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ABSTRACT

This report presents an overview of the results of an initial research effort in the development of a comprehensive national planning model for higher education. The design of the prototype model discussed in this report is based on existing or derivable institutional and student data and is designed to permit prototype planning studies to examine the impact of alternative federal programs on accessibility and, to a lesser extent, on institutional viability. The prototype model will assist primarily in identifying high-payoff areas for future research on a comprehensive planning model and additional data requirements of such a model. (Author)

A FEDERAL PLANNING MODEL FOR ANALYSIS OF ACCESSIBILITY TO HIGHER EDUCATION: AN OVERVIEW

Vaughn Huckfeldt

1973

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This report presents an overview of the results of an initial research effort in the development of a comprehensive national planning model for higher education. The design of the prototype model discussed in this report is based on existing or derivable institutional and student data and is designed to permit prototype planning studies to examine the impact of alternative federal programs on accessibility and, to a lesser extent, on institutional viability. The prototype model will assist primarily in identifying high-payoff areas for future research on a comprehensive planning model and additional data requirements of such a model.

The intent of this summary document is to present a discussion of the prototype model in nontechnical terms, so that the basic concepts can be more easily understood by the higher education community. This document includes a set of example calculations to illustrate the computations in the model.

PREFACE

This report has been developed as a result of research efforts funded by the U.S. Office of Education. An extensive amount of assistance in the design discussions and in review of the prototype federal model for analysis of accessibility to higher education was provided by Dr. George Weathersby and Dr. Wayne Kirschling. Additional comments were received from the NCHEMS Technical Council.

This report is released to officials of USOE and the NCHEMS advisory structure to provide an illustration of the prototype planning model including its assumptions, an example of calculations performed in the model, and an example output report.

The model is designed for use by the Office of Planning, Budgeting, and Evaluation in USOE, research agencies interested in national policy studies, and research agencies interested in planning models for higher education. The prototype model should not be used without due consideration given to its design assumptions, limitations on data reliability, and the fact that the model has not been pilot-tested. Consideration should also be given to the fact that the prototype model is not a comprehensive national planning model, since it provides only for analysis of accessibility to higher education. This report and the prototype model software

are being released as Type II NCHEMS software (not supported or guaranteed) and, depending on additional funding, may be replaced within one year by an improved prototype that has been fully pilot-tested and that has improved data. The model data should be updated at least yearly. The model describes terms necessary for national planning but does not attempt to set national standards on these terms.

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CHAPTER I

INTRODUCTION

Under a National Planning Model project contract from USOE, the National Center for Higher Education Management Systems (NCHEMS) has developed a prototype higher education model for the analysis of the impact of alternative financing plans on accessibility to higher education and institutional viability (the ability of institutions to meet explicit institutional goals with a given level and mix of federal aid). The basic purpose of the National Planning Model project is to provide an initial prototype higher education model that would permit prototype planning studies to demonstrate the feasibility of such analytical tools for national policy analysis of higher education and that would also assist in identifying high-payoff areas for further research needed to develop a comprehensive national planning model.

This report presents a review of where the National Planning Model project fits in the process of developing improved analytic tools at the federal level. An overview of the prototype model is presented in nontechnical terms, followed by example reports from the model and a description of other related project reports.

CHAPTER II

ONE STEP TOWARD A NATIONAL PLANNING MODEL

The National Planning Model project undertaken by NCHEMS is one step in the development of analytic tools which will assist USOE's Office of Planning, Budgeting, and Evaluation in answering questions such as, "Will basic opportunity grants or general institutional aid have the greatest impact on achieving the national goals in higher education?" There are a number of areas in which it would be desirable to measure the impact of alternative funding patterns, including:

1. Student access to various types of higher education.
2. The viability of various types of postsecondary institutions (that is, the ability of the institutions to meet explicit institutional goals with a given level and mix of federal aid).
3. National manpower production.
4. The amount and quality of research.
5. The quality of education.

A comprehensive National Planning Model would provide a simultaneous analysis in all of these areas, but limitations on modeling techniques, data availability, and the available resources have necessarily limited the scope of the present study. Student access to higher education was selected as the initial area to be studied. This initial effort is only one step in the direction of a compre-

hensive National Planning Model for Higher Education. This phase of the project has produced an operational prototype Federal Model for Analysis of Accessibility to Higher Education which:

1. is based on existing derivable institutional and student data.
2. permits prototype planning studies to examine the impact of alternative federal programs on accessibility and, to a lesser extent, on institutional viability.
3. assists in identifying high-payoff areas of research necessary to develop a comprehensive National Planning Model and the additional data requirements of such a model.

CHAPTER III

MODEL CONCEPTS AND DESIGN

A general overview of the concepts and design of the prototype model is presented in this section. To facilitate a better understanding of the computations performed in the Federal Model for Analysis of Accessibility of Higher Education, a set of examples of the computations is presented in Appendix A.

The role of the federal government in higher education in the United States is for the most part indirect. The federal government, with few exceptions, does not operate or directly control higher education institutions. Neither, with few exceptions, does it decide which students will and will not participate in higher education, nor does it direct students to particular institutions. Rather the federal government has an impact on higher education through various general and categorical financial aid programs for institutions and through many forms of student aid. The federal government does not fiscally dominate American higher education; it provides approximately 10 percent of the total resources devoted to institutions and students. Individual states and private sources collectively bear the major costs and make the majority of the financing decisions. However, the federal role is significant because it is the largest

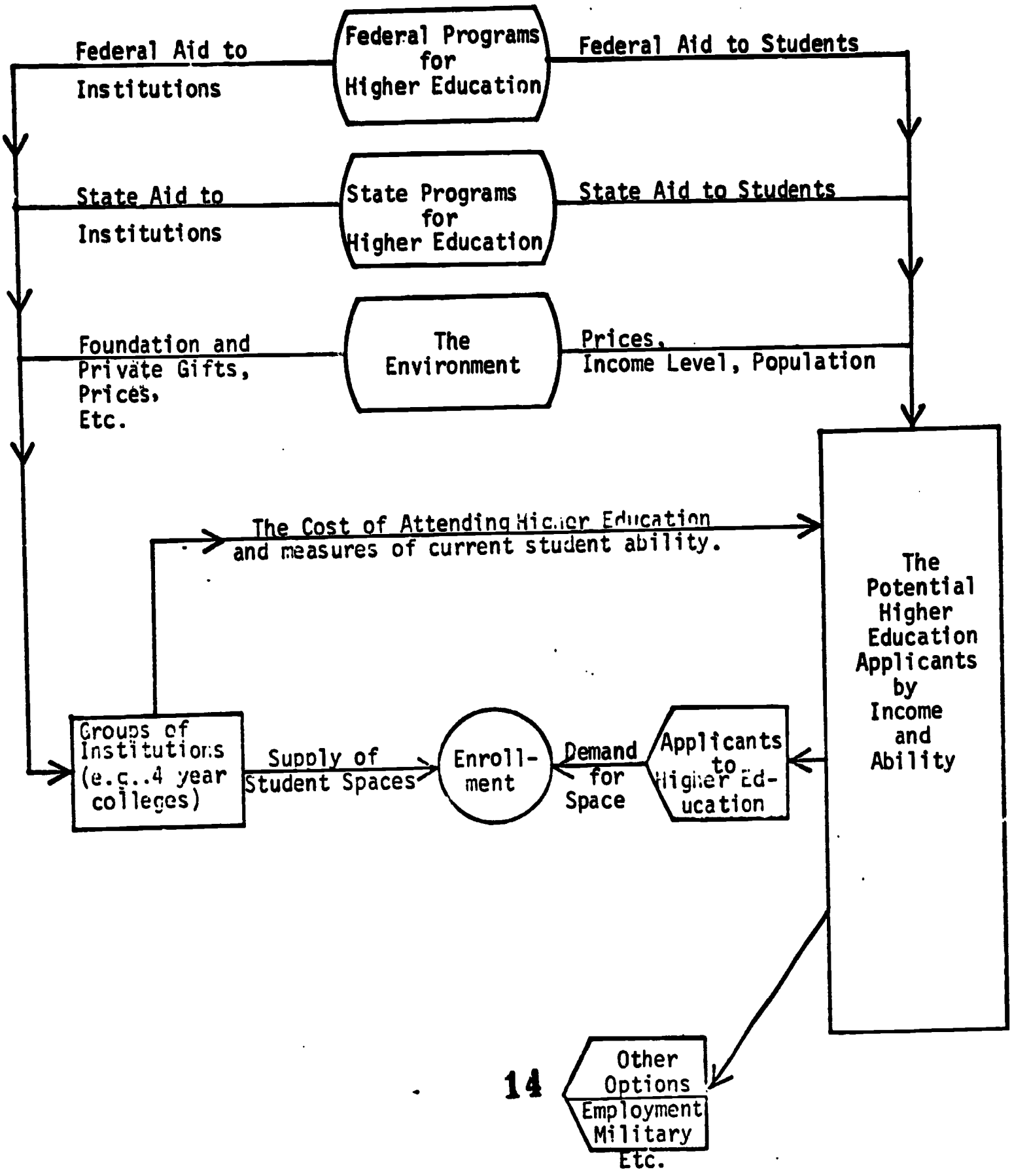
single financial supporter of higher education and the only public agent with national responsibilities.

In order to investigate the impact of federal educational programs, it is necessary to examine the complex pattern of interaction between state governments, federal governments, institutions, and individuals. This problem will be approached by first examining each of these components that influence or are part of the educational system, and then second by considering the interrelationships that exist between the components. This examination begins with the actual education aspects of each of the components of the system shown in Figure 1 and then follows with an explanation of the way the prototype model simulates or attempts to duplicate that component.

The components related to the higher education system, as shown in Figure 1, illustrate the indirect role of the government in providing financing incentives to institutions and students. The resulting actions taken by the institutions and students in satisfying their own objectives are illustrated by the interaction of the institutional supply of student spaces and the student demand for spaces, which results in the current enrollment in higher education. The components to be examined are the federal programs, state programs, environment, institutions, and individual students.

Figure 1

Components of Higher Education



(Federal Government)

The indirect nature of the educational influence of the federal government has already been mentioned. These federal actions take place when Congress establishes various institutional or student aid programs. The federal agencies then establish guidelines and administer the aid programs. The federal aid programs may be general in nature, like developing institutions aid, or may be categorical, like facilities aid.

An example of the combination of funding programs providing part of one of the current alternative funding packages is shown in Figure 2. A comprehensive summary of funding programs would include over 300 different programs.*

How, then, is this conglomeration of federal programs placed in the model? As shown in Figure 3, the prototype model does not attempt to identify each of the separate federal aid programs specifically. Rather a set of generic types of federal aid has been established. Federal aid to institutions is included in the model by establishing the following generic types of aid: federal construction aid per assignable square feet (ASF)

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*According to a study by the National Financing Commission.

FIGURE 2

THE FEDERAL CONTRIBUTIONS TO HIGHER EDUCATION

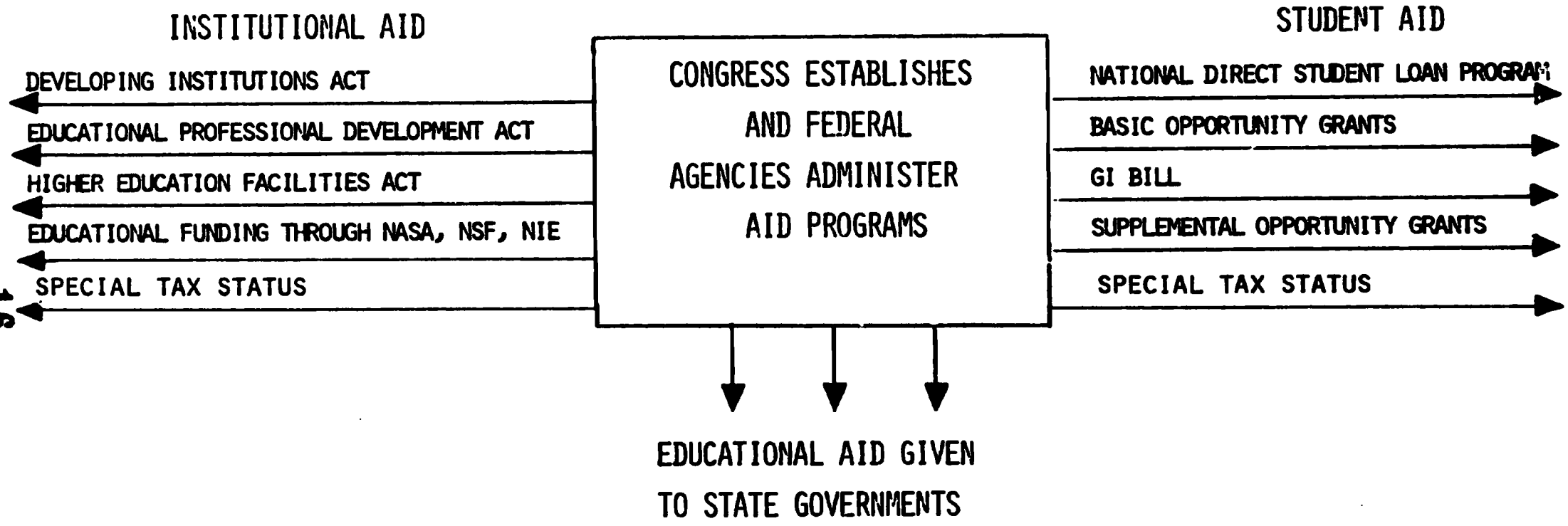
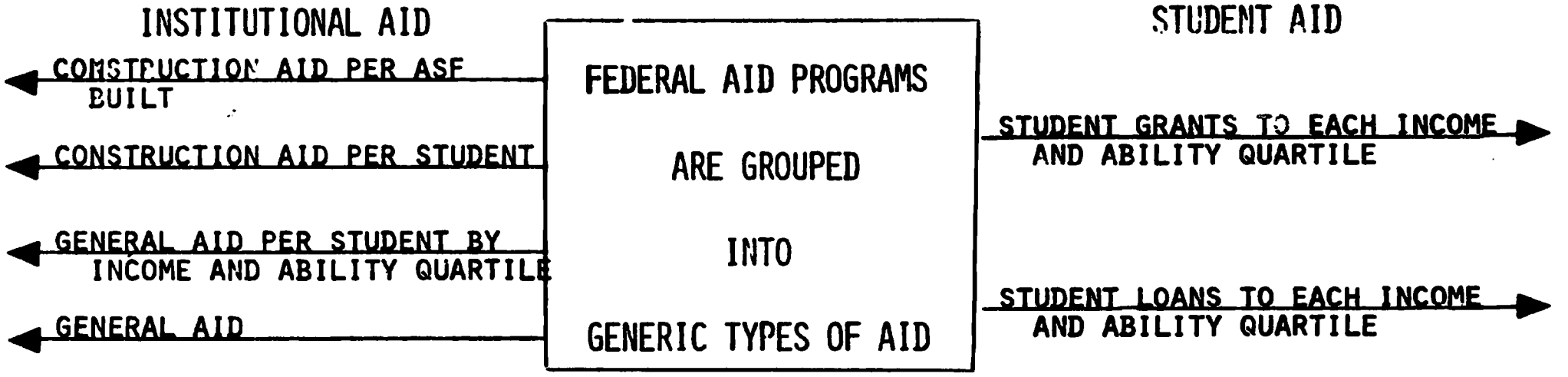


FIGURE 3

THE FEDERAL COMPONENT OF THE PROTOTYPE MODEL



of space built, federal construction aid per student, federal general aid. The financial incentives the federal government offers to individuals for attending higher education are grouped into federal grants to students and federal loans to students. Both the grant and loan categories are subdivided into income and ability quartiles for different socioeconomic groups in the population. The federal aid that is disbursed by the states is included in the institutional or student aid in the prototype model.

(State Governments)

State governments (see Figure 4) establish many institutional and student aid programs using a variety of legislative methods and organizational structures.* The state governments also function as a disbursing agent for a certain portion of the federal dollars, which come to the states as dollar matching grants or through revenue sharing. The interrelationship between the federal and state dollars is a complex set of decisions that are dependent upon many of the other statewide financial demands (transportation, health, welfare, environment, and so forth).

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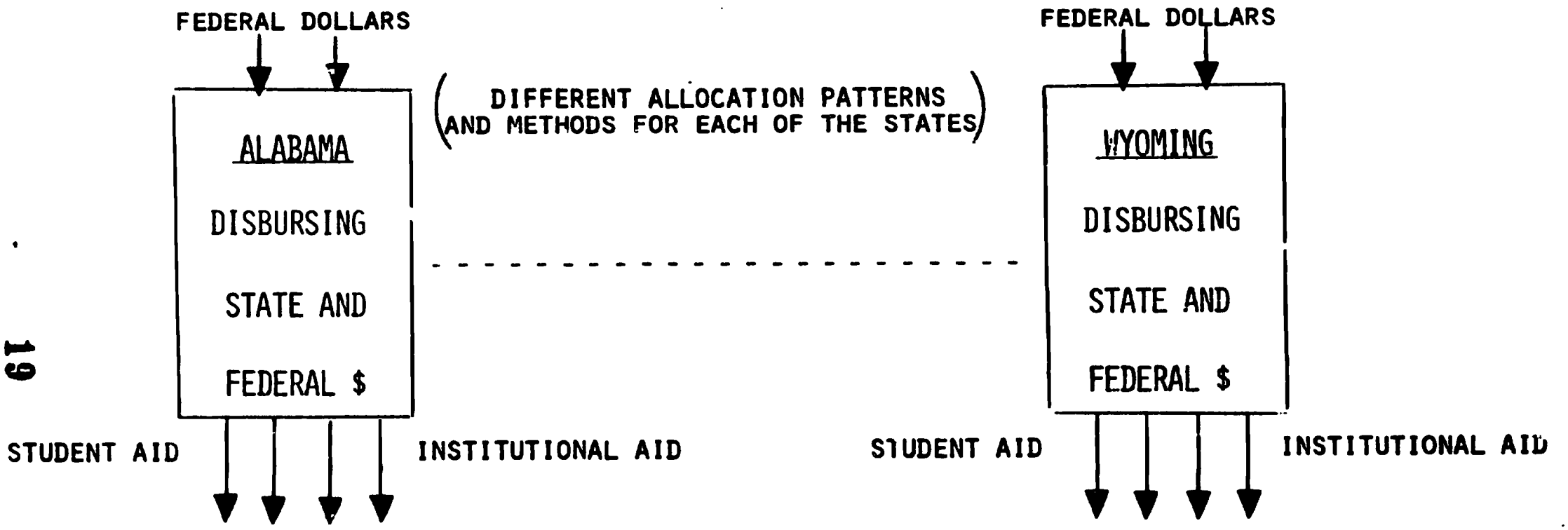
*A complete review of the statewide educational structures is found in Higher Education in the States, Vol. 2, No. 4, May 1971.

FIGURE 4

THE STATES' CONTRIBUTIONS TO HIGHER EDUCATION

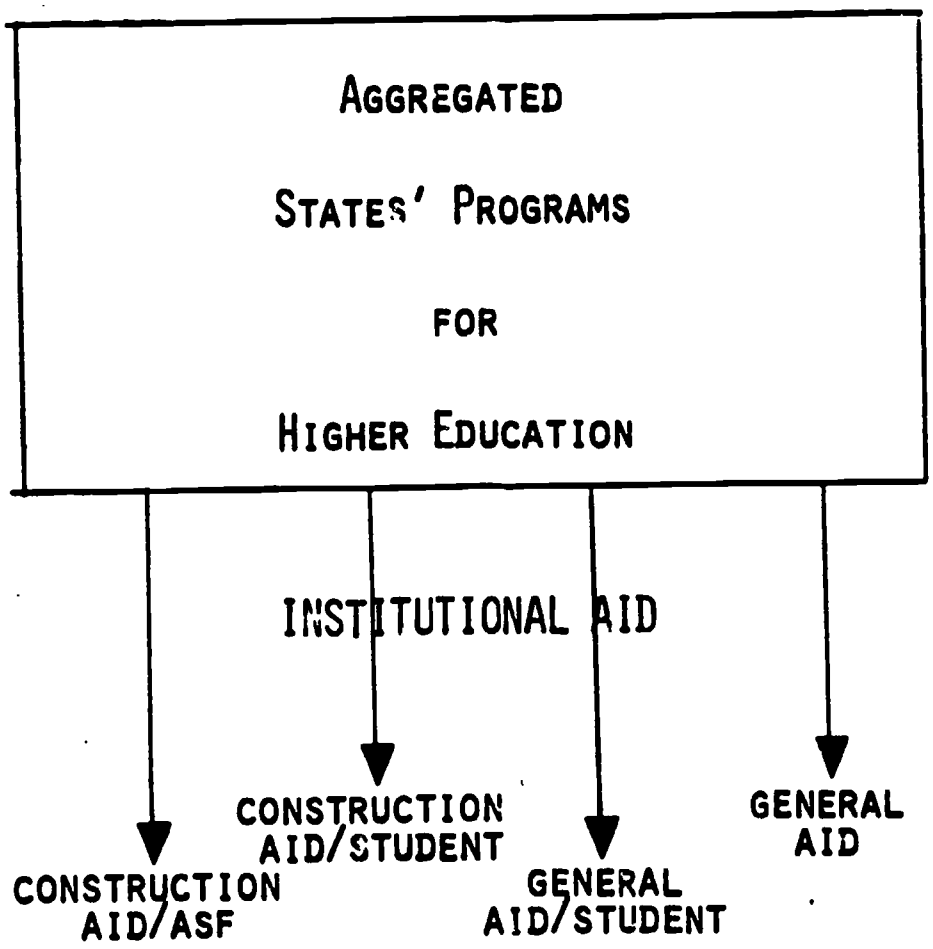


Typical state methods of allocating educational dollars to institutions include legislative allocations to line item budgets, categorical grants for facilities, general appropriations for coordinating councils or boards, and various forms of formula budgeting in which the budget is a function of items such as full-time students, credit hours, or degrees granted. The state student aid programs are typified by such programs as the regents scholarships, for example, of the state of New York. Other state student aid programs may develop as a result of future federal dollars being allocated to states with requirements that these dollars go directly to students.

As shown in Figure 5, the state governments are grouped into one unit in the prototype model. The prototype model is currently designed to look at the overall impact of alternative federal funding programs and not to provide specific state or regional information about the impact on higher education in a particular area of the country. The prototype model considers only the disbursing of generic types of the aggregated state higher educational dollars. State aid to institutions is categorized by: state construction aid per ASF built, construction aid per student, general aid per student, and general aid. The prototype model does not currently include state aid directly to students, but this is one of the first additions that should be made when sufficient data are available.

FIGURE 5

THE STATE COMPONENT OF THE PROTOTYPE MODEL



(The Environment)

To discuss all of the elements of the environment that have an effect on higher education is not possible in an overview report. Figure 6 simply illustrates several of the main environmental elements, such as industrial support, foundation grants and private gifts, general prices in the economy, rate of inflation, average yearly income, interest rates, current population, and the availability of employment and other alternatives to higher education.

FIGURE 6

THE ENVIRONMENTAL INPUTS TO HIGHER EDUCATION

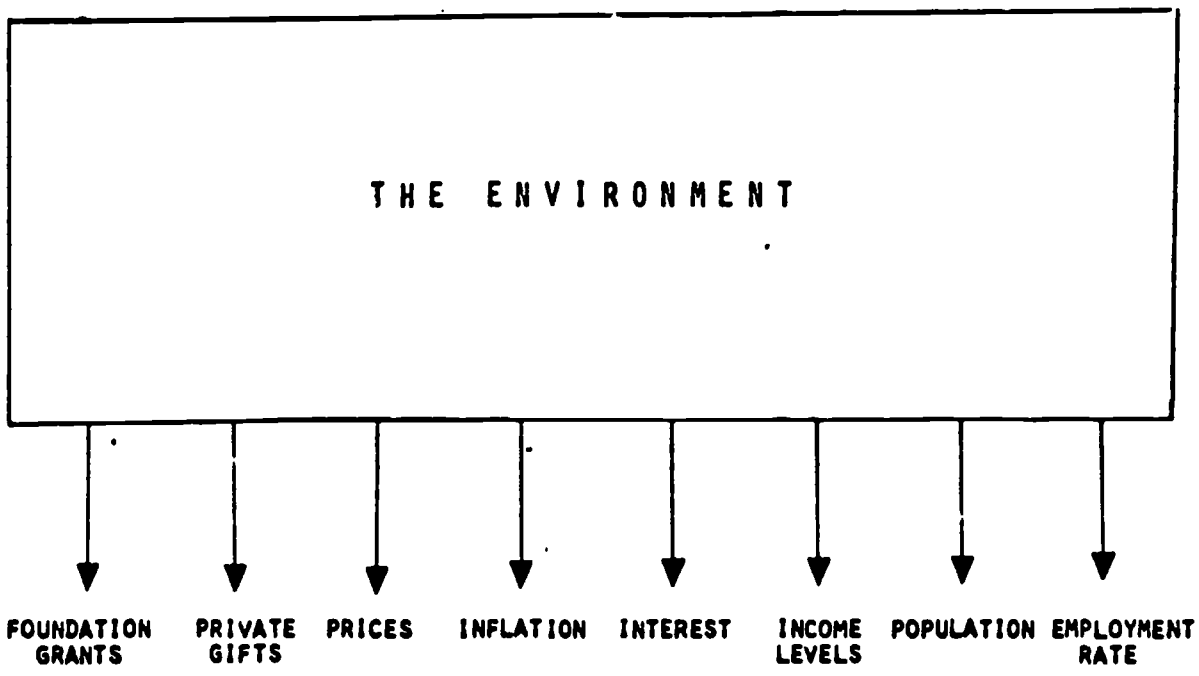
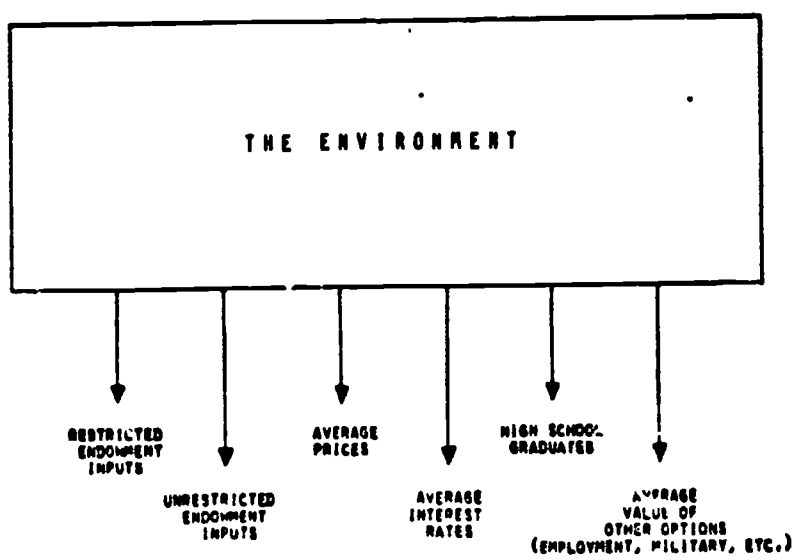


Figure 7 illustrates the elements of the environment that are included in the prototype model. The support is classified into unrestricted additions to endowments and restricted additions to endowments. Prices are included by using average prices, for example the average price of construction cost per ASF built. Average interest rates are included in the cost of capital funds financed, but inflation is not currently included in the prototype model. The population that may potentially enter higher education in the coming years is taken to be the predicted number of high school graduates, and their income level is specified as an average income for a given income quartile. The employment opportunities are simulated by considering the average economic value of selecting other options (business, military, government, unemployment, etc.) rather than attending higher education.

FIGURE 7

THE ENVIRONMENT COMPONENT OF THE PROTOTYPE MODEL



(Institutions)

There are more than 2600 higher education institutions in the United States. A comprehensive description of these institutions would consider the programmatic structure of the institutions, the primary programs of instruction, research, and public service, and the secondary support programs.* Through this programmatic structure the institutions combine the components shown in Figure 8 (faculty, facilities, students, and finances) to achieve certain institutional goals and objectives. With 2600 institutions, over 300,000 faculty members of different ranks, over 700 million square feet of space of various types, over 9 million students, and annual budget expenditures over 25 billion dollars, it is easy to see that individual institutions cannot be the components in the prototype model.

In the prototype model the institutions are categorized into groups of similar institutions as shown in Table 1. The categories used are basically those of the Carnegie Commission, with the addition of the groups of developing institutions. Each of the groups of institutions is described by the aggregate numbers of faculty by four ranks, facilities by two types,

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*See NCHEMS Technical Report 27, Program Classification Structure (1972).

FIGURE 3

AN INSTITUTIONAL GROUP IN THE PROTOTYPE MODEL

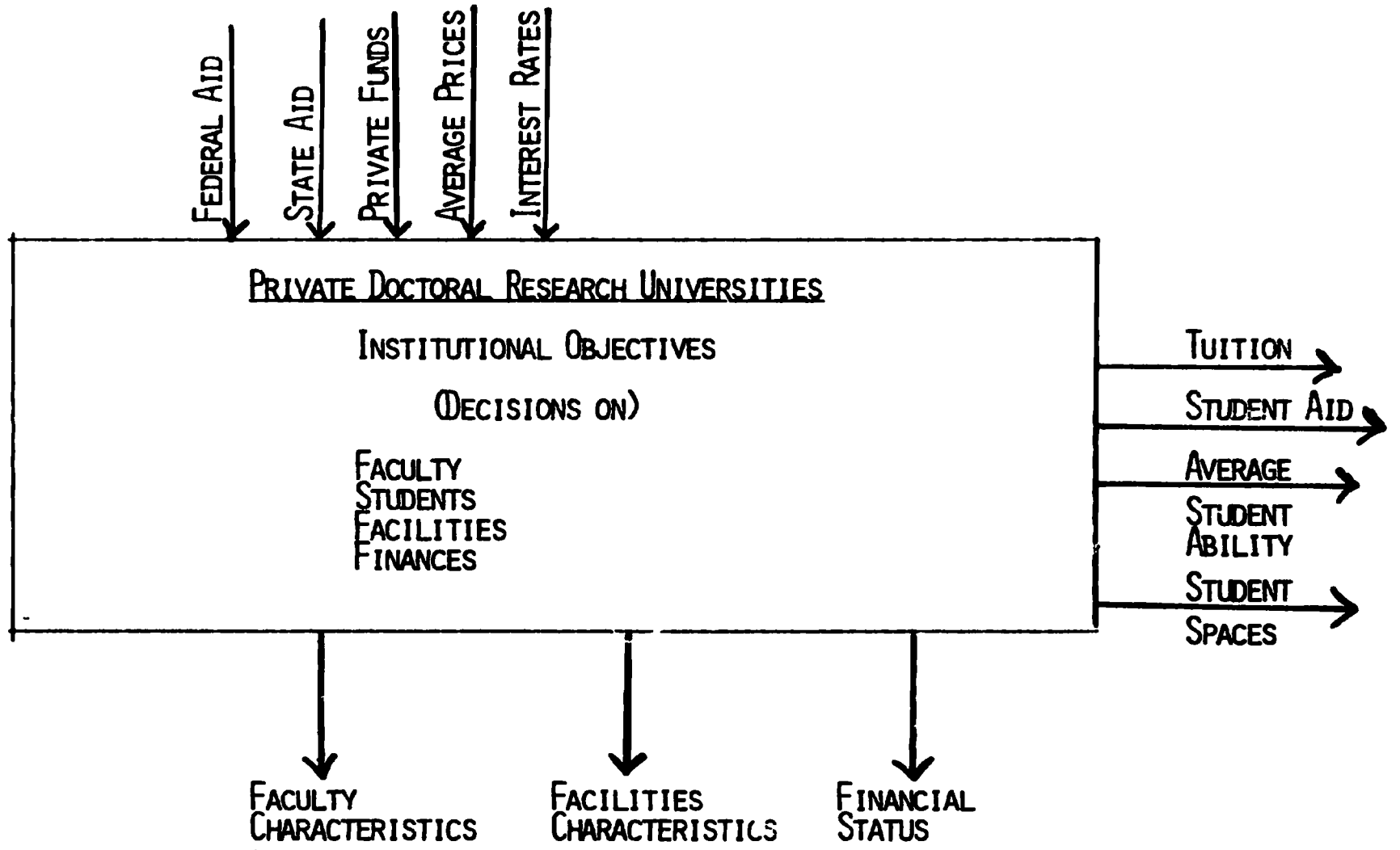

Table 1

List of Groups of Institutions

Used in the Model

1. Developing Two-Year Public Institutions
2. Public Two-Year Institutions
3. Private Two-Year Institutions
4. Developing Public Universities or Colleges
5. Developing Private Universities or Colleges
6. Public Liberal Arts Institutions
7. Private Liberal Arts Institutions
8. Highly Selective Private Liberal Arts Institutions
9. Public Comprehensive Colleges
10. Private Comprehensive Colleges
11. Public Doctoral Research Universities
12. Private Doctoral Research Universities

students by three levels (lower division, upper division, and graduate), several accounting funds, and a representation of the institutional goals and objectives. The relationships among these elements of the institutional groups are included in the prototype model by considering the decisions made by institutions as to the faculty to hire, the space to build, the students to admit, the tuition to charge, the student aid to grant, and the collective financial consequences of the decisions. The resource allocation decisions, made in the prototype model for each group of similar institutions, do not consider programmatic decisions allocating resources to specific programs of instruction, research, or public service. Thus the prototype model cannot evaluate specific funding programs that allocate aid to a type of program, and the prototype model cannot evaluate the manpower generated by specific programs. It can, however, consider the simplest version of manpower, the total number of graduates by type of institution.

Individual Students

The relationships between individuals and higher education are of two types: those individuals who are currently students in the system and those individuals who are the potential applicants to higher education. The individuals who are already students are considered as part of the institution. In examining the

accessibility of higher education to individuals, a model could take account of the fact that many socioeconomic characteristics can have an effect on an individual's decision to become an applicant to higher education. Among these characteristics are income, ability, age, sex, race, geographic location, previous educational attainment, individual goals and objectives, and peer group opinion.

In the prototype model, the potential applicants to higher education are classified into quartiles of income and quartiles of ability. While it would be desirable to include several of the other characteristics, they are omitted because of data unavailability, the increased dimensions of including them, and the fact that research has shown income and ability to be the significant components in an individual's decision about higher education.* The current prototype model considers only the new potential applicants to higher education (high school graduates) and not those seeking continuing education later in life. This can easily be expanded to a broader class of potential applicants on the availability of improved data.

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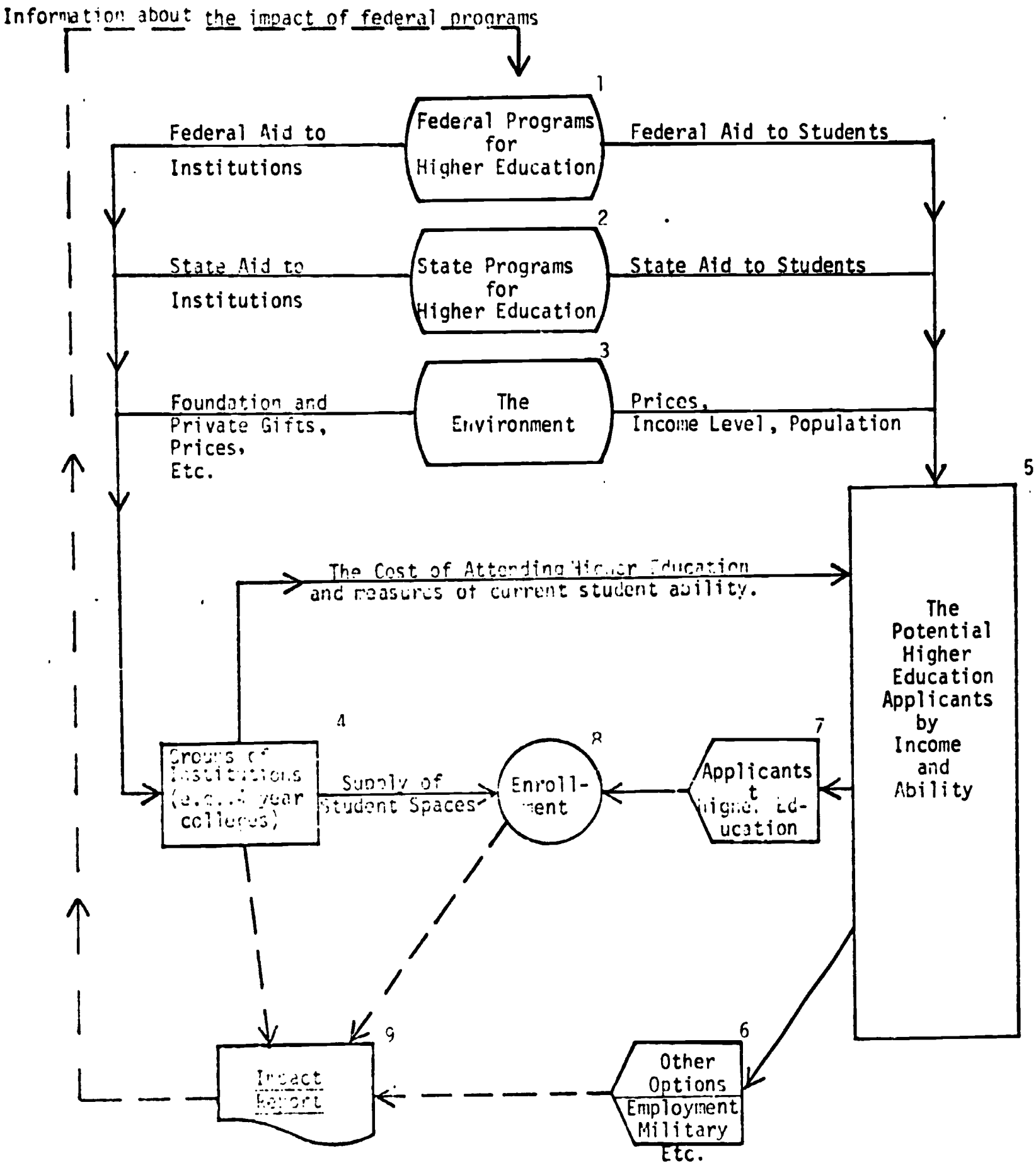
*See Miller (1971).

(Component Interrelationships)

In Figure 9, the interrelationships among the major components of the prototype model are illustrated. The user of the prototype model specifies (see box 1 in Figure 9) several years of the federal educational policies to be evaluated and specifies (boxes 2 and 3) the level of state programs, prices, population, and so forth to be held constant while varying federal policies. This enables the prototype model to separate the probable effects on student access over time that are induced by changes in federal programs from those induced by state programs or environmental factors. In response to these external financial incentives and consistent with their own internal goals and objectives, the institutions determine (box 4) a multiyear operating plan. This multiyear plan is simulated by calculating the numbers of faculty, square feet of space, students, and dollars based on average continuation rates for faculty, depreciation rates for space, and dropout rates for students. The multiyear capability permits the investigation of effects that occur over time as a result of changes in federal policies. From the multiyear institutional plan, the cost of attending a specific group of institutions (e.g., four-year colleges), and the average ability of students in the institutional group is determined. The prototype model next considers the possibilities open to individuals (box 5) as they choose the type of

Figure 9

A Federal Model of Access to Higher Education



institution they will attend. The individuals consider for each type of institution the cost of attending, the aid available to students, the makeup of the student body, and their own individual ability and income. Then, cognizant of alternative options (box 6) in employment, the military, and elsewhere, the individual may actively seek admission to a particular type of institution (box 7).

The model next combines the institutional spaces available, or the supply of education as determined from the institutional component of the model, with the demand for education as determined by the students selecting particular institutional types. This supply-and-demand interaction specifies the enrollment (box 8) to higher education, from which it is possible to determine the following: (1) the general level of enrollment in each type of institution, (2) the number of empty spaces in each type of institution, (3) the income and ability level of incoming students, and (4) the income and ability of persons who are not currently being served by higher education. Thus, each combination of alternative financing plans produces interactions among the students, institutions, states, and the federal government resulting in an impact on accessibility and institutional viability. This impact report (box 9) can then be used by the federal policy analyst to adjust the federal education policies until results consistent with federal goals and objectives are obtained.

CHAPTER IV

EXAMPLE REPORTS

The vast quantities of information available from the model would include:

1. Federal aid dollars by type of institution, general type of aid, and year in which the aid was used.
2. Institutional data on faculty by level, space by type of space, accounting statements for each type of funds, students for each income/ability quartile and level of student, and the number of empty spaces in the institution for each type of institution.
3. Student data on the number of applicants desiring entry to higher education, the number enrolling for the first time, and the number not entering higher education, all separated into income and ability quartiles.

Obviously, a report containing all of the above information for two alternative federal financing plans would be too detailed for effective use by a policy analyst. The first comparison of two plans should be made using summary reports, followed by an examination of more detailed reports as necessary.

One of the summary reports prepared for use with the model is shown in Figure 10, which may help in delineating the types of information the prototype model can provide. Consider an analysis of the following two alternative financing plans:

FINANCING PLAN 1

In addition to the current financing for higher education, add a $100 student voucher for every low-income-quartile student attending a higher education institution.

FINANCING PLAN 2

In addition to the current financing for higher education, add $100 of general institutional aid for every low-income-quartile student admitted to a higher education institution.

From Figure 10 it is seen that Plan 1 results in the admission of more students, while Plan 2 results in a higher net cash balance for the institutions and increased numbers of faculty. While this is necessarily a hypothetical evaluation of two plans, it does illustrate the types of comparisons that could be made with the model.

Figure 10

SUMMARY OF INSTITUTIONAL STATISTICS

NOTE

This report is presented as an illustration of the information the model can provide. The data presented in this report is hypothetical data and does not represent actual results of comparisons of the two financing plans.

****PLAN 1 -- SUMMARY OF 1974 INSTITUTIONAL STATISTICS---
(in Thousands)

	Net Cash Balance	Total Faculty	Total ASF Space	Total Students	Federal Dollars	Cost Per Student
PUBLIC UNIV	247,322	103.1	238,224	2,354	1,020,769	2.5
PUBLIC 4-YR	87,071	64.2	152,613	2,178	214,925	1.1
PUBLIC 2-YR	46,710	31.1	96,460	2,503	17,254	1.1
PRIVATE UNIV	84,643	38.2	94,500	706	718,774	4.6
PRIVATE 4-YR	126,164	64.2	123,806	1,339	522,310	1.4
PRIVATE 2-YR	3,779	5.5	11,250	119	4,262	2.4
--TOTAL--	586,689	306.3	746,853	9,199	2,498,294	1.8

****PLAN 2 -- SUMMARY OF 1974 INSTITUTIONAL STATISTICS---
(in Thousands)

	Net Cash Balance	Total Faculty	Total ASF Space	Total Students	Federal Dollars	Cost Per Student
PUBLIC UNIV	273,155	107.4	268,440	2,105	1,025,243	2.7
PUBLIC 4-YR	92,721	66.2	152,658	2,156	216,969	1.2
PUBLIC 2-YR	74,303	35.4	96,519	2,485	23,300	1.1
PRIVATE UNIV	92,175	42.3	94,327	688	721,254	4.7
PRIVATE 4-YR	143,643	71.2	123,744	1,274	520,250	2.4
PRIVATE 2-YR	11,205	5.9	11,113	107	4,341	1.9
--TOTAL--	687,207	328.1	746,842	8,815	2,511,357	2.0

CHAPTER V

DESCRIPTION OF OTHER RELATED REPORTS

Additional information related to the results of this research effort can be obtained from other National Planning Model - Phase II project reports. A listing of all of the project reports would include:

1. A Federal Planning Model for Analysis of Accessibility to Higher Education: An Overview. A summary document that presents a discussion of the prototype model in nontechnical terms such that the basic concepts can be understood by the higher education community. This includes a set of example calculations to illustrate the computations in the model.
2. A Design for a Federal Planning Model for Analysis of Accessibility to Higher Education. A documentation of the assumptions, design considerations, detailed prototype model relationships, and possible future research. This includes the most detailed explanation currently available for the prototype model.
3. Prototype Software for a Federal Planning Model for Analysis of Accessibility to Higher Education. A complete listing of the prototype software for:

a. MODIFY -- a routine that creates or updates the data base for the prototype model.

b. NPM 2.4 -- the current version of the prototype model.

c. VIEW -- output report routine that displays several summary reports from runs of the model comparing two alternative financing plans.

4. Preliminary Operating Instructions for a Federal Planning Model for Analysis of Accessibility to Higher Education. A report that presents very preliminary instructions for using the current prototype model software. This report is not a general user's manual as it does require extensive knowledge of the model and the software. It does, however, provide an initial set of instructions that can be used with the prototype and a basis for an improved user's manual in the future.

5. Preliminary Data for a Federal Planning Model for Analysis of Accessibility to Higher Education. A preliminary report to illustrate the types of data used in preliminary tests of the prototype model. This report contains all of the prototype data values, description of each variable, and the current source of the data.

6. Preliminary Test Reports from a Federal Planning Model for Analysis of Accessibility to Higher Education. A complete set of the current output reports illustrating the current

operational status of the prototype model. Included are the summary output reports comparing two alternative financing plans and a complete step-by-step report of the status of the model at a number of intermediate checkpoints in the model operation. The step-by-step report includes both a simulation run of the institutional sector of the model and a segment of an optimization run illustrating improvements in objective function values.

All of the above reports should be considered preliminary reports on the National Planning Models effort by NCHEMS. These reports should and will be updated and revised extensively as and if NCHEMS is able to further develop the model.

CHAPTER VI

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APPENDIX A

EXAMPLE MODEL COMPUTATIONS

To facilitate a better understanding of the computations performed in the Federal Model for Analysis of Access to Higher Education a set of examples of the computations is presented in this section. In order to keep the calculations simple and emphasize the concepts rather than the arithmetic, the data used are simple hypothetical data and not necessarily representative of the real world.

The sequence of examples follows the general logic flow of the model. For simplicity, assume only one type of federal and state institutional aid (general institutional assistance). Given that the state level of funding is $1,000,000, let us consider the impact of a federal plan of $400,000 of institutional aid and $50 of direct aid to each student. Assume the calculation of the best five-year plan for the two-year institutional group has been completed and start with the calculations for the four-year institutional group. To keep the dimensions of the problem reduced to a feasible visual display the example calculations will show one type of faculty (rather than four, as used in the model), one type of space (rather than two), one ability level (SAT = 600) and one income level ($10,000) of students (rather than four quartiles

of income and four quartiles of ability), one general operating fund (rather than several accounting funds), and a one-year institutional planning horizon (rather than five years as in the model). The model starts the four-year institutional calculations by using as input data the current state of the institutional group in terms of the current number of faculty, students, assignable square feet, and current operating fund dollars. To these values the model adds institutional decision values such as faculty to hire, space to build, students to admit, and tuition to charge according to a base-year operating plan called Plan I. The values resulting from these calculations for the four-year institutional group show the state of the institution one year later if it used Plan I. The calculations are illustrated in Figure A-1. The number of variables in each of these calculations is greatly expanded in the actual model, but the example does give a feeling for the first set of calculations.

The statement of changes in the operating fund resulting from the Plan I decisions is shown in Table A-1. The list of items included in the full statement of changes includes student aid, administrative cost, physical plan operations, and federal and state aid separated into several categories. The state and federal components of the model appear as dollar inputs to the financial statement of the institution.

Figure A-1

The Flow of Faculty, Space, and Students

	Next Year		Transition Value	x	This Year	+	Transition Value	x	Decision Variable
Faculty in FTE	98	=	.90 Continuation Rate	x	100 Current Faculty	+	.80 Continuation Rate	x	10 Faculty Hired
Space in ASF	140,000	=	.98 (2% Depreciation rate)	x	100,000 Current Space	+	1.0 (No Depreciation)	x	42,000 ASF Space Built
Students in FTE	1,000	=	.80 Continuation Rate	x	1,000 Current Students	+	.50 Continuation Rate	x	400 Students Admitted

Table A-1

Operating Fund Statement of Changes

Net Cash Balance Carried Forward From Last Year	$520,000
ADDITIONS	
Tuition Revenue (Tuition x Total Students) $300 x 1400	$420,000
State Aid	$1,000,000
Federal Aid	$400,000
DEDUCTIONS	
Faculty Salary (Average Salary x Total Faculty) $10,000 x 110	$1,100,000
Construction Cost (Cost per ASF x ASF Built) $20 x 42,000	$840,000
Net Cash Balance Forward to Next Year	$400,000

The next step in the model is to consider the planning parameters of this group of institutions. The planning parameters, desired level for each parameter, and current level of each parameter (assuming the Plan I decisions) are shown in Figure A-2. The institution desires to have a student faculty ratio of 15 to 1, while Plan I will result in a ratio of 12.7 to 1. The second planning parameter is to control the tuition level to $250, but the current plan has tuition set at $300. The last example parameter shown is for the net cash balance to equal $200,000, while Plan I will result in a $400,000 balance.

Figure A-2

The Institutional Planning Parameters

Planning Parameter	Desired Level	Current Level (Plan I)
$\frac{\text{Students}}{\text{Faculty}}$ Ratio	$\frac{15}{1}$	$\frac{\text{Total Students}}{\text{Total Faculty}} = \frac{1400}{110} = \frac{12.7}{1}$
Tuition - Desired Target Tuition	0	Tuition - Target = $300 - $250 = 50
Net Cash Balance	$200,000	$400,000

Since a number of the planning parameters calculated with current data are different from the desired levels, the model selects a better set of decision values to come as close as possible to the desired levels.* The new decision variable values for this alternative operating plan (Plan II) and the desired and realized planning parameter values are shown in Figure A-3.

Figure A-3

Alternative Operating Plans

Decision Variable	Plan I Decision Value	Plan II Decision Value	Planning Parameter	Desired Level	Plan I Level	Plan II Level
Faculty Hired	10	0	Students / Faculty	15 / 1	12.7 / 1	14 / 1
ASF Space Built	42,000	53,500	Net Cash Balance	$200,000	$400,000	$200,000
Students Admitted	400	400				
Tuition	$300	$250	Tuition - Desired Tuition	0	50	0

*Wagner, Gary W., and Weathersby, George B. Optimality in College Planning: A Control Theoretic Approach. Berkeley, California: Ford Foundation Program for Research in University Administration, 1972.

This is the process of finding the alternative decision variable values that come closest to meeting the desired levels for the planning parameters. This process is then repeated for all of the other groups of institutions.

The model then calculates the apparent cost to the student of attending each group of institutions. In this example we are using only one student type, while in the model these student calculations would be repeated for each of the 16 student income and ability classifications. In these calculations the apparent net cost to the student of attending an institution consists of tuition, plus a general cost of living, minus student aid received. For the students considered in the example institution, the general cost of living is assumed to be $1200, and the federal student aid policy being examined is assumed to be $50. Then:

Net Cost = Tuition + Living Cost - Student Aid

1400 = 250 + 1200 - 50

All of the information from this group of four-year institutions which will be needed in the student sector of the model is summarized as follows:

Supply of student spaces = 400

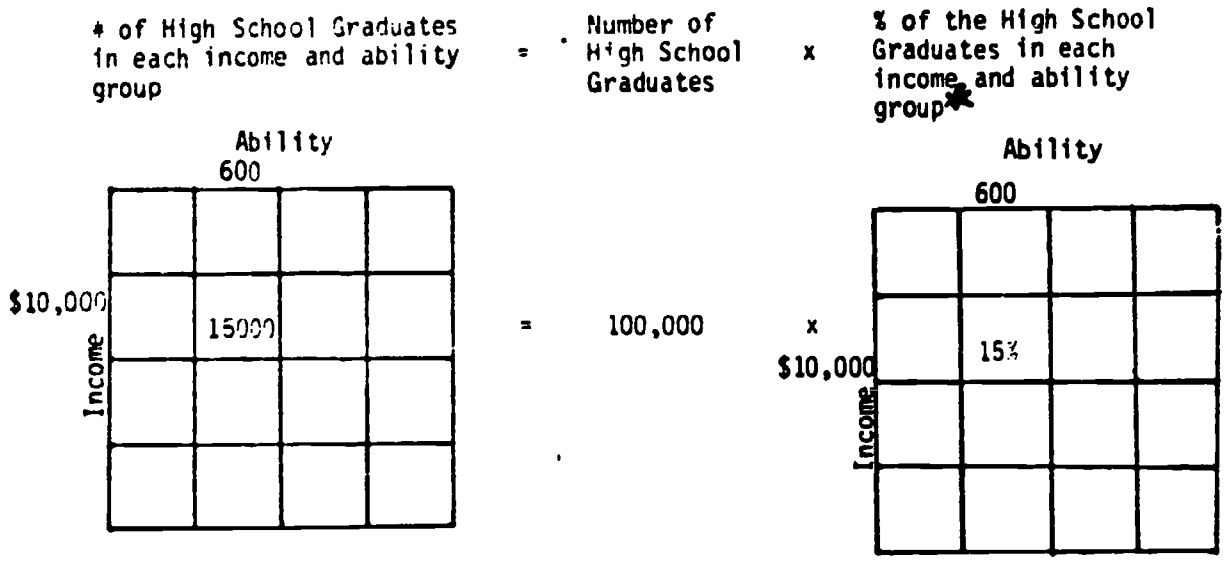
Average Total Student Ability, SAT = 600

Net Student Cost = $1400

Note that the federal financing plan being considered ($400,000 institutional aid and $50 per student) has entered into the institution's decision process in setting the supply of spaces at 400 and in the net student cost through tuition levels and student aid. The model now turns to the student sector and first calculates the number of potential postsecondary applicants by income and ability as shown in Figure A-4. To carry out the example calculations, we will trace the calculations through the student sector using an ability level of SAT = 600 and an income level of $10,000.

Figure A-4

Distribution of Applicants by Income and Ability



*Jewett, J. E., College Admissions Planning: Use of a Student Segmentation Model, Berkeley, California: Ford Foundation Program for Research in University Administration, 1971.

The model then calculates a probability that the 15,000 potential applicants will attend a given group of institutions. Consider the following data for two different groups of institutions and for the alternative of selecting employment, the military, or other options.

	Net Cost	Average Ability of Student in this Group
Group of two-year institutions	$700	500
Group of four-year institutions	$1400	600
Other options (employment, ...)	0	400

To calculate the three probabilities that the 15,000 potential students will attend the three choices, the model first calculates a value of attending each of the choices following a formula developed by Miller.* The actual constants in the formula were developed from historical student data. Remember, we are using the average applicant SAT = 600 and income = $10,000.

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*Miller, Leonard S. Demand for Higher Education in the United States. Presented at the Conference on Education as an Industry (Stony Brook, New York, June 4 and 5, 1971.)

$$\text{Value of attending} = \text{Constant}_1 \times \frac{\text{Net Cost}}{\text{Income}} + \text{Constant}_2 \times \frac{\text{Group Average Ability} \times \text{Applicant Average Ability}}{1000}$$

$$\text{Value of attending two-year group of institutions} = .28 = -4.6 \times \frac{\$\ 700}{\$10{,}000} + 0.02 \times \frac{500 \times 600}{1000}$$

$$\text{Value of attending four-year group of institutions} = .076 = -4.6 \times \frac{\$\ 1{,}400}{\$10{,}000} + 0.02 \times \frac{600 \times 600}{1000}$$

$$\text{Value of other options} = 4.8 = -4.6 \times \frac{0}{\$10{,}000} + 0.02 \times \frac{400 \times 600}{1000}$$

Then the probability of applying to any group of institutions is obtained by comparing its value to the value of attending all of the groups or selecting other options (i.e., employment, military, etc.). The actual formula in the model uses an expoential form, $e^{(\text{value})}$, but the following calculations illustrate the concept:

$$\text{Probability of applying to the four-year group of institutions} = \frac{\text{Value of attending the four-year institutions}}{\text{Value of attending two-year group of institutions} + \text{Value of attending four-year group of institutions} + \text{Value of other options}}$$

$$.015 = \frac{.076}{.28 + .076 + 4.8}$$

The next step for the model is to multiply the probability of applying to the four-year group of institutions (.015) the times the 15,000 potential applicants. Thus,

$$\text{Number of Applicants} = \text{Probability of applying} \times \text{Potential Applicants}$$

$$225 = .015 \times 15{,}000$$

Since the number of students the four-year institutional group desired to admit (the supply of spaces) was 400, all 225 applicants are admitted and the model calculates,

$$\text{Empty spaces in four-year institutions} = \#\text{ Desired} - \#\text{ of Applicants}$$

$$175 = 400 - 225$$

If the number of applicants were greater than the number the group desired to admit, the difference would then be expressed as unsatisfied student demand. When the model has completed this matching process for each of the 12 groups of institutions, the information on students, faculty, space, and finances can be obtained for each group of institutions. This evaluative information can be used to judge the impact of the selected

federal programs being analyzed. The model uses the concluding data for the first federal planning year as a base and can run a sequence of yearly plans, each building on the results of the previous calculations.

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