to indicate a typical application of an EAM.

This example sets the following analytical task: Investigate the impact on the colleges of an institution of a new enrollment projection that projects students by age categories. Figure III.5, which is continued for several pages, illustrates the different steps of this analysis. An important point of this example is that both historical and future conditions have to be placed into EAMs so that comparisons, or measurements of impact, can be made. Also, several different types of EAM are constructed as part of the investigation. A final point is that this example was chosen to be simple enough that it could be easily worked through by hand. An actual application would probably need a more detailed analysis and the displays would be produced by computer software.

The example in Figure III.5 assumes that a new enrollment projection is given to an institutional planner that predicts future headcount enrollments by five age categories (B). A comparison of the current enrollment distribution by age (A) reveals a prediction of an overall decrease of 10%, with much heavier losses in the 19- to 25-year-old categories and an increase in the over 26-year-old groups. Both (A) and (B) are examples of simple EAMs, age by headcount, and even that simple of a display reveals much more than a simple statement that overall enrollment is expected to drop by 10%. However, the planner is asked to investigate the impact of this prediction on the institution, not just the change in the composition by age of the student body. A more detailed EAM is necessary, perhaps one that shows the distribution of students by

FIGURE III.5

AN INVESTIGATION OF THE IMPACT ON AN INSTITUTION OF A NEW ENROLLMENT PROJECTION THAT IS SUBDIVIDED BY AGE CATEGORIES

(A) CURRENT ENROLLMENT

	19-UNDER	20-22	23-25	26-34	35-OVER	TOTAL
HEADCOUNT	1300	1200	1000	1000	500	5000

(B) NEW PROJECTION

	19-UNDER	20-22	23-25	26-34	35-OVER	TOTAL
HEADCOUNT	975	960	865	1100	600	4500
PERCENT CHANGE	-25%	-20%	-14%	+10%	+20%	-10%

FIGURE III.5 (CONT.)

(C) DISPLAY CURRENT ENROLLMENT (HEADCOUNT) BY COLLEGE IN THE INSTITUTION IN AN EAM

	19-UNDE.	20-22	23-25	26-34	35-OVER	TOTAL
LIBERAL ARTS	750	625	375	150	100	2000
FINE ARTS	350	350	125	50	25	900
BUSINESS	200	225	300	500	275	1500
LAW	0	0	200	300	100	600
TOTAL	1300	1200	1000	1000	500	5000

(D) DISPLAY CURRENT ENROLLMENT WITHIN EACH COLLEGE AS A PERCENTAGE OF THE TOTAL ENROLLMENT IN EACH AGE CATEGORY IN AN EAM

	19-UNDER	20-22	23-25	26-34	35-OVER	TOTAL
LIBERAL ARTS	.58	.52	.38	.15	.20	.40
FINE ARTS	.27	.29	.13	.05	.05	.18
BUSINESS	.15	.19	.30	.50	.55	.30
LAW	0	0	.20	.30	.20	.12

(E) DISPLAY THE POSSIBLE ENROLLMENTS BY COLLEGE IF STUDENTS IN PROJECTION ENROLL ACCORDING TO HISTORICAL PATTERNS

	19-UNDER	20-22	23-25	26-34	35-OVER	TOTAL	PERCENT CHANGE
LIBERAL ARTS	562.5	500	324	165	120	1671.5	-16%
FINE ARTS	262.5	280	108	55	30	735.5	-18%
BUSINESS	150	180	260	550	330	1470.0	-02%
LAW	0	0	173	330	120	623.0	+04%
TOTAL	975	960	865	1100	600	4500.0	-10%

(F) EXPLANATORY TABLES THAT SHOW THE PERCENTAGE OF AGE CATEGORIES IN EACH COLLEGE FOR BOTH THE CURRENT AND PROJECTED EAMS

CURRENT EAM	19-UNDER	20-22	23-25	26-34	35-OVER
LIBERAL ARTS	.38	.31	.19	.08	.05
FINE ARTS	.39	.39	.14	.06	.03
BUSINESS	.13	.15	.20	.33	.18
LAW	0	0	.33	.50	.17
TOTAL	.26	.24	.20	.20	.10

PREDICTED EAM	19-UNDER	20-22	23-25	26-34	35-OVER
LIBERAL ARTS	.34	.30	.19	.10	.07
FINE ARTS	.36	.38	.15	.07	.04
BUSINESS	.10	.12	.18	.37	.22
LAW	0	0	.28	.53	.19
TOTAL	.22	.21	.19	.24	.13

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different age groupings across the major colleges of the institution (C). An assumption can then be made that students will continue to enroll in the various colleges in the same proportions, by age, as they have in the past. (Such an assumption is a vital component of many EAM analyses and the validity of such assumptions will be discussed at the end of this chapter.

To project the impact of the enrollment projection in (B), the EAM in (C) must be converted into proportions that can be used to distribute students in each age category across colleges. Such an EAM is given in (D). For example, 750 out of 1,300 students who are 19 or under are enrolled in the College of Liberal Arts in (C), this is represented as 0.58 or 58 percent in (D). The proportions in (D) can then be used to apportion the projection in (B) across the colleges. Thus, the 975 students 19 or under in (B) are predicted to enroll in the numbers shown in (E). For example, (E) shows 562.5 headcount in the College of Liberal Arts (0.58 x 975 = 562.5), 262.5 headcount in the College of Fine Arts (0.27 x 975 = 262.5), etc. The rows and columns of (E) can be summed and percent changes of enrollment in each college can be computed by comparing the predicted college enrollment totals in (E) with the current totals in (B). This level of analysis provides a clearer picture of the impact of the enrollment decline on that institution. The analysis indicates that if students continue to enroll in the same proportions, that the declines in the Colleges of Liberal Arts and Fine Arts could be 16% and 18% respectively, while the business college would remain almost the same and the enrollment in the College of Law could even increase.

This type of information would be very valuable, and it would probably suggest even further analyses. The first result in this example,

39 BEST COPY AVAILABLE

however, is that age of student is an important variable in this analysis. If all four colleges had shown about the ame distribution of students by age, then age could have been eliminated from the study as an important component.

One further set of EAMs that might then be generated are shown in (F). Since age has been shown to be an important factor, the institutional planner may want to investigate if the new enrolment projection would result in vastly different distributions of student by age in each college. The EAMs in (F) show that while there are some minor shifts, the overall distribution within each college would remain fairly stable.

In such an analysis the planner would not stop at this point. The assumption that students will continue to enroll in the different colleges according to current enrollment patterns by age must be investigated. If future students are more interested in Business, across all age categories, then the decline in Liberal Arts and Fine Arts could be even greater than predicted. EAMs could be produced that reflect different assumptions and a range of alternatives for the institution should be produced. In addition, alternative strategies for coping with the predicted problems should be studied. For example, EAMs could be used to measure the impact of different policies that are designed to attract more adult students into the College of Liberal Arts. The point is that an EAM approach is a tool that helps the planner to focus in on the real underlying issues and to determine which factors are important and which strategies are feasible.

ERIC

Construction of an EAM

The task of constructing an EAM can be divided into three parts: (1) determine the variables and categories to be used, (2) collecting the necessary data, and (3) producing the reports by processing the data with the appropriate computer software tools. Chapter V concentrates on the technical aspects of this process, but the choice of variables to be included in an analysis is discussed here. The reason for this is that just looking at a list of the student and institutional variables that might be included can be very instructive. Many possible analyses come to mind when examining such a list and the full power of the EAM approach to institutional planning is therefore emphasized. Also, the example applications in Chapter IV will all use some combination of the variables suggested in this section.

One advantage of using enrollment analysis matrices is that much of the necessary data are already available at institutions. The student registration data collected by many institutions constitutes a rich source of information for EAM analyses. This data is either information that is necessary for the registration and record-keeping functions for students, or it is information that is felt to be important for institutional planning purposes. For example, Shirey and Kissel (1978) suggest that:

> "Some of the variables an enrollment data base should include are the number of students by county and state residence, school, department, undergraduate and graduate status, full-or part-time statue, sex, race, and class level." [p. 40]

These, of course, are also all variables that might be of use in an EAM. Figure III.6 lists some student and institutional characteristics that might be considered in an EAM analysis and provides a set of measurement

FIGURE III.6

POSSIBLE VARIABLES IN AN EAM ANALYSIS

STUDENT CHARACTERISTICS	INSTITUTIONAL CHARACTERISTICS	MEASUREMENTS
- PROGRAM (MAJOR)	- COLLEGE/SCHOOL	- SEMESTER AND YEAR
- STUDENT LEVEL	- DISCIPLINE (DEPARTMENT)	- NUMBER OF STUDENT CREDIT HOURS
- FULL-TIME/PART-TIME STATUS	- COURSE LEVEL	- COST OF A STUDENT CREDIT HOUR
- DAY/NIGHT	- PROGRAM	- TUITION AND FEES PAID
- AGE		- STUDENT AID RECEIVED
- SEX		- STUDENT OUTCOMES INFORMATION
- ETHNIC GROUP		- APPLIED TO INSTITUTION
- FAMILY BACKGROUND		- ACCEPTED BY INSTITUTION
- GEOGRAPHIC ORIGIN		
- INCOME LEVEL		
- ABILITY		
- STUDENT ASPIRATIONS/ CAREER OBJECTIVES		
- PREVIOUS EDUCATIONAL EXPERIENCE		
- JOB EXPERIENCE		
- EMPLOYMENT STATUS		

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variables that might be used in constructing the values that go into the cells of the matrix.

The items listed in Figure III.6 are fairly self-explanatory. The main problems would arise in determining how many categories to include of a particular variable. For example, if age groupings of students are being used, should the students be classified into four, six, ten, or some other number of categories? This is a key issue, because the level of data aggregation is very critical in any EAM analysis. Often the analyst may want to include a great many categories so as to be able to capture as accurately as possible the behavior of the student population. Unfortunately, this can lead to so much detail that the EAM reports are hard to interpret and the cost of each variable becomes prohibitive. However, to compensate too far in the other direction, can also lead to problems. The final study may be accused of being too superficial, or important interactions of the variables may be covered up. There is no exact answer to this problem. The analyst should take into account the purpose of the study, the level of detail already available on the student data base, and existing practices and conventions when making this decision.

In many cases, the categories to use will be predetermined. For example, if an institution is trying to evaluate the impact of a state-wide enrollment projection on its programs, then the internal EAMs should correspond to the categories provided in the external projection. In other cases, standard categorizations may be called for because of the audience expected to use the EAM. For example, programs could be classified according to the program classification structure (Collier 1978), and student outcome information could also be classified according to an accepted standard (Lenning, et.al. 1977). Finally, the data on the student data base may impose certain categorizations because of institutional habits or tradition. In such cases, any attempt to regroup the data into other categories would be prohibitively expensive and would also cause the reports to be less familiar to institutional administrators.

When the categories are not predetermined, there are a number of ways to narrow down the choice of variables. One very useful technique is to go on "fishing expeditions." In other words, to construct a number of small matrices, using different variables, just to see if they make a difference. An analyst is likely to discover important variables i. this way that would be missed if a purely "logical" approach was taken. Also, small matrices can be easi'y and quickly constructed, even by hand, so there is little cost in looking at a lot of variables one or two at a time. Other methods of choosing variables include: searches of the literature to see what variables have been shown to be important by others; past experiences of the analysts of what is important; the politics of the study; and the feasibility of obtaining or collecting the variables.

Whatever decisions are made for a particular EAM, the capabilities for EAM analyses at an institution should not be restricted by any fixed or inflexible standards. The value of an EAM approach to planning is to be able to respond to a variety of different problems and to be able to use whatever data is relevant to that problem. A particular categorization of a variable for one study may not be the same one that is needed the next time that variable is used in an analysis.

Caveats and Limitations

Despite its usefulness and value as a tool to aid decision makers, the EAM does not provide definitive answers--no analytical tool can. There are always limitations to any quantitative process, and the user should keep these limitations in mind before applying the results of any such process. The most important caveat about EAM analyses is related to the use of an EAM to project future enrollment behavior according to historical enrollment patterns. Such a projection methodology is subject to a large number of possible errors. Student preferences may not remain constant and events external to an institution, such as changes in the economy, may cause large shifts in student preferences. Even decisions within an institution about issues such as program offerings, degree requirements, or admission criteria can lead to large shifts in student behavior. Also, if many categories of the EAM contain small numbers of students, then the potential for errors when projecting from those cells based on a small sample is increased. Many small errors in this type of projection methodology can lead to quite large errors when all summed together.

Nevertheless, an EAM should not be rejected as a basis for projecting behavior. As Suslow (1976) says:

> "The high utility of the academic matrix lies not in its precision but in the fact that there is no substitute method that will develop equally good information." [p. 48]

Suslow also studied the stability of ICLMs over time and found that the stability of course patterns is remarkably high. His major conclusions about stability are (p. 48):

a) highly unstable coefficients generated by major field groups with small numbers of students (input) produce only small perturbations in the outputs;

b) highly unstable coefficients generated by major field with moderate or large numbers of students in courses not commonly taken by these majors produce only small perturbations in the outputs;

c) curriculum changes by departments of instruction usually cannot be anticipated, and they introduce instability to the academic matrix without any real change in student preferences;

d) arbitrary or unplanned shifting of course offerings from one part of the academic year to another may give the appearance of a change in student preference where there is none; and

e) dramatic changes in the numbers of students matriculated in a major field can account for greater inaccuracy in long-range predictions of outputs than can fluctuatons in matrix coefficient values for this field.

Suslow's conclusions are all derived from study of ICLMs (his academic matrix) but similar conclusions would probably apply to other types of EAMs. In all cases, if historical patterns are going to be used to project future conditions, then several years of data should be analyzed to measure the consistency of the pattern over time. Future shifts should also be considered and the analyst should always keep in mind that the farther a projection goes into the future, the greater the possibilities of errors. Nevertheless, the EAM is still a useful tool, as Suslow (1976, p.50) says: "The essential concern of the academic planner should not be

ERIC

the precise values of the coefficients but the potential impact of changes in these values." This is good advice for any EAM analysis.

The overall size of an EAM analysis is also a factor that must be considered in any analysis. This is because every time a new variable is added to further subdivide a dimension of a matrix, it multiplies the number of cells already there by the number of categories of the variable. This problem is graphically illustrated by the situation portrayed in Figure III.7.

The example in Figure III.7.1 shows a situation where variables on each axis are all natural choices and of interest in many analyses. Also, the number of categories for each variable in the example has been kept to a minimum. However, the product of all these categories results in a potential EAM of 3.6 million cells, a number many times the entire enrollment of any institution. This clearly points out that the analyst must focus in on the key variables and eliminate those that are not crucial in the analysis. Once the key variables are identified, then the number of categories for each variable must also be kept down to the smallest possible number.

The previous section discussed some techniques for choosing important variables. The same methods are also useful in determining the number of categories to use. Small exploratory analyses or "fishing expeditions" can help determine what level of detail is appropriate. Existing data structures and reporting conventions may dictate the categories that are most practical. Relevant literature and past experience may suggest the appropriate categories. And factors such as expense, political acceptability, and logic may determine the final decisions. But whatever

ERIC

FIGURE III.7

LIMITATIONS ON THE SIZE OF AN EAM

ONE CANNOT LOOK AT ALL THE INTERACTIONS OF ALL THE VARIABLES OF INTEREST AT THE SAME TIME. FOR EXAMPLE, AN EAM THAT INCLUDED THE FOLLOWING:

STUDENT CHARACTERISTICS

VARIABLE	NUMBER OF CATEGORIES
PROGRAM	40
STUDENT LEVEL	5
SEX	2
AGE	5
ETHNICITY	3
GEOGRAPHICAL ORIGIN	4

INSTITUTIONAL UNITS

VARIABLE	NUMBER OF CATEGORIES
DEPARTMENT	30
COURSE LEVEL	5

WOULD HAVE 24,000 STUDENT CATEGORIES AND 150 INSTITUTIONAL CATEGORIES
AND THE RESULTING EAM WOULD HAVE 3.6 MILLION CELLS

choices are made, they can only be made well when the questions to be studied are clearly stated and understood.

Even if one can't eliminate the importance of enough variables to get a matrix down to a reasonable size, the variables can still be analyzed, just not all at once. For example, take again the variables in Figure III.7. Various sub-EAMs could be produced, using those variables and a useful analysis would result that captured as much information as possible about their interactions. In addition, the large number of possible cells in the example does not mean that that many data records would be needed. Chapter V will discuss the type of data base that is needed and the construction of many different EAMs from the same standard data file.

Chapter IV

Alternative Applications of EAMs

This chapter describes eight potential applications of enrollment analysis matrices at institutions. As throughout this document, none of these examples are intended to be a workbook of exact steps and procedures to follow. Their intent, instead, is to suggest possibilities and ideas. Nevertheless, all of these applications are quite feasible--most of them are well established procedures and many institution will have done one or another of them at some time in the past. The most important and interesting point of this chapter is that if one conceives of each of these analyses as merely another example of the same basic approach, then a common data base and common analytical tools can be used to generate any of them.

This commonality of method means that if an institution invests time, staff, and resources into any one of these analyses from an EAM perspective, then each later analysis will be all that much easier to carry out. Another important advantage is that a standardized approach to this type of analysis will lead to a growing familiarity and acceptance within an institution of these methods and of the data reports that are produced. Administrators within the institution that initially react with skepticism, or even hostility, to more "computer printouts" may soon learn to welcome the information and may even begin to request new EAM analyses on their own.

The different applications to be discussed in the remainder of this chapter are:

(1) Estimation of the differential impact of demographic changes on the organizational units of an institution

(2) Costing of degree programs or other student characteristics

(3) Student flow analysis and the use of EAMs to assist in enrollment projections

(4) Analysis of equity concerns

(5) Retention/attrition studies

(6) Curricular analysis

(7) Market segmentation for recruitment strategies

(8) Student-aid analysis

This list is not meant to be all inclusive, and no one institution is likely to engage in each and every application, but these applications do give a good example of the types of uses that can be made of EAMs. At the end of this chapter, a summary is given of the data requirements of the eight applications.

Differential Impact of Demographic Changes

This type of analysis represents the prototypical EAM analysis since it most closely follows the pattern depicted in Figure 1.1, that of relating predicted changes in the environment to their probable impact within an institution. The long example in Figure III also represents the use of an EAM to evaluate the impact of demographic changes, in that case, a changing distribution of the ages of students combined with a declining enrollment.

Most of the literature cited in Chapter II describes the demographic changes expected in the student population over the next 20 years and the impacts of those changes on postsecondary education in different regions of the country or on different types of institutions. But a tool such as an EAM is required to measure the actual impact of these changes on a particular institution. Such an analysis would start with the construction of an EAM following the basic pattern of Figure IV.1 and using appropriate data elements from a list such as that given in Figure III.6. In this case, the data elements appropriate for the EAM should correspond to the demographic descriptions available in the environment.

Several examples of the use of an EAM to evaluate the possible effects of environmental changes on a particular institution could be cited. One that is particularly relevant involves institutions in the state of Virginia. In Virginia, the state has prepared demographic projections for the next 20 years in terms of sex, age, race, and planning district (geographic subdivisions of Virginia that divide the state into 24 regions of roughly equal population). These demographic projections are available for institutional anlaysis, along with the state's estimate of their impact on each institution's enrollment. However, the state's projections do not delve into the internal structure of individual institutions. Each institution in Virginia could use an EAM approach to evaluate the impact of the demogarphic projections on the different subdivisions of their school. Also, once the internal analysis was done, a school could evaluate for itself whether it agreed with the state's projection of its future enrollment levels. The internal analysis might suggest strategies that the institution could adopt to attract more students, and it would definitely give the school better information to help it cope with the upcoming changes.

FIGURE IV.1

THE USE OF AN EAM TO EVALUATE THE DIFFERENTIAL IMPACT OF DEMOGRAPHIC CHANGES ON THE ORGANIZATIONAL UNITS OF AN INSTITUTION

EAM	STUDENT DEMOGRAPHIC CHARACTERISTICS (E.G., AGE, SEX, ETHNICITY, GEOGRAPHIC ORIGIN)
INSTITUTIONAL UNITS (E.G., COLLEGES OR SCHOOLS, DEPARTMENTS, PROGRAMS, COURSES)	(HEADCOUNT, PARTICIPATION RATE, PERCENTAGE OF STUDENTS)

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Costing

As was mentioned in Chapter III, program costing is probably the most publicized application of EAMs in postsecondary education. Authors such as Hample (1980) cite the importance of induced course load matrices (ICLMS) in assigning instructional costs across programs (see Figure III.1 for a typical ICLM). But the chief authorities for describing the use of ICLMs in program costing are the NCHEMS publications that describe the various costing procedures and cost simulation models developed by NCHEMS (Gamso 1977; Gamso and Service 1976; Haight and Manning 1972; Haight and Martin 1975; and NACUBO and NCHEMS 1977). For as Haight and Manning say, "The ICLM is the foundation of NCHEMS cost simulation models. It is the basis for distributing the instructional cost of an institution to degree programs and for projecting the impact of new students upon different departments within an institution" (p. 1).

Figure IV.2, from Procedures for Developing Historical Full Costs (NACUBO and NCHEMS, p. 2.41) illustrates the basic conceptual steps in the typical NCHEMS costing procedure. In this figure, the basic EAM is called an IWLM (instructional work load matrix) rather than an ICLM. The only difference is that an IWLM contains total student credit hours in each cell, while an ICLM contains average student credit hours. The reader should be able to follow the basic sequence of steps in Figure IV.2. The IWLM is used first to take the costs for each discipline (department) and to determine the average cost per student credit hour for each discipline (steps 1 through 3). The columns of the matrix are then summed, multiplying the number of student credit hours in each cell by the average cost per student credit hour in that discipline and accumulating a total for each program (step 4). The average cost per student credit hour for

FIGURE IV.2

A CONCEPTUAL OVERVIEW OF THE CALCULATION OF PROGRAM COSTS*

Institution's Accounting Data ①

Biology Discipline	$ 20,000
Zoology Discipline	$ 15,000
Other Discipline	$ 90,000

Institution's Instructional Work load Matrix ②

	Biology Program	Zoology Program	Totals
Biology Discipline	1,000	1,000	2,000
Zoology Discipline	600	400	1,000
Other Discilplines	2,000	1,000	3,000

Calculation of Discipline Unit Costs ③

Total Expenditures		Total Credit Hours		Discipline Unit Costs
$ 20,000	÷	2,000	=	$ 10
$ 15,000	÷	1,000	=	$ 15
$ 90,000	÷	3,000	=	$ 30

Calculation of Program Costs ④

	Biology Program	Zoology Program
Biology Discipline	1,000 x $ 10	1,000 x $ 10
Zoology Discipline	600 x $ 15	400 x $ 15
Other Disciplines	2,000 x $ 30	1,000 x $ 30
Totals Credit Hours	3,600	2,400
Cost	$ 79,000	$ 46,000

Calculation of Program Unit Cost ⑤

Total Program Cost		Credit Hours		Program Unit Cost
$ 79,000	÷	3,600	=	$ 22

*FROM PROCEDURES FOR DEVELOPING HISTORICAL FULL COSTS, TR65, 1977, P.2.41

each program can then be easily computed (step 5). The value in the final box in Figure IV.2, $22, represents the average cost per credit hour for the biology program.

This same approach could be used to compute cost information for any set of student characteristics. Rather than degree programs by student level, the IWLM in Step 2 of Figure IV.2 could array students by full-time/part-time, day/night, ability, ethnicity, sex, or any combination of these or any other variables. The same basic calculations would be gone through, and the result could be, for example, the cost per student credit hour of a part-time, female, student enrolled in night school.

<u>Student-Flow Analysis</u>

If program costing is not the most common use of EAMs int institutional planning, then it would be their use in enrollment projections and in student-flow modeling. A very common projection technique is to use historical data to compute transition percentages that describe the flow of students over time. These transition percentages are then used to project future enrollment patterns in a Markov projection methodology (see Wing 1974, for a complete decription of Markov models).

An EAM is the basic underlying structure of these techniques because the variables of importance include standard student characteristics and their interaction with units of the institution over time. Kieft (1977) describes the use of student registration information and an ICLM for enrollment planning, but he does not expand the concept to use variables other than the standard ICLM variables of program, discipline, and student level. Cady (1979) points out that participation rates of students vary with age, sex, race/ethnicity, socio-economic status, and prior education.

Chisholm and Cohen (forthcoming) also cite data that show that student participation behalor varies with factors such as ability, income level, and age. A technique for institutional enrollment forecasting that includes many typical EAM components is desribed by Lasher, Bodenman, and Ivery (1980).

Many other enrollment forecasting examples that use stduentd characteristics could be cited, but the rest of this section will instead concentrate on a model for student-flow analysis developed by Young and Haight (forthcoming). Their approach is a particularly graphic example of the use of commonly available student data and of a standard EAM software tool to perform a useful analysis. (Their software tool will be discussed more thoroughly in chapter V.)

Figure IV.3 illustrates the basic steps of their calculations. In part A of Figure IV.3, student data is accumulated from two different points in time, such as Fall 1977 and Fall 1978, into a matrix of degree program by degree program. This may seem a little strange at first glance, but it actually produces a very useful report. For example, the first column of (A) indictes that of the students enrolled with major A in Fall 1977, 400 were still enrolled in major A in Fall 1978, 100 had shifted to major B, 200 to major C, and 50 to major D. The matrix could also be read across each row, showing where all the students in a particular major in Fall 1978 were in the previous Fall term.

Another very useful aspect of (A) is that it also provides a report of the <u>exiting</u> and <u>entering</u> students at the institution by each degree program. These values are automatically generated when the data for the two terms are matched to generate the matrix. If a student is enrolled in 1977 but is not on the registration list in 1978, that student is assumed

Figure IV.3*

CALCULATION OF TRANSITION PERCENTAGES FROM HISTORICAL DATA AND THEIR USE IN PROJECTING DEPARTMENTAL WORKLOADS

(A)

HEADCOUNT MATRIX OF STUDENTS IN TWO TIME PERIODS:

		FALL 1977					
		MAJOR A	MAJOR B	MAJOR C	MAJOR D	ENTERING STUDENTS (NOT ENROLLED 1977)	TOTAL 1978 STUDENTS
FALL 1978	MAJOR A	400	100	100	100	200	900
	MAJOR B	100	400	100	150	250	1,000
	MAJOR C	200	150	350	100	200	1,000
	MAJOR D	50	150	200	350	350	1,100
	EXITING STUDENTS (NOT ENROLLED IN 1978)	250	200	250	300		1,000
	TOTAL 1977 STUDENTS	1,000	1,000	1,000	1,000	1,000	

*FROM YOUNG AND HAIGHT, FORTHCOMING

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FIGURE IV.3 (CONTINUED)

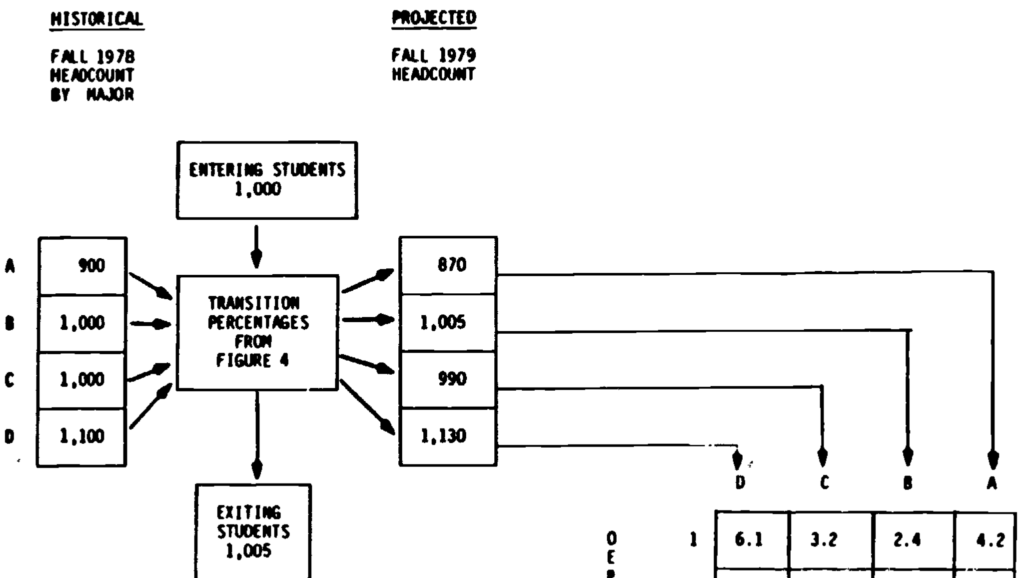
(B)
TRANSITIONAL PROBABILITY MATRIX,
(HEADCOUNT MATRIX DIVIDED
BY COLUMN TOTALS):

		FALL 1979				
		MAJOR A	MAJOR B	MAJOR C	MAJOR D	ENTERING STUDENTS
FALL 1978	MAJOR A	.40	.10	.10	.10	.20
	MAJOR B	.10	.40	.10	.15	.25
	MAJOR C	.20	.15	.35	.10	.20
	MAJOR D	.05	.15	.20	.35	.35
	EXITING STUDENTS	.25	.20	.25	.30	

FIGURE IV.3 (CONTINUED)

(C)

SAMPLE CALCULATION OF DEPARTMENT WORKLOADS



HISTORICAL FALL 1978 CURRICULUM MATRIX

DEPARTMENTS	D	C	B	A
1	6.1	3.2	2.4	4.2
2	4.3	4.5	2.0	5.2
3	2.6	5.7	3.8	2.1
4	3.0	1.6	5.8	3.5
	16.0	15.0	14.0	15.0

PROJECTED AUTUMN 1979 INSTRUCTIONAL WORKLOAD MATRIX

DEPARTMENTS	D	C	B	A	PROJECTED AUTUMN 1979 DEPARTMENTAL WORKLOAD
1	6893	3168	2412	3654	16,127
2	4859	4455	2010	4524	15,848
3	2938	5643	3819	1827	14,227
4	3390	1584	5829	3045	13,848

→ BUDGET PROCESS & DEPARTMENTAL PLANNING to have exited the institution in the interim. Similarly, a student enrolled in 1978 who was not present in 1977 is assumed to be a new student and is counted in the entering students column.

The headcount matrix (A) is transformed into a transitionalw probability matrix (B) by dividing the cells of the headcount matrix by the headcount column totals. The cells of (B), therefore, contain percentages that describe the transition of students from Fall 1977 into Fall 1978. The percentages who exit from each program are computed, as well as a prediction of the distribution across programs of new students to the institution.

The final page of Figure IV.3, part (C), shows the projection of the next fall's enrollment from the historical transition matrix. (The years in this example are not important--this student-flow technique could be applied to any two years of historical data to predict enrollments in the third year.) The calculations in part (C) of Figure IV.3 are similar to those for program costing in Figure IV.2. Note that a curriculum matrix (or ICLM, Young and Haight have changed that terminology but it is exactly the same basic matrix) is used to distribute the program enrollments back into departments at the institution so that total departmental workloads, by student credit hour, are produced as the final result.

As with the costing example in the previous section, this flow technique is not limited to program, level, and department. Any other student characteristics could be incorporated into the EAM to show the flow of students within those different categories.

Analysis of Equity Concerns

Another useful application of an EAM could come up during an investigation of equity concerns at an institution. This would be a fairly straight-forward analysis, with the matrix being used to determine if students in different programs were enrolled in proportions similar to those in the institution's target population. Figures IV.4A and IV.4B represent some of the data elements and institutional and student characteristics that were identified by Cloud (1980), in her report on Equity Self-Assessment in Postsecondary-Education Institutions. The general EAM data base and software tools useful in the other EAM applications would be of value here in preparing reports of equity conformance and in analyzing differences across different subunits of an institution.

FIGURE IV.4.A*

EXAMPLES OF INDIVIDUAL CHARACTERISTICS AND CIRCUMSTANCES THAT CAN RELATE TO EQUITY ISSUES REGARDING BOTH STUDENTS AND EMPLOYEES

Age
Citizenship
Color
Dependents/Dependency Status
Economically Disadvantaged Status
Education-Related Background
- Institutions attended
- Grade point average
- Educational attainment—level/degrees

Handicapped Status
Height
Income Level
Location of Residence
Marital Status
National Origin
Political Beliefs
Pregnancy Status
Race/Ethnic Identification
Religious Preference
Sex
Veterans Status
Work-Related Background
- Previous work experience
- Professional accomplishments
- Occupational capabilities/skills

Etc.

Qualities
Attitudes and Beliefs
Knowledge
Perception
Personality and Personal Coping Capabilities
Physical and Physiological Characteristics and Capabilities
Skills
Etc.

Resources
Access to Information
Financial Assets (or liabilities)
Physical Assets
Personal Contacts
Etc.

Relationships/Affiliations
Student(s) to Other Student(s)
Employee(s) to Other Employee(s)
Student to Educational Institution
Employee to Educational Institution
Student to Teacher
Employee to Supervisor
Student to Social Group
Employee to Professional Organization
Student or Employee to Role Model or Mentor
Etc.

Note: These examples are *not* intended for or necessarily related to data-collection needs.

*TABLE FROM EQUITY SELF-ASSESSMENT IN POSTSECONDARY EDUCATION INSTITUTIONS, COULD 1980, P.15

FIGURE IV.4.B*

WHO AND WHAT ARE CONCERNED IN ACHIEVING EQUITY FOR STUDENTS IN POSTSECONDARY-EDUCATION INSTITUTIONS

<table>
<tr><th>WHO:</th><th colspan="4">WHAT: MAJOR EQUITY ISSUES</th></tr>
<tr><th>Individuals, Classified by Specific Characteristics and Circumstances</th><th>Access to Institution of Choice</th><th>Access to Program of Choice</th><th>Access to Resources and Satisfactory Completion to Self-Determined Level</th><th>Access to Employment Opportunities</th></tr>
<tr><td>Affiliations with Groups and Organizations
Age
Attitudes and Beliefs
Citizenship
Educational Background
Financial and Physical Assets
Handicapped Status
Knowledge
Location of Residence
Perceptions
Personal Contacts
Race or Ethnic Status
Relationships with Individuals
Sex
Work-Related Background
↓
Etc.</td><td colspan="4">As a result of trends, questions, perceptions, allegations, rulings, and such, there can be policies, practices, processes, activities, laws, and regulations regarding evaluation of or changes in aspects of the major equity issues for individuals categorized by specific characteristics and circumstances</td></tr>
</table>

*TABLE 2 FROM EQUITY SELF-ASSESSMENT IN POSTSECONDARY-EDUCATION INSTITUTIONS. CLOUD, 1980 (P. 19)

Retention/Attrition Studies

One way to reduce the effect of enrollment decline on an institution is to increase the retention rate of currently enrolled students. But just knowing the aggregate retention rate for all freshmen, however, is not going to suggest many policy changes might be effective in lowering attrition. In order to design strategies to increase retention rates, institutional administrators need to have more information about which students tend to drop out and which ones are likely to remain enrolled. Once again, enrollment analysis matrices can be a valuable tool. In this case, the cells of the matrix might represent the percentage of a category of students that were still enrolled in an institutional unit after a given number of years. Such a matrix is depicted in Figure IV.5.

Matrices such as the one in Figure IV.5 require many years of data so that a student can be tracked longitudinally across time. Each matrix is built with reference to a particular base year, and several matrices from that base year would be needed to fully depict the attrition behavior of that base class of students. The student characteristics to be included could be any combination of the ones shown in Figures III.6 or IV.4.A, and analytical techniques would be used to determine which student characteristics exhibited different retention/attrition patterns. Also, the analysis should be started from different base years, to insure that freshmen in 1977, for example, exhibit similar retention patterns to freshmen in 1976.

FIGURE IV.5

AN EAM FOR RETENTION/ATTRITION ANALYSIS

EAM	STUDENT CHARACTERISTICS (E.G., MAJOR, SEX, GEOGRAPHIC ORIGIN)
INSTITUTIONAL UNITS (E.G., COLLEGE OR SCHOOL, DEPARTMENT, PROGRAM)	(STILL ENROLLED AFTER N YEARS)

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Curricular Analysis

A very natural application of EAMs is to analyze the curriculum of a department at an institution in terms of the clientele served by each course and of its role within the various program offerings at an institution. EAMs for this type of analysis, therefore, would include details down to the individual courses (or even sections) taught by a department on one axis, and student descriptors such as program, student level, full-time/part-time, etc. on the other axis (see Figure IV.6).

Each course in a department could be analyzed according to its role at the institution. For example, does a course serve as a core course for students in a particular program, does it serve as a service course for students in a number of programs, or does it serve as an elective course for students throughout the institution. Such evaluations can help an administrator evaluate which courses in a department could be trimmed or cut back, which courses need to be maintained, which courses need to be expanded or added to, and where are there opportunities to add new courses. Curriculuim matrices of this type are also vital tools to an institutional administrator in determining the effects of program deletion, of adding a new program, of changes in the graduation requirements of students in a major, or of changes in student preferences regarding choice of major.

Market Segmentation for Recruitment Strategies

A new activity that many institutions are engaging in as an answer to declining enrollments is marketing (Ihlenfeldt 1980). Effective marketing strategies that increase the yield from recruitment efforts depend, in a large part, to understanding the market in which the institution competes. Some approaches to enrollment planning, such as the approach of Zemsky

FIGURE IV.6

AN EAM FOR CURRICULAR ANALYSIS

EAM FOR A DEPARTMENT	STUDENT CHARACTERISTICS (E.G., PROGRAMS, STUDENT LEVEL, FULL-TIME/PART-TIME, DAY/NIGHT, ...)
INSTITUTIONAL UNITS (E.G., COURSES BY DEPARTMENT)	(E.G., HEADCOUNT, STUDENT CREDIT HOURS, FTE)

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et.al. described in Chapter II, depend on identifying an institution's market from data external to an institution. For example, the lists of schools marked by students to receive college board scores is one means of determining competing groups of institutions. But institutions can also determine for themselves the types of students and regions of the country in which they should concentrate their recruitment efforts.

An EAM is, once again, a useful device for such an analysis. In this case, a variable such as student or enrollment yield might be used in the cells of the matrix. Student yield would measure the percentage or number of applicants who were accepted and then enrolled. Enrollment yield might be some measurement of the student yield that results from a certain amount of recruitment effort in a given area. The EAM itself could include various student characteristics such as geographic origin (possibly even to high school), ethnic group, age, sex, ability, socio-economic status, etc.; and institutional units such as programs or college in which the students are enrolled. Figure IV.7 illustrates such a matrix.

The purpose of the analyses of these EAMs would be to identify and classify different markets for the institution. One possible classification would be to identify:

- Primary Markets -- High Yield Students
- Secondary Markets -- Moderate Yield Students
- Tertiary Markets -- Unknown Yield

Recruitment efforts would then be designed to maintain the institution's primary markets, to discover which tertiary markets might be made into primary markets, and not to waste too much effort on secondary markets or other markets that had a low yield.

FIGURE IV.7

MARKET SEGMENTATION FOR RECRUITMENT STRATEGIES

EAM	STUDENT CHARACTERISTICS E.G., GEOGRAPHIC ORIGIN, HIGH SCHOOL, AGE, ETHNIC GROUP, SEX, ABILITY, SOCIO-ECONOMIC STATUS,...
INSTITUTIONAL UNITS (E.G., COLLEGE OR SCHOOL, PROGRAM)	(E.G., NUMBER OF APPLICANTS, NUMBER ACCEPTED, STUDENT YIELD, ENROLLMENT YIELD)

Student Aid Analysis

The final, and perhaps least typical, example of an EAM analysis to be discussed in this chapter suggests the use of an EAM to identify students as candidates for student aid on the basis of maximizing net revenue yield at the institution. In this case, net revenue yield is defined as the student's tuition and fees minus any student aid awards or other costs directly attributable to that student. The objective of the analysis would be to identify students who might attend the instituiton if offered aid, but who are otherwise likely to go elsewhere. If such students are offered a scholarship for some percentage of their tuition, and if the marginal costs of instruction is less than the remainder of their tuition and fees, then the institution will receive a net profit from their enrollment. On the other hand, if student aid is awarded to a student who planned on attending the institution anyway, then the institution will suffer a net overall loss of revenue for that student. (See page 42, in Chapter Four of Costing for Policy Analysis for a further discussion of marginal costs of instruction and of this approach to student aid awards or "tuition discounting").

An EAM for such a study would include a measure of net tuition in the cells of the matrix revenue and student characteristics by institutional units on the axes. One important institutional dimension to be considered is degree program. since there is more potential of high revenue yield in a program that is underenrolled than in one that is already serving more students than it can easily handle. An EAM for this type of analysis is depicted in Figure IV.8.

FIGURE IV.8

AN EAM FOR STUDENT AID ANALYSIS

EAM	STUDENT CHARACTERISTICS E.G., INCOME LEVEL, ABILITY, PROGRAM, ETHNICITY,...
INSTITUTIONAL UNITS (E.G., SCHOOL OR COLLEGE, DEPARTMENT, PROGRAM)	(E.G., NET TUITION REVENUE)

Summary of Applications

This chapter has presented a variety of applications of enrollment analysis matrices, focusing on many different areas of importance to institutional planning and management. In each case, the EAM could be used to: (1) explain the current situation; (2) forecast alternatives, based on different assumptions; or (3) evaluate the effectiveness of different institutional strategies. The same analytical techniques would be used in all of these applications since they are all built around the same standard relationship of students to institutional units. The precise student and institutional variables in any given analysis might vary, but they could all be derived from the same master data file. An example of a typical record for such a file, using only the data elements mentioned in this chapter, is given in Figure IV.9.

Figure IV.9

A Master Data File for the Applications in Chapter IV

Each record on data file should contain:

Identification Information:

- Student ID
- Age
- Sex
- Ethnicity
- Geographic Origin
- High School
- Ability Scores
- Socioeconomic Status

Current Status:

- Semester and Year
- Student Level
- Major
- Full-Time/Part-Time
- Day/Night
- Tuition and Fees Paid
- Student Aid Awarded

Institutional Activities:

- Courses Enrolled In and for Each Course:
  - Student Credit
  - Course Level
  - Department
  - College or School
  - Cost per Student Credit Hour

Chapter V

Implementation Guildelines

Institutional Commitment

Up to here, this document has discussed the EAM in very general terms and has postponed detailed discussions of implementatoin, limitations, and the cost of actually creating and using EAMs within an institution. This chapter will remedy some of these omissions and try to provide some general guidelines and advice to anyone who is considering the feasibility of an EAM analysis. There will be separate sections on: technical limitations; the student data base; report formats; and analytical requirements.

One additional factor that is of critical importance to the success of the EAM concept at a campus is the commitment of the institutional administrators to the process. Having a good tool that provides useful and important information is not sufficient, it must also be used by those who are making decisions. In addition, the staff and computer resources necessary to develop a powerful and flexible EAM capability are such that support for that development effort must come from the highest levels at the institution. Without that support, it would be very difficult for a research office to establish th data base and analytical expertise that are required.

Once a commitment has been made at an institution, then the development of EAM analyses can proceed. This development can be carried out one step at a time, so the initial expense does not have to be very large. As EAM reports become more accepted and more in demand at the institution, then additional elements can be added to the data base and additional analytical and reporting capabilities can be developed.

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Eventually, the institution should have evolved the internal staff expertise, student data base, and analytical software support to be able to carry out any of the EAM analyses listed in Chapter IV, in a timely and effective fashion.

Data Requirements

There are data accuracy problems to be considere in any EAM analysis. In many cases, the institutional data available when an EAM study starts may not have been used before for any analytical purpose. For example, there may be definitional problems that lead to different departments within an institution submitting incompatible data. Much time and effort may be required to identify the incompatibilities and to institute common definitions throughout the institution.

In other cases, all the student data on a campus may not be housed in one central office. Different sets of data may be "owned" by different offices at the institution, such as those responsible for admissions, student aid, and registration. Coordinating the data from many different sources, insuring that records for individual students match up, and even getting access to some of the data can all prove to be obstacles when first embarking on an EAM analysis.

One of the most frustrating problems may be the incompleteness and inaccuracy of much of the data. Variables that are dependent on student responses to questions on forms and questionnaires may be incomplete. Other variables, such as a student's residency before applying may be hard to determine from current information. And if campus data collection procedures have changed during the past few years, then the establishment of a multiyear data file could prove to be particularly difficult.

The only solace to all these initial data problems is that the data will get better over time. As people at the institution see the data being used in interesting and useful ways they will become more careful about supplying correct values. Common data bases and definitions will become established and the coordination problems between different organizational units will become part of an everyday routine. Future EAM analyses will be able to depend on more accurate and reliable data and will be able to delve more deeply into complex analytical issues.

But solving the data problems is not the only task facing the analyst. The level of detail required for most EAM studies makes a computer a necassary tool. Not only is computer storage the only feasible method for storing large amounts of student data, but computer programs are also needed to aggregate the data and produce the EAM reports. Unfortunately, the computer software needed to construct EAMs and to display them in useful formats is not uniformly available. Some institutions have commercial software packages that make EAM analysis very easy, but others may have to develop the necessary report-writing and data-management tools from scratch. Some of these software options are discussed in a later section.

The basic data requirements for EAM analyses require that information be stored for individual students, with all students records marked with a unique I.D. If course-level data is to be kept, then a record should be made of each course taken by a student. In addition, student-specific information for each student must be maintained, including descriptions of both student and institutional characteristics that apply to the student. The master student data base should be as complete as possible so that many different EAM analyses can be drive from the same set of standard

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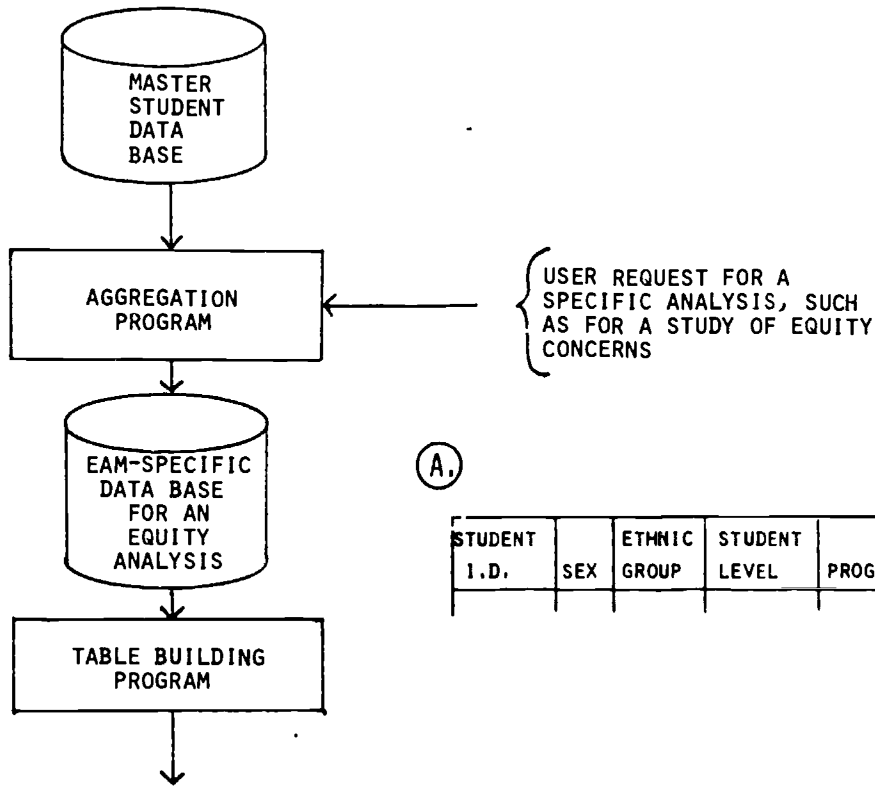
data. Aggregation programs should be used to access the master data base and pull off the subset required for a particular analysis. A table-building program would then produce the EAM to be used in the analysis. Figure V.1 provides for a graphic illustration of these steps.

A master data base is important because it greatly reduces the effort required to carry out a new analysis. The analyst can select only those variables needed (and a sample of the total number of students if appropriate) to produce a much smaller file for a particular analysis. The detail stored in the master data base can also be aggregated to more concise categories when the analysis data base is created (step (A) in Figure V.1). This "collapsing" of data is easy to do if the master data base is carefully and thoroughly documented. A full description should be written that gives a definition for each variable, describes where it is located on the data file, and discusses problems of data accuracy or incomplete information for each variable. This description will help insure that the data remain available for use for many years and that access to the data is as easy as possible.

Other considerations for the master data base are that the structure of the data file should kept as flexible as possible. It should remain possible to add new variables to the file if the need arises and updates and corrections to existing data should also be possible. A multiyear timeframe should also be kept in mind so that historical and comparative analyses can be made. The actual method chosen for storing the data on the computer is not too critical as long as the above considerations are met. A sequential data base with one block of records per student is sufficient, though if sufficiently effective and inexpensive data base

FIGURE V.1

GOING FROM A MASTER DATA BASE TO A SPECIFIC EAM ANALYSIS



(A.)

STUDENT I.D.	SEX	ETHNIC GROUP	STUDENT LEVEL	PROGRAM	FT/PT STATUS

(B.)

		MALE						FEMALE					
		FULL-TIME			PART-TIME			FULL-TIME			PART-TIME		
		WHT	BLK	OTH	WHT	BLK	OTH	WHT	BLK	OTH	WHT	BLK	OTH
MATH	LD												
	UD												
	GRAD I												
	GRAD II												
	PROF												
HISTORY	LD												
	UD												
	GRAD I												
	GRAD II												
	PROF												

HEADCOUNT ENROLLMENTS IN EACH CATEGORY

management software is available, a hierarchical or relational data base structure could be considered.

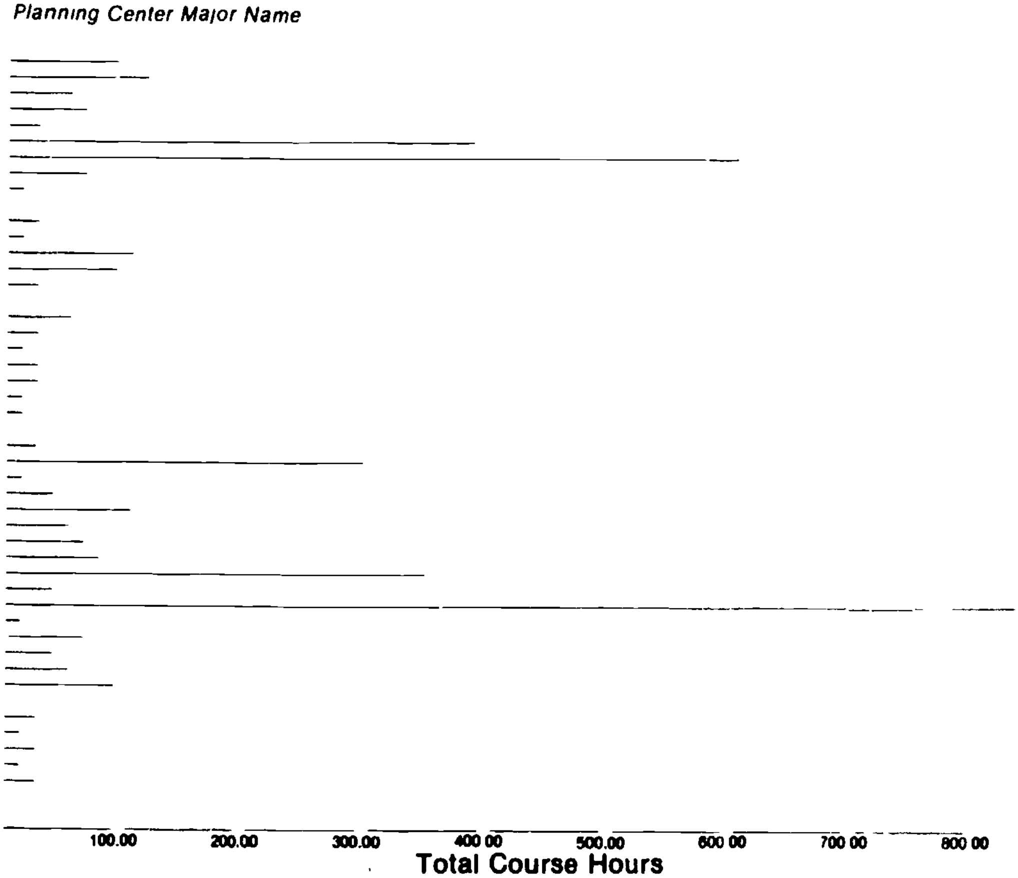
Report Formats

One very important aspect of any EAM analysis is the form of data presentation. If the reports are uninterpretable by those who are to use them then they are of little use. The table-building and report-writing software that is used must be able to produce well-labeled, concise, and intelligible output. It is also valuable to be able to generate summary reports, often consisting of row and column totals or of higher-level aggregations of the data These summaries are very useful for helping an analyst determine which cells of the detailed matrix need to be carefully examined. Summaries can also be of value in providing an overview and a quick intuitive understanding of the results of an analysis.

One very useful report-summary format is to use a histogram to represent a row or column summary of a matrix. Figures V.2 and V.3 illustrate two such histograms for a standard ICLM. Figure V.2 represents the distribution of majors across the student credit hours (SCH) generated by a department. Each bar in the histogram represents the SCHs taken from the department by students in the corresponding major, and a column on the right counts the number of course sections in the department containing at least one student with that major. Figure V.3 is similar, but it collapses the matrix to the other axis. It represents the total SCHs taken by students in a particular degree program, and it shows their distribution across different departments at the institution.

Figure V.2

Total Course Hours Taken from a Department by Different Majors*



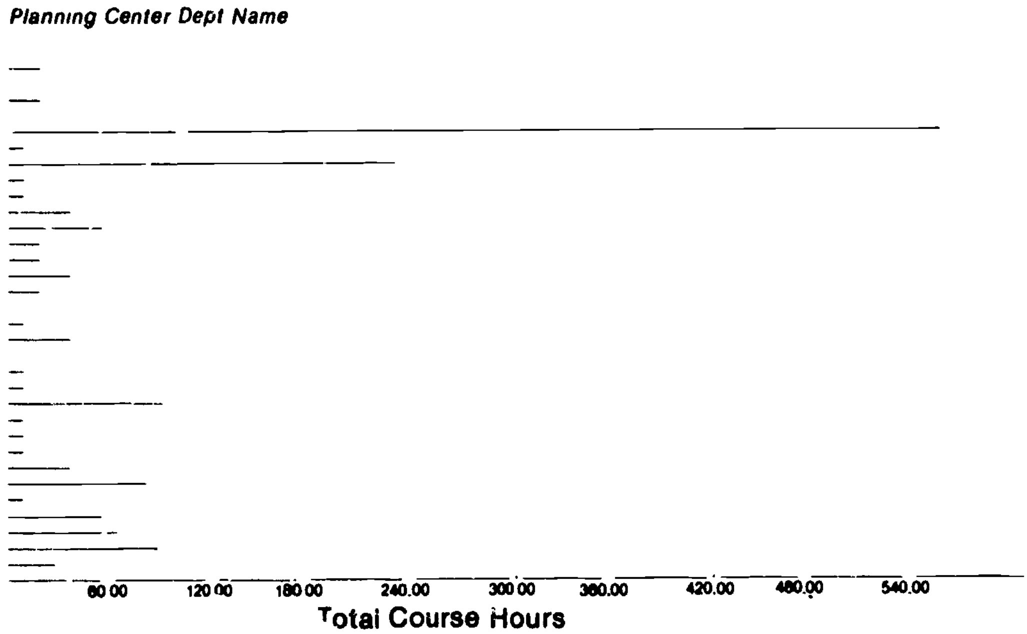
PC-Majors	Number of Sections	Total SCH
ACCT	9	75.00
ADV/PR	6	112.00
ART	10	38.00
B/OTH	6	55.00
BGS	4	23.00
BIO/P/P	25	373.00
BIOLOGY	34	565.00
CHEM	7	56.00
CIS	4	12.00
COM/SC	1	3.00
EA/SC	6	21.00
ECONOMICS	3	12.00
ED/OTH	10	95.00
EL/ED	5	54.00
ENGLISH	4	22.00
FA/OTH	1	3.00
FIN	6	49.00
G/BUS	3	21.00
GRAPHIC ARTS	5	12.00
H/PE	4	22.00
HISTORY	3	19.00
IMMAJ	4	9.00
INREL	2	11.00
INS	1	3.00
J/OTH	5	19.00
LA/OTH	19	262.00
LAW/E	1	6.00
MAGAZINE	3	29.00
MED/T	11	85.00
MGT	5	35.00
MKTG	6	48.00
NEWS EDITORIAL	7	65.00
NURSE	1	327.00
OTHER	5	79.00
PHARMACY	13	811.00
PHY/AST	2	7.00
POL SCI	6	57.00
PSYCH	6	26.00
PUB/AD	6	37.00
RAD/TV/BRD	5	76.00
RELIGION	2	2.00
RETAILING	4	21.00
SEC/ED	3	10.00
SOCIOLOGY	5	20.00
SPANISH	2	9.00
SPEC ED	2	22.00
SPEECH COMM	1	3.00
UND/U	1	1.00

*From NACUBO & NCHEMS, <u>Costing for Policy Analysis</u>, p.47

FIGURE V.3

Total Course Hours Taken by Students in a Major from Each Department*

PC-Dept	Number of Sections	Total SCH
ACCT	6	12.00
ACT/S	1	3.00
APPLIEDMU	8	16.50
ART	1	3.00
BIOL	34	586.00
C + I	1	9.00
CHEM	9	228.50
CURR	3	6.00
EA/SC	1	4.00
ECON	6	27.00
ENGLISH	13	54.00
FA/OTH	4	16.00
FIN	3	12.00
FOR LANG	5	33.00
GEOG	4	12.00
GUID	1	1.00
HEASCI	2	4.00
HIST	9	30.00
HMN SERV	1	3.00
HUMAN	2	8.00
JOURN	3	10.00
MATH	10	88.00
MGT	3	6.00
PE	5	8.00
PHARM	3	8.00
PHIL	9	31.00
PHYS	2	80.00
POL/S	3	9.00
PSYCH	5	51.00
REL	9	57.00
SOC	18	93.00
SPEECH COMM	6	21.00



*FROM NACUBO & NCHEMS, COSTING FOR POLICY ANALYSIS, P.48

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Other possible summary formats could include pie charts, scattergrams, graphs, and tables that sort the data by size of coefficient. Tables are probably the most common method, and this sorting capability is very useful. For example, a transitional probability matrix can be put into a useful report format if the transitional probability values can be displayed by magnitude (see Figure V.4).

Tables can also be used to represent values in a large EAM. If the EAM is also an ICLM, then a table of courses taken by students in a certain major is called a consumption report (corresponding to Figure V.3) and a table of programs, whose students take the courses offered by a certain department, is called a production report (corresponding to Figure V.2). Figure V.5 illustrates part of a consumption report for an institution.

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FIGURE V.4

A TRANSITIONAL PROBABILITY MATRIX, SORTED BY SIZE OF COEFFICIENT*

		SCH	FLOW COEFFICIENT	CUMULATIVE FLOW
ADM SCI MAJORS	JUNIOR			
ADM SCI MAJORS	SENIOR	777	.6196	.6196
EXITING STUDENTS	JUNIOR	298	.2376	.8572
ADM SCI MAJORS		127	.1013	.9585
	MASTERS	7	.0056	.9641
ENGINEERING MAJR	SENIOR	6	.0048	.9689
SOC&BEH SCI MAJ		5	.0040	.9729
EDUCATION MAJORS	JUNIOR	5	.0040	.9769
AG&HOME EC MAJOR	SENIOR	4	.0032	.9801
HUMANITIES MAJOR		3	.0024	.9825
SOC&BEH SCI MAJ	JUNIOR	3	.0024	.9849
LAW MAJORS	PROFESSIONAL	3	.0024	.9873
UNDECIDED MAJORS	SENIOR	2	.0016	.9889
ADM SCI MAJORS	LOWER DIVISION	2	.0016	.9905
DENTISTRY MAJORS	PROFESSIONAL	2	.0016	.9921
CAP- ADM MAJORS	SENIOR	2	.0016	.9937
UNDECIDED MAJORS	JUNIOR	1	.0008	.9945
ARTS MAJORS	SENIOR	1	.0008	.9953
SOC&BEH SCI MAJ	MASTERS	1	.0008	.9961
ADM SCI MAJORS	OTHER UG	1	.0008	.9969
AG&HOME EC MAJOR	JUNIOR	1	.0008	.9977
ENGINEERING MAJR		1	.0008	.9985
EDUC SERV MAJORS		1	.0008	.9993
CAP- ENG MAJORS	SENIOR	1	.0008	1.0001
	1,254.00=ENRL 1,254		FLOW=AMT/ENRL	

*Report from Young and Haight (forthcoming)
This table shows the flow of students from a junior Administrative Science major--various majors in the following year.

Figure V.5

CONSUMPTION REPORT EXAMPLE

	SCH
UPPER DIVISION MATH MAJORS --	1250
MATH DEPARTMENT	
LD COURSES ------------	90
UD COURSES ------------	500
GRAD COURSES ------------	170
PHYSICS DEPARTMENT	
LD COURSES ------------	10
UD COURSES ------------	35
GRAD COURSES ------------	5
ENGLISH DEPARTMENT	
LD COURSES ------------	50
UD COURSES ------------	20
GRAD COURSES ------------	3
⋮	

There may also be cases when simple statistical summaries of an EAM are desired. Therefore, basic capabilities for means, medians, subtotals, etc. are highly desirable in a reporting system. The system should also be as flexible as possible, since no set of predetermined, standard reports is even going to be able to meet all the needs that come up during an actual analysis.

Analytical Requirements

The above discussion, plus all the different types of EAM analyses described in Chapters III and IV, implicitly define the analytical requirements for an EAM analysis. Since no one system exists that solves all EAM needs, the analyst must choose from existing systems and packages the ones that best fit the needs of the institution. The needs that are not met by the standard programs must then be supplied by writing additional software that ties everything together. This section will give some criteria to help with that selection process, and then list some of the software tools that are available.

There are three basic components to a complete EAM software system: data base management, report writing, and analytical support. The major functions that each component should be able to provide are listed in Figure V.6. Any software tool being considered as an aid to EAM analysis should be evaluated according to its ability to meet some of the requirements listed in Figure V.6. Other considerations would include the tools:

- availability to the institution
- cost of operation
- ease of use

FIGURE V.6

ANALYTICAL CAPABILITIES NEEDED FOR EAM ANALYSIS OF A SOFTWARE

DATA BASE MANAGEMENT

- MAINTAIN MULTIYEAR STUDENT DATA IN A MACHINE-READABLE FORMAT
- ALLOW FOR THE ADDITION OF VARIABLES TO EXISTING STUDENT RECORDS
- ALLOW FOR THE UPDATING AND CORRECTION OF DATA VALUES
- PROVIDE AGGREGATION AND SUBSETTING CAPABILITIES SO THAT SMALLER FILES CAN BE GENERATED FROM THE MASTER DATA BASE FOR INPUT TO REPORT-WRITING AND ANALYTICAL PROGRAMS

REPORT WRITING

- A FLEXIBLE REPORTING CAPABILITY THAT ALLOWS FOR THE EASY CREATION OF USER-SPECIFIED REPORTS
- WELL-LABELED AND READABLE FORMATTING
- SUMMARY CAPABILITIES, SUCH AS HISTOGRAMS, PIE CHARTS, SCATTERPLOTS, GRAPHS, AND AGGREGATED TABLES
- SORTING FEATURES THAT ALLOW FOR THE PRESENTATION OF DATA REPORTS IN ANY USEFUL SORT ORDER

SORTING SUPPORT

- CONTINGENCY TABLE ANALYSIS TECHNIQUES FOR EVALUATING THE SIGNIFICANCE OF DIFFERENT VARIABLES AS AN EXPLANATION OF OBSERVED DATA
- SUMMARY STATISTICS SUCH AS MEANS, MEDIANS, AND STANDARD DEVIATIONS
- MODEL-BUILDING AND FORECASTING TOOLS FOR USING HISTORICAL EAM DATA AS A BASIS FOR FUTURE ALLOCATIONS OF STUDENTS OR STUDENT CREDIT HOURS ACROSS PROGRAMS, DEPARTMENTS, OR ANY OTHER EAM DIMENSION

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- time needed to train staff to use effectively
- flexibility
- versatility

Some of the tools that are available for use in EAM analyses are listed below along with a brief description of some of their strengths and weaknesses with regard to Figure V.6. Analysts who are putting together their own system should make their own judgments about these products and about any others that might be available at their institution.

- SAS--Statistical Analysis System (SAS User's Guide 1979 Edition)
  Possibly the single most versatile and useful tool for EAM analysis. Unfortunately, it is only available on computers that run IBM operating systems. It is particularly useful for its reporting functions. It is easy to sort data files and histograms, pie charts, scatterplots, and graphs can be produced with very simple commands. Labels can be provided for all data values and SAS performs most labeling and formatting automatically. SAS is not as useful as a data base management tool, but it can be used to aggregate and sort data files. SAS contains many standard statistical procedures for producing contingency table analyses and summary statistics, but it does not have any built-in modeling or forecasting capabilities.
- SPSS--Statistical Package for the Social Sciences (NIE,et.al. 1975)
  SPSS has a wider availability than SAS, but it is not as convenient to use and its report-writing and data- base manipulation capabilities are not nearly as powerful. SPSS does

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have a very good set of statistical procedures that are well documented.

- BMDP--(Dixon and Brown 1979)

  BMDP is an alternative to SPSS, but it has even less of a file manipulation capability and no report-writing features. However, it does contain some statistical routines that are not available in SPSS or SAS.

- MARK IV--(MARK IV Reference Manual, 1975)

  MARK IV is, like ..., only available on IBM computer systems. It is a powerful data-base management tool, allowing one to maintain large data files and to do merges, updates, and subsets fairly easily. It also provides a good automatic documentation feature for describing the structure and contents of a data file. MARK IV can also be used to produce a large variety of well-labeled tabular reports with simple summation and aggregation features. It cannot produce any graphical output, it does not contain any statistical procedures, and it does not have any modeling building or forecasting features.

- RRPM--Resource Requirement Prediction Model (Gamso 1977)

The RRPM is an NCHEMS product that uses an ICLM to produce institutional cost simulations. It would be of some use to institutions that wanted to use ICLM data for institutional forecasts. It does not have general data-manipulation capabilities, and while the specification of the detail of calculations is left up to the user, most of the calculations in the forecast are predetermined by the program.

- SDM--Student Data Module of the Costing and Data Management System (Haight and Martin 1975)
  The SDM is used by the NCHEMS tools to process student registration data and produce ICLMs. While NCHEMS has used SDM primarily for the production of ICLMs, it is a general tool that could be used to produce simple EAMs that used variables other than program, discipline, and student level.
- Student Flow software--(Young and Haight, forthcoming)
  The Student Flow software consists of modified and improved versions of the student data module and data management module from NCHEMS' Costing and Data Management System. It produces more readable reports than SDM (allowing the user to sort by coefficient values as in Figure V.4) and it can be more easily used to organize a series of calculations and forecasts than the RRPM. The Student Flow software can be used with any student characteristics that are available, but the total number of dimensions is limited to two different variables on each axis.
- SPS--State Planning System (Bassett, et.al. 1977)
  The SPS is a very flexible modeling and forecasting tool that was originally developed by NCHEMS for use at the state-level. The generality of the tool, however, is such that it can also be used at the institutional level. The user must completely specify the set of calculations to be used, so while it is a very powerful system, it requires a fairly high level of user sophistication. There are also practical limits on the overall size of a model developed with this tool.

- User-Written-Programs

In many institutional settings, it will be necessary to produce locally- developed software that is specific to the data base and analytical needs of that institution. Even if a tool such as SPSS is to be used, special programs often have to be written to format the data from institutional files into the form needed for input to SPSS. In other cases, an analytical method (such as some of the data-reduction and display techniques described by Tukey 1977) may not be available and special programs may need to be developed to perform those analyses. And, of course, many modeling or forecasting techniques might require local programming if tools such as the SPS are not available or are not suited to the problem being studied. The choice of computer language and the design of these programs must be determined by the local circumstances. The language chosen should be one in common usage at the institution. COBOL is usually the preferred language for file manipulation and report writing, while FORTRAN is more useful for model building and forecasting. Another language that could be utilized, it if available, is APL. APL contains many built-in matrix manipulation facilities, and it would be a very useful tool for -teractively constructing simple EAMs from a data base.

The above list is by no means exhaustive, but it is typical of the types of tools currently available. However, as with the initial establishment of a data base for EAM analysis, the first steps of assembling a system of analytical tools will be more painful than the use of an established and well-documented system. As long as the analyst keeps in mind the ultimate objective of an easy-to-use and flexible set of tools for performing EAM analyses, each development effort will build upon that overall capability and help make future analyses easier and quicker to complete.

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Bibliography

Allen, Richard H. A Proposal: Enrollment Analysis at the State Level. Boulder, Colo.: National Center for Higher Education Management Systems [NCHEMS], 1980.

Allen, Richard H., and Collier, Douglas J. Higher Education Finance Manual. Vol. 3: The Source/Use Concept. Boulder, Colo.: NCHEMS, 1980.

Bassett, Roger; Chisholm, Mark; Cherin, Ellen; and Huckfeldt, Vaughn. Introduction to the State Planning System. Technical Report 86. Boulder, Colo.: NCHEMS, 1977.

Beal, Philip E., and Noel, Lee. What Works in Student Retention. Iowa City, Iowa: American College Testing Program and NCHEMS. 1980.

Cady, Richard H. "Projecting College and University Enrollment at Institutions." Paper presented at Rocky Mountain Association of Collegiate Registrars and Admissions Officers workshop, Colorado Mountain College, Glenwood Springs, Colorado, 24-26 July 1979.

Carnegie Council on Policy Studies in Higher Education. Three Thousand Futures. San Francisco: Jossey-Bass, 1980.

Centra, John A. "College Enrollment in the 1980s". Journal of Higher Education 51 (January/February 1980):18-39.

Chisholm, Mark, and Cohen, Bethaviva. A Review and Introduction to Higher Education Price Response Studies. Boulder, Colo.: NCHEMS, forthcoming.

Cloud, Sherrill. Equity Self-Assessment in Postsecondary Education Institutions. Boulder, Colo.: NCHEMS, 1980.

Collier, Douglas J. Program Classification Structure. 2nd ed. Technical Report 106. Boulder, Colo.: NCHEMS, 1978.

Dixon, W. J., and Brown, M. B., eds. BMDP-79. Biomedical Computer Programs P-Series. Berkeley, Calif.: University of California Press, 1979.

"Enrollment Patterns: Meaning of Change." Educational Record 61 (Winter 1980):46-47.

Frances, Carol. College Enrollment Trends: Testing the Conventional Wisdom Against the Facts. Prepared for the Association Council for Policy Analysis and Research. Washington, D.C.: American Council on Education, 1980.

Gamso, Gary. The RRPM Guide: A Primer for Using the NCHEMS Resource Requirements Prediction Model (RRPM 1.6). Technical Report 104. Boulder, Colo.: NCHEMS, 1977.

Gamso, Gary S.; Service, Allan L. Introduction to Information Exchange Procedures: A Guide for the Project Manager. Technical Report 76. Boulder, Colo.: NCHEMS at Western Interstate Commission [WICHE], 1976.

Glenny, Lyman A. "Demographic and Related Issues for Higher Education in the 1980s." Journal of Higher Education 51 (July/August 1980):363-80.

Haight, Mike, and Martin, Ron. An Introduction to the NCHEMS Costing and Data Management System. Technical Report 55. Boulder, Colo.: NCHEMS at WICHE, 1975.

Haight, Michael J, and Manning, Charles W. Induced Course Load Matrix Generator. Boulder, Colo.: NCHEMS at WICHE, 1972.

Hample, Stephen R. "Cost Studies in Higher Education." The AIR Professional File 7 (Fall 1980):1/4.

Henderson, Cathy, and Plummer, Janet C. Adapting to Changes in the characteristics of College-Age Youth. Policy Analysis Service Reports, vol. 4, no. 2. Washington, D.C.: American Council on Education, 1978.

Hyde, William. "Educational Delivery Systems: Implications for Enrollment Projections for Youth and Adults." Journal of Education Finance 5 (Spring 1980):415-27.

Ihlanfeldt, William. Achieving Optimal Enrollments and Tuition Revenues. San Francisco: Jossey-Bass, 1980.

Kieft, Raymond N. "Enrollment Planning Using Student Registration Information and An Induced Course Load Matrix." College and University 52 (Winter 1977):187-94.

Kraetsch, Gayla A. "Appendix A: An Analysis of Enrollment Projections in Ohio and Nationwide: Methodology and Limitations." In A Strategic Approach to the Maintenance of Institutional Financial Stability and Flexibility in the Face of Enrollment Instability or Decline, pp. 1-46. Washington, D.C.: Academy for Education Development, 1979.

Lasher, William F.; Bodenman, David C.; and Ivery, Marsha K. "A Comprehensive Technique for Forecasting University Enrollment, Instructional Workloads, and Funding Levels." Paper presented at the Association for Institutional Research forum, Atlanta, Georgia, 27 April - 1 May 1980.

Lenning, Oscar T. The Outcomes Structure: An Overview and Procedures for Applying It in Postsecondary Education Institutions. Boulder, Colo.: NCHEMS. 1977.

Lenning, Oscar T.; Lee, Yong S.; Micek, Sidney S.; and Service, Allan L. A Structure for the Outcomes of Postsecondary Education. Boulder, Colo.: NCHEMS, 1977.

MARK IV Reference Manual. 2nd ed. Canoga Park, Calif.: Informatics, 1975.

Miyataki, Glenn K., and Byers, Maureen. Academic Unit Planning and Management. Technical Report 75. Boulder, Colo.: NCHEMS at WICHE, 1976.

National Association for College and University Business Officers [NACUBO] and National Center for Higher Education Management Systems [NCHEMS]. Costing for Policy Analysis." Washington, D.C.: NACUBO, 1980.

NACUBO and NCHEMS. Procedures for Determining Historical Full Costs. Technical Report 65. 2nd ed. Boulder, Colo.: NCHEMS, 1977.

Nie, Norman H.; Hull, C. Hadlai; Jenkins, Jean G.; Steinbrenner, Karin; and Bent, Dale H. Statistical Package for the Social Sciences. 2nd ed. New York: McGraw-Hill, 1975.

Patrick, Cathleen; Myers, Edward; and Van Dusen, William. A Manual for Conducting Student Attrition Studies. Boulder, Colo.: NCHEMS and the College Board, 1979.

SAS User's Guide 1979 Edition. Cary, N.C.: SAS Institute, 1979.

Shirey, Donald L., and Kissel, Mary Ann. "Information Requirements for Strategic Planning." In Research and Planning for Higher Education: Proceedings of the 17th Annual AIR Forum, pp. 39-43. Edited by Richard Fenske and Paul Stashey. Tallahasse, Fla.: Association for Institutional Research, 1978.

Suslow, Sidney. "Induced Course Load Matrix: Conception and Use." In Assessing Computer-Based Systems Models, pp. 35-51. New Directions for Institutional Research, no. 9. Edited by Thomas R. Mason. San Francisco: Jossey-Bass, 1976.

________. "Using a Matrix of Coefficients as a Planning Tool." In Design and Methodology in Institutional Research. Stony Brook, N.Y.: Association for Institutional Research, 1965.

Tukey, J. W. Exploratory Data Analysis. Reading, Mass.: Addison-Wesley, 1977.

Virginia State Department of Community Colleges. The Effects of Tuition Increases on Virginia Community College Enrollments. Arlington, Va.: ERIC Document Reproduction Service, ED 184 622, 1979.

WICHE. High School Graduates: Projections for the Fifty States. Boulder, Colo.: WICHE, 1979.

Wing, Paul. Higher Education Enrollment Forecasting. Boulder, Colo.: NCHEMS at WICHE, 1974.

Young, Michael E., and Haight, Michael J. Student Flow Analysis: A System for Credit Hour Projections, Enrollment Forecasting, and Attrition/Retention Studies. Boulder, Colo.: NCHEMS, forthcoming.

Zemsky and Associates. "Can Colleges Control Enrollment." Educational Record 61 (Winter 1980):10-23.

Zemsky, Robert; Shaman, Susan; and Berkberich, Mary Ann. "Toward an Understanding of Collegiate Enrollments: A First Test of the Market Segment Model." Journal of Education Finance 5 (Spring 1980):355-74.

97