Planning and budgeting in adult and part-time education.

Diana Haynes Romer

University of Massachusetts Amherst

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PLANNING AND BUDGETING IN
ADULT AND PART-TIME EDUCATION

A Dissertation Presented
By
Diana Haynes Romer

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of
DOCTOR OF EDUCATION
September 1980
Education
PLANNING AND BUDGETING IN
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Approved as to style and content by:

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Robert F. Grose, Member
William Lauroesch, Member

Mario Fantini, Dean
School of Education
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ABSTRACT

Planning and Budgeting in Adult and Part-Time Education

September, 1980

Diana H. Romer, A.B., Smith College
Ed.D., University of Massachusetts
Directed by G. Ernest Anderson

This paper reports the results of a study of resource allocation and decision making in adult and part-time postsecondary education. The focus of the study was on systems of university continuing education and their efforts to meet the needs of a wide segment of the adult population. University continuing education programs were viewed within the broader framework of adult and part-time education in the United States.

The study had three phases:

1) an analysis of part-time postsecondary education from the perspective of planning and budgeting,

2) a review of the major kinds of analysis that are relevant to planning and budgeting, and

3) the development of a simple model for the analysis of alternative programs and budgets.

The major project of the study was the development of a budget model called LEARN (Lifelong Education for Adults: Resources and Needs). The model is intended serve as a tool
for planning and budgeting. It allows users to examine the financial consequences of alternative plans under a variety of assumptions about student behavior and external circumstances. Although it was designed to represent the Division of Continuing Education of the University of Massachusetts at Amherst, it can serve as the basis for models for other systems that serve part-time students.

LEARN is a variable budget model, that is, it represents income and costs as combinations of fixed and variable components and permits the analysis of the relationships between cost, price, enrollment, and net income. The model organizes and displays information in two ways, computing both direct and program budgets. Programs may be defined in terms of students' educational goals or of such personal characteristics as age and sex. Among the key features of the model are two induced load matrices, or tables giving the ratios of service use to program enrollments (for example, the number of visits to counselors by a typical fourth semester student). There is one matrix for instructional services and one for support services.

LEARN is a small, interactive model that is intended for use with highly aggregated data. Data requirements are minimal and output is concise. Each run of the model represents a single time period.

LEARN was tested with data representing the University of Massachusetts Division of Continuing Education. The
model appears to be accurate and easy to use. The variable budget provides a simple, flexible mechanism for representing income and cost. The induced load matrices appear to be helpful in analyzing the relationships between student characteristics, on the one hand, and income, cost, and the use of services, on the other. It should be noted that LEARN has not been tested by potential users; there is no direct evidence of its value as practical planning tool.

Modifications of the model to permit the representation of capacity limits and the interrelationship between enrollments and instructional salaries would increase its value as a planning tool. It would appear that such changes could be made without adding significantly to the complexity of the model.

Other additions to the model that merit consideration include the development of enrollment projection and student flow models for use with LEARN and the development of a taxonomy that can be used to describe the scope of individual services provided by an educational system.
### CONTENTS

**PART I. DECISION-MAKING IN ADULT AND PART-TIME EDUCATION**  
1

I. The Purpose of the Study; the Need for a Budget Model for Educational Systems Serving Part-Time Students 2

II. Part-Time and Adult Education  
1. Full-Time and Part-Time Postsecondary Education 13
2. Characteristics of Part-Time Postsecondary Education 29
3. Decisions about Students, Programs, and Educational Services in Adult and Part-Time Education 59

**PART II. QUANTITATIVE ANALYSIS FOR PLANNING EDUCATIONAL PROGRAMS** 67

III. Part II: Introduction and Overview: Quantitative Analysis for Planning Educational Programs 68

IV. The Role of Evaluation in Planning  
1. Introduction 74
2. Economic Outcomes 77
3. The Use of Goals and Objectives in Planning and Analysis 105
4. The Analysis of Effectiveness and Cost-Effectiveness 123
5. The Role of Evaluation in Planning: Conclusion 134
V. Enrollment Forecasting

1. Introduction
2. Forecasting Methods and Forecasting Problems
3. The Traditional Tools of Enrollment Forecasting
4. The Analysis of Demand
5. Judgmental Forecasting
6. Market Research and Needs Assessment
7. Enrollment Forecasting: Conclusion

VI. Financial Analysis for Planning and Budgeting

1. Budgeting
2. Cost Analysis and Managerial Accounting
3. Budget Models

VII. Taxonomies and the Institutional Data Base

<table>
<thead>
<tr>
<th>PART III.</th>
<th>L-IFELONG E-UCATION FOR A-ULTS, R-ESOURCES AND N-EEDS: THE BUDGET MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIII.</td>
<td>An Overview of Part II: The Project to Develop and Test a Budget Model for Adult and Part-Time Education</td>
</tr>
<tr>
<td>IX.</td>
<td>Description of the Model</td>
</tr>
<tr>
<td>X.</td>
<td>Testing the Model and Demonstrating Its Use</td>
</tr>
<tr>
<td>XI.</td>
<td>Discussion of Results</td>
</tr>
</tbody>
</table>
### APPENDICES

#### A. Estimating Course Enrollments and Use of Student Services

1. Introduction 402
2. The Use of Student Transcripts to Develop ICLM's 403
3. Using Data from Other Sources for Estimating Course Enrollments and Use of Student Services 421
4. Changes in Enrollment with Time 442
5. Enrollment Analysis Using Institutional Data: Summary and Conclusions 449

#### B. LEARN - Documentation of Listings of Computer Programs

1. Documentation for LEARN 456
2. Program Listings 477

#### C. LEARN Computer Runs - Sample Input and Output

1. Sample Terminal Session to Input New Data 521
2. Input and Output Displays 534
3. Sample Terminal Sessions to Modify Existing Data 547
LIST OF TABLES

1. LEARN - Input and Output 12
2. Enrollment in Non-Degree Programs at the Postsecondary Level 26
3. Characteristics of Adult Learners 32
4. Sources of Income for Postsecondary Education 53
5. Outline of Continuing Education Systems Suggesting Inputs and Outputs 54
6. The Program Classification Structure 268
7. Missouri Extension Management Information System 272
8. Some CESIS Descriptors, Michigan State University 274
9. Conference Classifications, Division of Continuing Education, University of Massachusetts, Amherst 274
10. LEARN: Simplified Flow Chart 283
11. LEARN - Variables and Equations 291
12. Alphabetical List of Variables (Fold-Out Sheet) 297
13. Mini-Extension, The Base Case 313
14. Mini-Extension, 10% Enrollment Increase 314
15. Mini-Extension, 10% Enrollment Decrease 315
16. Mini-Extension, 5% Decrease in the Size of Extension Classes 316
17. Mini-Extension, Adding Off-Campus Classes 317
18. Mini-Extension, Dropping the Nursing Program 319
19. University of Massachusetts Evening College, Fall, 1979, The Base Case - Input 328
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.</td>
<td>University of Massachusetts Evening College, Fall, 1979</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td>Comparison of Alternatives I Three Short-Term Alternatives</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>University of Massachusetts Evening College, Fall, 1979</td>
<td>333</td>
</tr>
<tr>
<td></td>
<td>Comparison of Alternatives II Two More Short-Term Alternatives</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>University of Massachusetts Evening College, Fall, 1979</td>
<td>334</td>
</tr>
<tr>
<td></td>
<td>Comparison of Alternatives III Three Long-Term Alternatives</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Transcript Analysis: Sample Selection</td>
<td>404</td>
</tr>
<tr>
<td>24.</td>
<td>A Typical Transcript</td>
<td>406</td>
</tr>
<tr>
<td>25.</td>
<td>Transcript Analysis: Variables</td>
<td>407</td>
</tr>
<tr>
<td>26.</td>
<td>General Computer Program for Developing ICLM's from Student Transcripts</td>
<td>409</td>
</tr>
<tr>
<td>27.</td>
<td>Fractional Load Matrices and Student Profiles from Transcript Data</td>
<td>416</td>
</tr>
<tr>
<td>28.</td>
<td>Total Enrollment and Course Enrollments from Registration Data</td>
<td>423</td>
</tr>
<tr>
<td>29.</td>
<td>Transcript and Registration Studies: Comparison of Results</td>
<td>430</td>
</tr>
<tr>
<td>30.</td>
<td>Use of Counseling Services</td>
<td>433</td>
</tr>
<tr>
<td>31.</td>
<td>Pilot Survey of Students Enrolled at the University of Massachusetts at Amherst through the Division of Continuing Education: Survey Results</td>
<td>434</td>
</tr>
<tr>
<td>32.</td>
<td>Pilot Survey: Sample Questionnaire</td>
<td>438</td>
</tr>
<tr>
<td>33.</td>
<td>Enrollment Data for LEARN: Final Estimates for the Division of Continuing Education, University of Massachusetts at Amherst, Fall 1979</td>
<td>444</td>
</tr>
<tr>
<td>34.</td>
<td>Sources of Information about Student Characteristics and Behavior</td>
<td>454</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

1. University of Massachusetts, Division of Continuing Education - Amherst Campus
   1976-1978 Registration Data
   Undergraduate Enrollment - Day and Evening 424

2. University of Massachusetts, Division of Continuing Education - Amherst Campus
   1976-1978 Registration Data
   Undergraduate Credits Per Student - Day and Evening 425

3. University of Massachusetts, Division of Continuing Education - Amherst Campus
   1976-1978 Registration Data
   Undergraduate Credits by School - Day and Evening 426

4. University of Massachusetts, Division of Continuing Education - Amherst Campus
   1976-1978 Registration Data
   Undergraduate Credits Per Student by School - Day and Evening 427

5. University of Massachusetts, Division of Continuing Education - Amherst Campus
   1976-1978 Registration Data
   Percent of Course Load by Department Groups and for Day versus Evening Classes 428

6. University of Massachusetts, Division of Continuing Education - Amherst Campus
   1976-1978 Registration Data
   Percent of Course Load - Lower and Upper Division Evening Classes 429
PART I. DECISION MAKING IN ADULT AND PART-TIME EDUCATION
CHAPTER I

THE PURPOSE OF THE STUDY: THE NEED FOR BUDGET MODEL FOR EDUCATIONAL SYSTEMS SERVING PART-TIME STUDENTS

Understanding Planning and Budgeting in Adult and Part-Time Education

The goal of this study is to improve understanding of planning and budgeting in continuing education and other programs that serve part-time students. The study has been undertaken in three phases: 1) an analysis of part-time postsecondary education - its clientele, programs, organization, and financing - from the perspective of planning and budgeting. 2) a review of the kinds of information and analysis that are relevant to planning and budgeting, and 3) the development and demonstration of a simple tool for the analysis of alternative programs and budgets.

The focus of the study is upon systems of university general extension and their efforts to identify and meet the needs of a wide segment of the adult population. University general extension programs are viewed from within the broader framework of education for part-time students.
Budget Models as Aids to Decision Making

Major decisions in educational institutions, like policy decisions in any system, are based mainly on intuition and judgment. These, in turn, are based on experience, on a broad understanding of the goals, traditions, and operations of the system, and on a knowledge of current needs and their relationship to the present political, economic, and social environment. Obviously, these complex relationships cannot be represented mathematically or programmed on a computer.

Although systematic, quantitative tools like program budgeting and management informations systems cannot replace intuition and judgment, they can supplement and sharpen them (Fisher, 1965). Models and other analytic tools can provide decision makers with relevant information that would otherwise be unavailable. Furthermore, the actual process of developing and adapting a model for an educational system can improve understanding of the system, can point up needs for additional information, and can lead to more systematic approaches to problem solving.

Systematic, quantitative analysis may be of greatest value to organizations that are breaking new ground and developing new programs — where tradition and experience are relatively weak guides to the solution of current problems. Such is often the case for adult and continuing education.
Clients, Delivery Systems and Financial Planning

For the planning, management, and evaluation of the programs and activities of an educational system, financial information should in general be organized and displayed in two different ways, the first relating income, costs, and enrollments to the delivery of services (instruction, student services, administration, etc.), and the second relating them to the groups of students served. In analyzing an agency from the perspective of its delivery system, all activities — and the income and costs associated with them — are grouped into "services" such as classroom instruction, counseling, and registration. In analyzing a system from the perspective of the needs of its students, the costs of the various services are allocated among "programs" that meet the needs of each client group served (Novick, 1965; D. Clark, et al., 1973).

Budget models can be designed to compute the income and costs of both programs and services. Such models facilitate the investigation of alternative policies and of the outcomes of decisions under various assumptions about external events. The models may help answer such "what if"

1 that is, the portion of the costs of instructional, student, and support services attributable to each client group is computed.
questions as:

-- What will be the cost of increasing the enrollment of a special bachelor's degree program by 10%? Will the change affect the level of fees required to support the program?

-- What will be the change in costs of the program if certain changes are made in the instructional and student services offered? Should the fees be changed?

-- What will be the effect of the aging of the population on the demand for instructional and student services? Will income and costs be affected?

**Requirements of a Model for Adult and Part-Time Education**

A model designed to aid in planning and budgeting for adult and part-time educational systems should be easy to understand and use and inexpensive to operate, and it should be able to represent the special characteristics of such systems.

Budget models for programs that serve part-time students must provide for:

-- classification of client groups by their educational goals and by such personal characteristics as age and sex.

-- classification of services in a manner that takes
into account both the nature and scope of each service.¹

-- consideration of the costs of any or all of the following in the analysis of individual programs: instructional services, student service, support services, and facilities.

-- analysis of both income and cost.

It is not possible to explain the need for these provisions briefly. Several features common to many systems of adult and continuing education are involved (Gould, 1974; Committee on the Financing of Higher Education for Adult Students, 1974; Cross, et al., 1974; Houle, 1974; Miles, 1973). Among the most important are:

-- the diversity of the clientele.

-- the small size and experimental nature of many of the programs.

-- the great variety of programs, formats of instruction, and support services.

-- the heavy dependence on charges to students.

-- the relatively low level of committed costs - because of the absence of a full-time, permanent faculty.

It is the thesis of this project that the needs

---

¹ The scope or level of service differs, for example, depending on whether credits are offered by examination, by various independent study arrangements, or by conventional classroom instruction. It is important to take such differences into account when the costs of alternative plans are compared.
outlined above can be met by a small variable budget model that computes - for both programs and services - estimated budgets, unit costs, and surpluses, or deficits.¹

Existing Models: The Need for a Model Designed Especially for Continuing Education

Several algebraic resource models were developed in the early 1970's as tools for planning and budgeting in higher education. The two most comprehensive and most widely tested were RRPM (D. Clark, et al., 1975) and CAMPUS (Mowbray and Levine, 1971). The models have proved to be of limited value for traditional higher education and none is directly applicable to systems that serve part-time students.

Several years of experience with the large, comprehensive models has led many analysts to conclude that these models provide only limited assistance to decision makers and that, for smaller institutions at least, the expenditure of the time, effort, and money required to develop the necessary data bases and to operate and interpret the models cannot be justified by the value of the

¹ Variable budget, or cost-price-volume-income, analysis is the study of the relationship of costs, prices, and volume to net income. Costs and income are divided into fixed and variable components. The technique is used widely for budget preparation by organizations that that depend on sales for their income (Horngren, 1970).
results. Their most serious limitations stem from the use of very large matrices to represent the relationship between program enrollments classified by students' major and level and instructional enrollments classified by department and level. As used in the early resource models, these matrices have the triple disadvantage that they: 1) require vast amounts of data, 2) use large amounts of computer time, and 3) are unstable over time (Bell, 1972; Hopkins, 1971). Because of the difficulties with these models, research in recent years has taken other directions, including the construction of smaller models for individual systems and the development of modeling systems to aid in the construction of such individualized models (Hopkins, 1972; Wiseman, 1979; Porter, 1979).

In addition to their more general limitations, the large resource allocation models have the disadvantage that they cannot represent certain important features of educational systems that serve part-time students. Major differences in financing, clientele, and organization result in different decision making patterns and in different information needs:

1 These tables are called induced course load matrices (ICLM's). All models that compute instructional enrollments from program enrollments must use ICLM's or perform the necessary calculations in ways that are equivalent to using them.
In the existing models, programs are defined in terms of college majors, graduate fields, etc. Although, in principle, the models might be used with programs that are defined in terms of student characteristics other than educational goals, this is not easily done.

In the existing models, only instructional costs and some associated departmental costs are assumed to vary with program enrollment.

Except for some versions of CAMPUS, most of the early algebraic budget models do not provide for the analysis of expenditures.

In short, because of their need for large amounts of data and their orientation towards the analysis of the relationship between traditional undergraduate majors and traditional academic departments, the earlier resource models are unsuited for the analysis of part-time postsecondary education.

**LEARN: Lifelong Education for Adults, Resources and Needs.**

A Model for Part-Time Postsecondary Education

LEARN\(^1\) is a simple, variable budget model that computes - for both programs and services - estimated budgets, unit costs, and surpluses or deficits. The model is intended for

\(^{1}\) LEARN is described in Chapter IX. Table 1 outlines the input and output of the model.
use with highly aggregated data, that is, for use with broad classifications of client groups and services. Data requirements are minimal and output is concise. The model is interactive; all data are entered at the computer terminal and results are returned directly to the terminal.

The mathematics of the model are similar to those of other algebraic resource models. There are some differences to allow for the special requirements mentioned earlier. In particular, income is included, and special features facilitate the classification of clients by characteristics other than educational goals and the analysis of the relationship between program enrollment and the budgets of noninstructional services.

It should be noted that LEARN does not provide for the description of services by type and scope. This means that the burden of deciding whether the unit costs of alternatives can be compared lies entirely with the user.

LEARN has been designed specifically to represent the characteristics of the on-campus credit programs of the Division of Continuing Education of the University of Massachusetts at Amherst. Although its usefulness will probably be greatest for systems with clients and missions similar to those of divisions of continuing education of public college and universities, its major features should be transferable to a variety of systems that provide part-time educational programs.
Anticipated Advantages of the Model

The development of LEARN was undertaken with the expectation that a small variable budget model would have the following advantages:

-- The use of conventional techniques of cost-volume-income, or variable budget, analysis would make the model easy to use and understand and assure that its output would be directly applicable to institutional planning.

-- The provision for analyzing the relationship between student characteristics and budgets would be a valuable aid to planning, especially for systems whose enrollments are sensitive to market fluctuations.

-- Highly aggregated representations of enrollment would be stable over time.

-- Data could be gathered quickly and easily.

-- The model would be simple and inexpensive to use.

-- The small size and interactive nature of the model would make it possible for users to test many alternative plans in a short period of time.

The model and the results of the tests will be described in Part III. The next few chapters will be devoted to the major features of part-time education and the analytic tools available for planning and budgeting for such systems.
### TABLE 1: LEARN ———— INPUT AND OUTPUT

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
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<tbody>
<tr>
<td>POLICIES</td>
<td>PRIMARY RESOURCE REQUIREMENTS</td>
</tr>
<tr>
<td>PROGRAMS AND SERVICE</td>
<td>number of classes, counselors, etc.</td>
</tr>
<tr>
<td>section sizes</td>
<td></td>
</tr>
<tr>
<td>counseling ratios</td>
<td></td>
</tr>
<tr>
<td>funds for program development</td>
<td></td>
</tr>
<tr>
<td>staffing policies</td>
<td></td>
</tr>
<tr>
<td>etc.</td>
<td></td>
</tr>
<tr>
<td>ENROLLMENT DATA</td>
<td>PROGRAM BUDGET</td>
</tr>
<tr>
<td># of students in each program</td>
<td>income, costs, and profit or loss for each service</td>
</tr>
<tr>
<td># of courses(^1) taken by a typical student from each program in each instructional unit(^2) (instructional load matrix)</td>
<td></td>
</tr>
<tr>
<td>impact of a typical student from each program on each support service (service load matrix)(^3)</td>
<td></td>
</tr>
<tr>
<td>INCOME DATA (income matrix)</td>
<td>DELIVERY SYSTEM BUDGET</td>
</tr>
<tr>
<td>PROGRAM, SERVICE, AND GENERAL INCOME</td>
<td>income, costs, and profit or loss for each service, including program development and central support</td>
</tr>
<tr>
<td>unit income (per student, per credit hour, etc.)</td>
<td></td>
</tr>
<tr>
<td>by income category (fees, grants, etc.)</td>
<td></td>
</tr>
<tr>
<td>COST DATA (cost matrix)</td>
<td>GRAND TOTAL INCOME, COSTS, AND PROFIT OR LOSS</td>
</tr>
<tr>
<td>PROGRAM AND SERVICE COSTS</td>
<td></td>
</tr>
<tr>
<td>unit price (per student, per course, fixed costs, etc.)</td>
<td></td>
</tr>
<tr>
<td>by cost category (instructors' salaries, counselors salaries, materials, publicity, etc.)</td>
<td></td>
</tr>
</tbody>
</table>

1 or other measure of output.

2 Units must be the same for all instructional services.

3 Units may be different for different services.
CHAPTER II
PART-TIME AND ADULT EDUCATION

1. FULL-TIME AND PART-TIME POSTSECONDARY EDUCATION

This chapter will present an analysis of adult and part-time postsecondary education from the perspective of planning and resource allocation. Special attention will be given to college and university extension programs and the features that are peculiar to them. Traditional college and university programs for full-time students will be used as a reference point in describing planning and budgeting in part-time education.

Three basic characteristics of part-time postsecondary education — the students served, the services provided, and financing — must be considered before it will be possible to explain the requirements of a budgeting model for this kind of educational system.¹

¹ From another perspective, these three areas represent two fundamental aspects of educational policy: the goals of the institution determine what kinds of students are served, while the delivery systems and financing determine the means for achieving the goals (and the degree to which they can be achieved!). The third fundamental area of educational policy, the curriculum, is related to both goals and means. However, planners and budget analysts are rarely directly involved in decisions in this area. For the purpose of resource allocation, the curriculum can almost always be considered to be part of the delivery system.
Full-Time Students and Instruction in Traditional Colleges and Universities

American higher education has been characterized for more than a hundred years by change, by diversity, and by periodic expansion of its mission to include services to ever broader segments of the population. Hence, calling a particular approach to postsecondary education "traditional" cannot be correct. Nonetheless, the term traditional higher education is widely used to identify a relatively stable and well-defined set of activities that are intended to meet the needs of young adults engaged in full-time undergraduate study at two- and four-year colleges and universities. Traditional undergraduate education is full-time degree-oriented study in regular day classes at colleges and universities (T. Clark, et al., 1973). This definition excludes many long-established programs such as honors projects, practice teaching, and adult evening classes. It is useful, however, because most undergraduates at most schools receive most of their instruction in regular day classes, and planning and budgeting for instructional programs at both two- and four-year colleges are focused on

1 See Rudolf (1961) and Veysey (1965) for the history of traditional higher education in the United States.

2 Traditional graduate education is not discussed here.
these traditional activities.

The important features of traditional higher education from the perspective of planning and budgeting can be summarized as follows:

The students are young adults engaged in full-time degree-oriented study in a limited number of well-defined fields.

Major changes in program occur infrequently. The kinds of students served and the programs of individual institutions remain relatively constant over the short term. Although American higher education has been remarkably responsive to changing needs over the long term, individual institutions tend to adapt their programs gradually and within the frameworks of existing departmental structures. The development of new programs is not considered to be a primary function of traditional higher education (Carnegie Commission, 1973c).

Instructional delivery takes the form of three or four credit courses one semester in length offered on the campus during the day using the lecture, discussion section, and/or laboratory format.

Instruction, evaluation of learning, and certification of learning are inseparably linked within the format of the traditional course. Other activities related to instruction, such as curriculum development and academic advising, are also bound together within the
course-department framework.

Supporting services are stable and well defined and do not vary among undergraduate programs: Student services (e.g., counseling and recreational activities) and institutional support (e.g., admissions and maintenance) serve needs common to young adult full-time students; similar services are provided for all undergraduates regardless of their class, program, or major. At the same time, tradition and accreditation requirements have fixed standards for institutional facilities and academic support services (e.g., libraries). Consequently, decisions about student services, academic support, and general administration can usually be separated from those related to instructional programs.

The organization is centered about the academic department as the primary producing and budgetary unit for instruction.

The teaching staff is permanent and full-time.

The income of the institution usually includes substantial sums from gifts, endowments, and/or state appropriations. Americans have always considered the college education of young adults to be a public obligation and have contributed to colleges and universities through private charity and public taxation. Such support reduces dependence on fees from students and thereby diminishes the need to consider market demand.
The analysis of instructional costs takes place in two dimensions: 1) the major and associated program of study, and 2) the instructional activities of the academic department (D. Clark, et al., 1973). The number of students in each major or other program, the number and kinds of courses they take, and the relative number and average sizes of lectures, discussion sections, and laboratories together determine the financial needs of the school and how funds are apportioned among the various departments.¹

In summary, in traditional undergraduate education, virtually all instruction occurs within the department-course framework. Programs, educational delivery, staffing, support services, and funding are all relatively stable over time. Planning and budget analysis focus on the academic department and on the direct instructional costs associated with majors and other programs — with the cost of supplementary services, such as counseling, libraries, and general administration,

¹ For example, if the department of environmental science substitutes a requirement of a laboratory course in physics for a lecture course in biology, the cost of operating the biology department will fall, while the cost of operating the physics department will rise, assuming that the necessary adjustments in numbers of faculty can be made. At the same time, the cost of educating majors in environmental science and the operating budget of the institution will also both rise because laboratory courses are more expensive than lecture courses.
considered separately. Emphasis is placed on the expenditure budget; analysis of the relationship of program and departmental income to enrollment is not a routine part of the annual planning and budgeting process.

**Recent Trends in Postsecondary Education**

The 1970's and 1980's are often described as hard times for higher education. Enrollments are dropping as the number of eighteen to twenty-two year olds in the population decreases and as the proportion of young men choosing to enter college declines. At the same time, inflation and decreasing public support for higher education and for governmental spending have hurt the schools financially. Many institutions have looked to continuing education and other programs for older students to help offset enrollment declines and alleviate their financial problems. The increased interest in adult and part-time programs did not begin with current hard times, however. Rather, the declines in enrollment and financial support have given impetus to changes that reflect fundamental long term shifts in public attitudes towards postsecondary education.
Many policy makers and educators have come in recent years to broaden their view of higher education and now think in terms of postsecondary education in general rather than focusing their attention on traditional college and university programs. The term postsecondary education refers to almost every kind of formal learning experience for adults regardless of goal, audience, sponsorship, duration, format, or academic credit offered. The use of the newer term reflects the shift in emphasis from the education of a selected portion of the young adult population to programs that can serve a major part of the adult population (Carnegie Commission, 1973c). The change in perspective stems in part from dissatisfaction with the results of traditional programs and in part from the recognition of the new needs and demands for education beyond the high school (Newman, 1971; Carnegie Commission, 1971c; Cross, et al., 1974).

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1 Excluded from the strict definition of postsecondary education are basic education and high school equivalency programs. For planning and budget analysis, the distinction between adult education and postsecondary education is unimportant.
Over the years, colleges and universities have been expected to serve an increasing portion of the eighteen to twenty-two year old population. Recent evaluations of their effectiveness in meeting the needs of a broad population of young adults suggest that traditional college programs are not suitable for many students, given their abilities, learning styles, prior experiences, and personal needs. These studies indicate that many students now marking time or dropping out of school might benefit from different kinds of learning experiences or from additional schooling when they are somewhat more mature and have had experience in full-time jobs (Carnegie Commission, 1973c).

A rapidly changing technology has caused a need for a more highly trained work force and for frequent retraining of workers at all levels. Workers may be required to learn new skills or to take advanced training to remain in their present careers, and with increasing frequency, people must change occupations, sometimes more than once during their

---

1 The literature on continuing education for professionals is extensive. Trivett (1977) has prepared a brief review of recent research. Vogel (1979) summarizes current statutory requirements for professional continuing education.
working lives.¹

As opportunity for postsecondary education has expanded, public policy has increasingly reflected a commitment to "full educational opportunity". People, it is held, are entitled to all the education that they can profit by; in particular, those whose opportunities for postsecondary education were limited when they were at the conventional college age should not be cut off forever from the advantages of further education.

The granting of adult status to persons between eighteen and twenty-one years of age has been accompanied by new perceptions of the kinds of instructional and student services appropriate for postsecondary students.

Additional leisure time has increased the demand for opportunities for personal development and enrichment.

Demand for part-time education increased during the 1970's as people born during the baby boom of the 1950's reached adulthood. The demand for such programs is greatest among people between twenty-five and thirty-five and is also high among those between thirty-five and forty-five. Demand is expected to remain high during the rest of the century even though the number of twenty-five to thirty-four year

¹ Arbeiter (1979) has reviewed the evidence on midlife career changes and concluded that voluntary changes are relatively rare and that the overall extent of major shifts in careers is not large.
olds will begin to drop in the mid-1980's (Centra, 1980; Jones, 1978).

Recognition of these needs and demands had caused a shift in emphasis from the education of a selected portion of the young adult population to programs that are adapted to the needs of many groups who together make up most of the adult population. This new, broader clientele has a far wider range of goals than do college students. They may be seeking enrichment, diversion, career-related competencies, a degree, or some other kind of certification. Because learning experiences must be structured to fit the constraints imposed by the varied life styles and learning styles of adults, instructional delivery is varied and may include such formats as practical experience, television, correspondence study, and workshops, as well as traditional classes offered at both traditional and nontraditional times and places. In addition, there have been changes in approaches to the providing of such supporting services as counseling and libraries. Finally, recognition of the continuous change in the needs and demands of adult learners has given increased importance to program development (Gould and Cross, 1974).
New and Old Programs for Adult Learners

Recent interest in education for a broad segment of the adult population had been accompanied by important innovations in two areas of postsecondary education. One change has been the development of new approaches to instruction and learning in degree-oriented programs. More significant has been the recognition that the importance of an educational program is related neither to its sponsorship nor to the awarding of degrees. As the adoption of the term postsecondary education indicates, public interest and public policy have broadened to include institutions and programs that lie beyond college and university walls.

Degree-oriented Programs

There have been two important and closely related developments in degree-oriented study: 1) the evolution of part-time programs as alternatives to full-time day study,

1 Among the many studies of adult and part-time programs are general works by Cross, et al. (1974), Gould (1974), and Portman (1978).

Shanon and Schoenfeld (1975) review the history of university extension. Works on adult and part-time degree programs include those by Houle (1974), Perry (1977), and Eldred and Marienau (1979).

Overviews and review articles on experiential learning and credit for experience have been prepared by Keeton (1976), Sharon (1976), and Shulman (1978).

The use of educational technology is reviewed by Chamberlain (1979).

Change magazine occasionally reports on in-house programs of businesses. See, for example, Luxenburg (1978).
and 2) the growth of nontraditional programs for full-time students at new and existing institutions. The philosophy and many of the features of the two kinds of program are similar. They emphasize competency-based learning and include options for directed independent study, work experience, and credit for prior learning, as well as for traditional college courses. Faculties at nontraditional institutions tend to spend a high portion of their time acting as advisors and facilitators. Many institutions offering external degrees hire advisors and mentors to fill these roles, while schools offering residential programs tend to rely on their regular faculty. As yet, relatively little use has been made of the newer educational technologies such as programmed learning, instructional television, and computer-assisted instruction, but use of these techniques is growing, and it is quite possible that they will begin to play an important role within the next few years (Gould, 1974).

Non-Degree Study

In recent years the importance of non-degree programs, particularly to job training and retraining, has received increased recognition as has the need to include this aspect of postsecondary education in the development of public policies for education. Although, until recently, public policy was focused on the "core" of postsecondary education, namely traditional colleges and universities, governmental
policies now include the educational "periphery", that is non-educational organizations and private specialty schools.

The total number of individuals enrolled in non-degree programs in the United States in 1970 was estimated to be over fifty million, with a majority of the participants engaged in vocational education. Formal, non-degree study is sponsored by a wide variety of organizations. Programs are conducted by private specialty schools, businesses, public schools, universities, charitable agencies, and individual tutors (see Table 2, p. 26).

In-house programs for employees and the programs of private specialty schools are often vocational in nature, but a significant fraction of the offerings of both types of organization are directed toward avocational interests. Programs sponsored by public and private agencies are as varied as the organizations themselves. They include church-sponsored religious education, job-training programs sponsored by anti-poverty agencies, and library-sponsored hobby, recreational, and general, educational programs. Departments of continuing education of schools and colleges offer a wide variety of programs. The public schools offer basic education and school equivalency programs as well as citizenship, vocational, and avocational programs (Carnegie Commission, 1973c).
### TABLE 2:

**ENROLLMENT IN NON-DEGREE PROGRAMS AT THE POSTSECONDARY LEVEL**

<table>
<thead>
<tr>
<th>TYPE OF ORGANIZATION OR PROGRAM</th>
<th>PERCENT OF ALL ENROLLMENTS IN NON-DEGREE PROGRAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private specialty schools</strong> (e.g., schools of truck driving,</td>
<td>20%</td>
</tr>
<tr>
<td>cosmotology, and guitar playing)</td>
<td></td>
</tr>
<tr>
<td><strong>In-house educational programs</strong> of business and governmental</td>
<td>60%</td>
</tr>
<tr>
<td>agencies</td>
<td>(20% military, 40% other)</td>
</tr>
<tr>
<td><strong>Adult and extension programs</strong> of primary, secondary, and</td>
<td>10%</td>
</tr>
<tr>
<td>postsecondary institutions</td>
<td></td>
</tr>
<tr>
<td>**Other public and private organizations, such as churches, libraries,</td>
<td>8%</td>
</tr>
<tr>
<td>and anti-poverty agencies</td>
<td></td>
</tr>
<tr>
<td><strong>Tutors</strong></td>
<td>2%</td>
</tr>
</tbody>
</table>

(Carnegie Commission, 1973c)
College and University Extension Programs

The extension programs of universities and two- and four-year colleges continue to be important elements in both degree-oriented and non-degree postsecondary education. Colleges and universities sponsor a variety of specialized programs through individual departments, schools, and other agencies and through general extension or continuing education programs.

The Cooperative Extension Service is the most important of the specialized programs. It was established to bring the services of the land-grant colleges to farmers and farm families and now offers a wide range of programs directed towards agricultural and economic development as well as to nutrition and other family needs. In the last few years, increasing emphasis has been placed on meeting the needs of low-income youth and families. In conducting its programs, the Cooperative Extension Service uses a wide variety of approaches, including radio, television, newspapers, seminars, demonstrations, and occasionally, formal classwork.

In its early years, college and university general extension was primarily extension in time and location; credit courses equivalent in content to regular university courses were offered to individuals who were unable to attend regular classes as full-time students. This service remains an important component of university extension.
Today, however, university general extension involves a much broader range of clients and activities. In fact, divisions of continuing education and general extension are involved in the full range of degree-oriented and non-degree study.

Extension programs will be discussed at greater length later in this chapter.
2. CHARACTERISTICS OF PART-TIME POSTSECONDARY EDUCATION

As was pointed out in the beginning of the chapter, the kind of information needed for planning and budgeting in adult and nontraditional educational systems is determined in large part by their clientele, delivery systems, and financing. These three characteristics will now be discussed.

**Adult and Part-Time Learners**

Who are the potential clients of part-time postsecondary education, why are they seeking further education, and what encourages them to return to school or keeps them away?

Approximately fifty million Americans - or about half the adult population - engage in some sort of part-time, formal learning activity each year. Some are enrolled in Bible study classes, some take golf lessons, many are learning to grow vegetables and to plan low-cost menus, still more enroll in short professional courses, and many hardy souls are working slowly towards bachelors' and advanced degrees. Adult learners are almost as varied a group as adults generally. They have diverse goals, diverse lifestyles, diverse approaches to learning, and a variety of reasons for enrolling in educational programs. What is more, their needs and wants change rather rapidly
with time.

Understanding the motivations and needs of adult students is essential in part-time postsecondary education — for financial planning as well as for making decisions about the subject matter, times, places, and methods of instruction and for designing such supporting services as counseling and study centers.

There have been many studies, surveys, and analyses of participation in adult education.¹ Some of the most important findings will be summarized at this point.

Cyril Houle (1961) has examined students' approaches to learning. He suggests that there are three basic types of adult student: The goal-oriented learner has specific vocational, personal, or other reasons for seeking further education. The activity-oriented learner is seeking diversion or social experiences, while the learning-oriented individual seeks knowledge and skills for their own sakes. The relative importance of these motivations to an individual student helps determine the types of program and

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¹ Studies of participation in adult education fall into two general categories: 1) statistical reports, and 2) studies of motivation.


Studies of motivation include works by Houle (1961), Carp, et al. (1974), and the Committee on the Financing of Higher Education for Adult Students (1974).
modes of instruction that will satisfy his or her needs.

Carp, et al. (1974) investigated the educational goals of adult students. 1) Job-related and vocational goals predominate among adult learners. Also important are 2) social and escape reasons and 3) information and intellectual development. Smaller numbers of students seek further education for 4) citizenship, 5) family reasons, and 6) church and spiritual reasons. The same survey also investigated the areas of learning pursued by adults and obstacles to learning cited by persons not now enrolled in educational programs (see Table 3, p. 32).

Using a third approach to classifying adult learners, the Committee on the Financing of Higher Education for Adult Learners (1974) characterized students by the direct force that persuaded them to enroll in educational programs. Students may enroll: 1) for personal reasons, 2) for family reasons, 3) because the program is sponsored by or required by their employer, 4) because of other job-related incentives or requirements (salary incentives, peer pressure, or legal or professional requirements), or 5) because they are recruited by a government-sponsored, public problem solving program. ¹ The last three categories often involve requirements by an employer or some other

¹ For example, the Job Corps, home economics programs of the Cooperative Extension Service, and federal drug abuse programs.
### TABLE 3. CHARACTERISTICS OF ADULT LEARNERS

#### REASONS FOR LEARNING

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information and intellectual development</td>
<td>69%</td>
</tr>
<tr>
<td>Job and educational development</td>
<td>48%</td>
</tr>
<tr>
<td>Requirements of employer, profession, or authority</td>
<td>27%</td>
</tr>
<tr>
<td>Social reasons</td>
<td>22%</td>
</tr>
<tr>
<td>Escape reasons</td>
<td>21%</td>
</tr>
<tr>
<td>Desire to be a better parent or spouse</td>
<td>19%</td>
</tr>
<tr>
<td>Church or spiritual reasons</td>
<td>16%</td>
</tr>
<tr>
<td>Citizenship</td>
<td>16%</td>
</tr>
</tbody>
</table>

#### AREAS OF LEARNING GIVEN AS FIRST CHOICE BY ADULT LEARNERS

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hobbies and recreation</td>
<td>42%</td>
</tr>
<tr>
<td>Vocational subjects</td>
<td>38%</td>
</tr>
<tr>
<td>General education</td>
<td>25%</td>
</tr>
<tr>
<td>Religious studies</td>
<td>14%</td>
</tr>
<tr>
<td>Home and family life</td>
<td>13%</td>
</tr>
<tr>
<td>Personal development</td>
<td>11%</td>
</tr>
<tr>
<td>Public affairs</td>
<td>6%</td>
</tr>
</tbody>
</table>

#### OBSTACLES TO LEARNING CITED BY WOULD-BE LEARNERS

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>53%</td>
</tr>
<tr>
<td>Not enough time</td>
<td>46%</td>
</tr>
<tr>
<td>Don't want to go to school full time</td>
<td>35%</td>
</tr>
<tr>
<td>Home responsibilities</td>
<td>32%</td>
</tr>
<tr>
<td>Job responsibilities</td>
<td>28%</td>
</tr>
<tr>
<td>Amount of time required to complete program</td>
<td>21%</td>
</tr>
<tr>
<td>Afraid that I'm too old</td>
<td>17%</td>
</tr>
<tr>
<td>Lack of information about programs available</td>
<td>17%</td>
</tr>
<tr>
<td>Scheduling problems</td>
<td>16%</td>
</tr>
<tr>
<td>Strict attendance requirements</td>
<td>15%</td>
</tr>
<tr>
<td>Low grades in past, no confidence</td>
<td>13%</td>
</tr>
<tr>
<td>Desired courses unavailable</td>
<td>12%</td>
</tr>
<tr>
<td>No child care</td>
<td>11%</td>
</tr>
<tr>
<td>Too much red tape in getting enrolled</td>
<td>10%</td>
</tr>
<tr>
<td>Not enough energy</td>
<td>9%</td>
</tr>
<tr>
<td>Don't enjoy studying</td>
<td>9%</td>
</tr>
<tr>
<td>No transportation</td>
<td>8%</td>
</tr>
<tr>
<td>No place to study or practice</td>
<td>7%</td>
</tr>
<tr>
<td>Tired of school</td>
<td>6%</td>
</tr>
<tr>
<td>Don't meet entrance requirements</td>
<td>6%</td>
</tr>
<tr>
<td>All other</td>
<td>12%</td>
</tr>
</tbody>
</table>

*Carp, Peterson and Roelfs, 1974*
authority. As would be expected, financial support tends to come from the general public, from employers, and from individual students in proportion to the degree to which each group sees itself benefiting from a particular program.

There have been many other studies of participation in part-time postsecondary education. For example, there have been analyses of the effects of financial aid on motivation, comparisons of participants in home study versus classroom programs, and statistical studies of the educational and social backgrounds of participants in various kinds of programs.¹

The characteristics of adult learners will be discussed from another perspective in the chapter on enrollment forecasting (see Chapter V).

Educational Delivery

The second basic characteristic of an educational institution is its delivery system - the teaching, advising, libraries, extracurricular activities, and other services that are provided to the students and the facilities and administrative services that are associated with them. The delivery systems of part-time postsecondary education are varied, and they may even be quite traditional. But

¹ See the references cited earlier in this section.
whatever the delivery system of a particular institution, the variety of possible approaches to instruction, student services, and other activities creates a need for additional information for educational planning. For program planning and budget analysis in part-time postsecondary education, it is usually desirable to have detailed information about the services actually used by different types of students and the costs of these services.

Systems of postsecondary education may provide any of the following services and facilities for non-residential students:

**Instructional services:** Instruction, evaluation-examination, certification of learning, coordination of instruction, and the planning and development of instructional services.

**Academic support services:** Libraries, computers, museums, etc.

**Other direct support services:** Academic advising, counseling, admissions, registration, records, financial aid, public information, program development, and service enterprises (e.g., bookstores).

**Internal support services:** Personnel services, accounting, mailing, clerical services, etc.

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1 The list of services is based, in part, on the Program Classification Structure (Gulko, 1971).
Facilities: Classrooms, laboratories, libraries, computer centers, study centers, etc.

Although all of these services and facilities must be available to those who need them, the means of providing them vary from institution to institution and even from program to program within a single system. In many part-time programs, not all the needed services and facilities are provided directly by the sponsoring institution.

Instructional Services

Traditionally in American colleges and universities, instruction is centered about the academic department (Houle, 1974). While at European universities for example teaching, examination and the granting of degrees are sometimes the responsibility of different agencies, in American schools these components are rarely separated. The academic department acting through its individual members or as a body provides a full complement of instructional services. In addition to the basic functions of instruction, evaluation-examination, and certification of learning, the college professor helps students seek out other sources of information and expertise, advises them about their courses of study, and guides their academic development. As a member of a department and of the faculty, the professor also shares responsibility for coordinating instructional activities and for program
development (Houle, 1974). In part-time programs the package of services associated with the traditional course and department structures is often split apart; this is the case for such programs as credit-for-prior learning, independent study and credit-by-examination. Often the students themselves are expected to seek out services that are not provided by the institution (Miles, 1974).

Facilities and Support Services

In traditional colleges and universities, facilities and support services are similar among most programs and institutions. This is because they are designed to meet needs that are common to young adult full-time students, because of the standards of accrediting agencies, and also quite simply because of tradition. In part-time programs however there are great differences in facilities and services. For example, such programs may use WATS telephone lines, television studios, study centers, or conventional classrooms, they may offer accommodations in dormitories or in hotel rooms or offer no accommodations at all, and they may or may not provide such services as counseling. In addition, certain services (placement, for example) may be made available to some students and not to others. In fact, for some programs (many external degree and correspondence programs, for example) no facilities and only a minimum of support services are provided.
Not only are there differences among part-time programs in the facilities and services that are provided, but there are also differences in the ways in which they are provided and financed. Services and facilities may be provided directly by the educational institution or indirectly through some other public or private agency (the public library, another school, or the parent institution of a university general extension system, for example). Furthermore, the facilities and services may be available at no direct cost to the sponsoring institutions or to the students, or there may be charges to the institutions or directly to the students.

In short, in part-time postsecondary education there is great diversity in kinds of facilities and support services, in their quality and scope, in their source, and in the manner in which costs are assessed to various agencies and individuals.

Resource Analysis in Delivery Systems Serving Part-Time Students

The diversity in the clientele and services of part-time postsecondary education creates special difficulties for the analysis of the programs and services of such systems. In the planning and evaluation of traditional college programs (majors, for example), it is possible to concentrate on the direct costs of instruction and on anticipated outcomes. It can be assumed, for the
purpose of quantitative analysis at least, that both instructional and supplementary services are similar among programs with similar goals.

In part-time education, because of the variety of services and of mechanisms for providing them, analysis is more complex. It is necessary to specify what services are provided, how much service is available (i.e., the quality and scope of each instructional and supplementary service), who is providing the service, and who is paying for it. Furthermore, in comparing programs it is usually impossible to consider instructional costs alone; if an institution offers significantly different supporting services to students in different programs, it may be necessary to allocate the costs of the services among the programs.

Unfortunately, there are serious obstacles to using cost analysis and other quantitative techniques to provide information of this sort in a form that can be helpful for decision making:

1) A budget must be organized according to some system of classifying activities, but classifications and taxonomies can never capture all the important differences between delivery systems. This difficulty exists, of course, in the analysis of traditional systems, but in the latter case, familiarity with relatively uniform systems enables decision makers to use simplified classification as
starting points for evaluating and comparing programs.

2) The number of credit hours assigned to nontraditional learning experiences is not necessarily an indicator of the resources expended by the institution or of the changes brought about in the skills and knowledge of the students. Consider, for example, the awarding of college credit for passing standard examinations, for a university sponsored program in Europe, and for correspondence courses. ¹

3) The allocation of the costs of support services is also arbitrary and must be done differently for different types of decisions. ²

In short, the simplifying assumptions that make cost analyses for traditional programs relatively uncomplicated and their results relatively easy to interpret usually do not apply in part-time education. For this reason,

¹ The traditional credit hour serves a number of functions. It is primarily a device for certification of learning. In addition, it is often thought of as a measure of both input (resources made available to the student) and output (amount learned). Whatever the limitations of using the credit hour as a measure of input and output in traditional programs, they are far greater in nontraditional ones. In fact, the credit hour may have no relationship whatever either to what is provided by the institution or to what is expected of the student. (Consider credit for prior learning, for example).

² For most decisions, the relevant cost is the incremental cost of providing the necessary services to students in a particular program.
quantitative analysis will probably continue to play a limited role in the planning and evaluation of part-time programs (Glenny, 1974). The use of cost analysis in comparing part-time programs will be discussed in somewhat greater detail in Chapter VI.

**Educational Delivery in College and University Extension**

Up to this point, characteristics that are common to most part-time postsecondary systems have been considered. While college and university extension programs share most of these characteristics, they have other attributes that make planning for these systems different from that for proprietary schools, noneducational agencies, and other institutions that offer programs for part-time students.

Beginning with the passage of the first land-grant act and continuing with the emergence of community colleges, American colleges and universities have developed a strong commitment to community service. Extension systems were created to help fulfill this commitment. As general extension systems have evolved over the years, they have developed tradition of serving a broad segment of the adult population. In carrying out their missions, most have operated without permanent faculties and instead have acted

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1 In contrast to the U.S. Cooperative Extension Service and other specialized programs of individual schools, departments, and agencies within a college or university.
as facilitating agencies, bringing together students and a variety of resources from their parent institutions and from other sources.

Although not all college and university extension systems have developed in this particular way, a significant number have. The fact that such systems are facilitating agencies that are committed to serving a wide range of needs has important effects on educational delivery and consequently on planning and resource allocation. The discussion that follows will focus on this kind of system. 

Diversity and Change in University General Extension

The extension systems of universities and two- and four-year colleges are unique among providers of postsecondary education in the breadth of their programs, in the diversity of their delivery systems, and in their commitment to responding to the changing needs of adult learners. The offerings of many general extension systems span almost the entire spectrum of postsecondary education. They may include undergraduate and graduate degree programs, entry level vocational training programs, professional and

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1 The U.S. Cooperative Extension Service and the continuing education systems of many large public school systems offer a considerable variety of programs and rely, in part at least, on temporary teaching staffs. Methods of analysis that are appropriate for college and university general extension systems are likely to be of value for these systems as well.
vocational continuing education programs, and a variety of recreational and other avocational programs. In addition, general extension systems offer special programs for particular population groups such as women and the elderly. These programs may be directed towards personal, family, or vocational needs, they may be largely recreational, or a single program may attempt to meet a wide range of needs of the population group it serves.

The delivery systems of general extension services reflect the diversity of needs and lifestyles of their students. Instruction may be offered through conference programs, day and evening classes held at a variety of times and places, television broadcasts, correspondence programs, and so on. A wide range of supporting services may be available. Finally, because the needs of adult learners change over time, program development is a major on-going responsibility of general extension systems.
General Extension Systems as Facilitating Agencies

The second distinctive characteristic of extension systems is that they operate without permanent faculties. A system that lacks a permanent teaching staff performs a fundamentally different kind of service from that of a school with a regular faculty. The major service of a traditional college or university is instruction, while that of a system with no permanent faculty is one of broker or agent between students and services.

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1 Among other educational agencies and programs that are often operated without permanent faculties are: 1) college and university general extension services, 2) special extension services of colleges and universities (i.e., programs in particular fields offered by individual schools, departments, and other agencies), 3) public school adult and continuing education programs, 4) educational programs of agencies other than schools (e.g., libraries, churches, the "Y"), and 5) in-house programs of businesses and industries. There are also agencies in every one of these categories that operate with permanent faculties. Among the programs that usually operate with permanent teaching staffs are those of 1) private specialty schools, 2) private tutors, and 3) the Cooperative Extension Service. The Cooperative Extension Service, however, does not rely exclusively on its own staff for its educational programs. (See Table 3 for a list of the kinds of agencies that sponsor part-time programs.)

2 Research and other non-teaching programs are not being considered in this paper.

3 The following analogy illustrates the difference. Airlines and travel agencies are both in the travel business, but airlines provide transportation while travel agencies provide travel services. Even though both kinds of agency may provide ticket sales, travel information, and tours, their purposes and functioning are quite different.
In traditional colleges and universities, academic departments that are staffed by full-time professional scholars and teachers provide the primary services of the institutions. The major long-term financial commitment of these institutions is to instruction, that is to the permanent teaching staffs. There is also a significant investment in a physical plant.

In contrast, the resources of systems without permanent faculties are devoted to the coordination of instruction, program development, public information, and other facilitating activities. The professional staffs of these systems are made up of coordinators and administrators who bring together students and educational services. Instruction is provided either in cooperation with other agencies or by teachers who are hired for specific short-term assignments.

The absence of long-term financial commitments to specific programs contributes in no small measure to the ability of general extension systems to respond to changing needs. These systems have the flexibility to revise their programs and services when opportunities arise and when market or financial studies indicate the need for change.¹

¹ Obviously, organizations that have control over their own finances have more flexibility than do those under tight control of their parent institutions or of state agencies.
Planning and Educational Delivery in General Extension Systems

The characteristics just described have significant effects on the operation of general extension systems, especially on program development and on the organization of instructional delivery.

Program development in general extension systems. The needs and wants of adult learners change continuously, not only with respect to job-related programs, but also for programs designed for recreational and other avocational purposes. In order to meet these needs, general extension divisions must continuously identify and evaluate needs, develop an awareness of the needs among the appropriate clientele and funding authorities, and develop the curricula and the instructional and other services required to meet them. The development of programs, then, requires a combination of market analysis, financial planning, advocacy, organization, and promotion.

While, in traditional schools, new programs are usually developed by the faculty, in extension systems, approaches vary. Program development may be the responsibility of instructional units, of separate program development units, or of certain administrative units within the extension division. The process, especially as it relates to the curriculum, is complex. It usually involves extensive consultation and negotiation between representatives of the
extension system, members of the faculty of the parent institution, and/or representatives of such outside agencies as professional associations and businesses. The roles of the various participants tend to be ill-defined and overlapping (Daigneault, 1963). Several approaches are common as are combinations of these: 1) credit offerings and degree programs are often developed in cooperation with the appropriate faculty of the parent institution; such programs almost always require faculty approval, 2) programs may be developed in cooperation with outside agencies, and 3) programs may be designed by members of the extension system; in this last case, either the staff members must themselves be experts in the appropriate field, or they must consult with those who are so qualified.

Planning, analysis, and program development. Because general extension divisions often expend substantial sums on program development, they must consider its costs and effectiveness. This need creates special problems for analysis. First, because program development is usually a shared responsibility of several units, its costs may be difficult to isolate. Second, because program development does not always result in the implementation of changes, it is often impossible to allocate development costs to the individual programs that they were intended to benefit. Third, the questions of how much should be expended on program development and what level of risk-taking is
acceptable for a particular system are matters of basic policy that cannot be answered by cost-effectiveness analysis. For these reasons, the evaluation of program development is largely a matter of educated judgment. Nonetheless, if program development costs are identified and, where possible, associated with changes in income and enrollment, some insight may be gained into this aspect of the operation of general extension services.

The organization of instructional delivery in extension systems. The nature of general extension has another major impact on the functioning — and on the decision-making patterns — of these systems. Because of the absence of academic departments and permanent faculties, there can be, and in fact is, considerable variety on the organization of instructional delivery (Shannon and Schoenfeld, 1965).

In traditional higher education, the academic departments are responsible for the programs of majors1 as well as for instruction in particular academic disciplines. That is, the academic departments are responsible for specific client groups and for well-defined components of the educational delivery systems; they are also cost centers for accounting purposes.

In systems with no permanent faculties, the units

1 Lower division general education programs, however, are the responsibility of the entire faculty.
responsible for instruction function quite differently. They may have one of three kinds of focus or some combination of the three:

--- academic or professional disciplines (e.g., law, education),

--- client groups (e.g., women, the elderly, public officials),

--- instructional delivery (e.g., correspondence, television, evening classes, conferences).

As is the case for traditional academic departments, units may draw upon the services of each other. In contrast to traditional schools, however, the instructional units of general extension divisions are often heavily involved with such supporting activities as program development, counseling, and public information.

Planning in systems with diverse organizational structures. For planning and evaluation in any postsecondary educational system, it is desirable to know the costs of each service (e.g., the evening school, the registrar's office) and of each instructional program (e.g., lower-division general education, nursing associate degree).

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1 For example, in a traditional school, the chemistry department may require its majors to take physics, while in an extension division, an agency for the continuing education of teachers may use the services of the instructional television center and the evening school.
At the same time for day-to-day management and cost-control it is necessary to associate costs with organizational units. In traditional higher education this kind of information can be obtained from a relatively straightforward two-dimensional analysis of instructional costs: 1) the instructional components of the departmental budgets and 2) the costs of each major and lower division program as determined by the course load distributions of typical students in each program. Because of the variations in the organization of instruction in extension systems, there is no single generally applicable approach to budget analysis for these systems. The method of analysis most suitable for a particular agency depends upon its clientele, delivery system, and organizational structure.

Educational Delivery in General Extension: Conclusion

It has been seen that certain features of general extension systems affect planning and budget analysis. First, because of the commitment of the systems to respond to changing needs, special attention is given to program development and to the evaluation of this activity. Second, because of the diversity in the organization of the delivery systems, approaches to planning and budget analysis vary

1 Although there is more uniformity in methods of budget analysis for traditional education, variations are significant (see Chapter VI).
among institutions. For these reasons, any general model for budget analysis in extension systems must permit alternative ways of displaying information about programs and services and must allow for a variety of approaches to allocating costs and income.

Finally, it may be noted that there are many similarities between the operations of university general extension systems and those of the Cooperative Extension Service and of continuing education divisions of large public school systems. Like general extension, these systems offer a wide range of programs and use a variety of approaches to providing services. A budget model for university general extension may be useful for these systems as well. In fact, since a model for general extension must take into account the widest possible range of clientele, delivery systems, financing, and organization, such a model can represent any system of postsecondary education.¹ Simpler and less general models may, of course, be more useful for systems with more traditional delivery systems or with only one or two programs.

¹ As will be seen in Chapter VI, only a modular model, or more likely, a model building system, could achieve this goal.
The Financing of Part-Time Postsecondary Education

Now that the special characteristics of university extension systems have been outlined, the discussion will return to the basic features of part-time postsecondary education and to financing, the last of the major factors that shape the decision making processes of these systems. After a general comment, three topics will be considered: 1) sources of income, 2) the influence of the income structure on the planning process, and 3) the effects of suggested changes in financing.

Three closely related features characterize the income structure of most systems that serve part-time students: funding is client related, institutional subsidies are low or nonexistent, and income is subject to a relatively high degree of uncertainty. Although the funding of part-time programs runs the full range from complete subsidy to complete self-support, many programs are heavily dependent on student fees, other direct payments for services, or enrollment-based subsidies. Unlike traditional college and university programs, these systems rarely

---

1 The major exceptions are manpower training programs and other government sponsored public problem solving programs (the Cooperative Extension Service, for example).
receive a substantial portion of their incomes in the form of flat appropriations, endowment income, or donations. Most public assistance for part-time and adult education is for programs that meet special needs (e.g., literacy programs, drug education, and basic job training). In short, the income structure of most programs for part-time students resembles that of a market system.

**Sources of Income in Part-Time Postsecondary Education**

Several types of funding are common in part-time postsecondary education. Funds may be received: 1) for the education of individual students, 2) for the support of programs or services, or 3) for general institutional support (see Tables 4 and 5, pp. 53 and 54).

1) Fees and tuition received from individual students or on their behalf may be:

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1 Many states have shifted in recent years from flat appropriations to enrollment-based formula funding for traditional full-time programs in higher education. The change is one of many factors pushing colleges and universities toward a market approach to planning for their traditional programs as well as for their part-time programs. This matter will be discussed in Chapter VI.

2 According to Nolfi and Nelson (1973), continuing education divisions in private colleges are usually expected to return a substantial profit to the institutions while state laws often require that public programs for part-time and adult students be self-supporting. In both cases, however, there are usually hidden subsidies, such as the use of space and services. The true net income of divisions of continuing education is rarely known.
### TABLE 4: SOURCES OF INCOME FOR POSTSECONDARY EDUCATION

#### PUBLIC AND PHILANTHROPIC FUNDS

**GENERAL SUPPORT**
- Flat grant appropriations
- Endowment income
- Gifts and other direct aid
- Indirect support (services, facilities)

**PROGRAM SUPPORT**
- Grants for public problem solving programs
  - (e.g., teacher training, community development)
- Grants for special interest programs (e.g., fine arts)

**STUDENT SUPPORT AND ENROLLMENT-BASED AID**
- Student subsidies for public problem solving programs
  - (e.g., law enforcement)
- Subsidies for students with special needs or merits
  - (e.g., the G.I. Bill and traditional scholarships)
- General entitlement\(^1\) (e.g., "two-years in the bank")
- Appropriations based on enrollment

#### PRIVATE FUNDS\(^2\)

**GENERAL SUPPORT**
- Support of in-house educational units

**PROGRAM SUPPORT**
- Support of in-house educational programs
- Payments for services by business and other organizations

**STUDENT SUPPORT**
- Unsubsidized student fees, tuition, etc.
- Employer subsidized payments
- Employment related entitlements

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1. No programs of this type are currently in effect in the United States.

2. Including payments by public and philanthropic agencies when they are acting as employers.
TABLE 5. OUTLINE OF CONTINUING EDUCATION SYSTEMS SUGGESTING INPUTS AND OUTPUTS

<table>
<thead>
<tr>
<th>Input Sources</th>
<th>Instructional Programs</th>
<th>Output Products/Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student fees and tuition</td>
<td>Doctors' degree programs</td>
<td>More highly trained and educated men and women</td>
</tr>
<tr>
<td>Business and Philanthropic funds</td>
<td>Masters' degree programs</td>
<td>Doctors, Masters</td>
</tr>
<tr>
<td>Grants from public and philanthropic sources</td>
<td>Bachelors' degree programs</td>
<td>Bachelors, Certificates</td>
</tr>
<tr>
<td>Endowment funds and gifts</td>
<td>Professional and technical licensing programs</td>
<td>No degree or certificate</td>
</tr>
<tr>
<td>State legislature appropriations</td>
<td>Non-degree, general education programs</td>
<td></td>
</tr>
<tr>
<td>Direct services by state, college or university</td>
<td>Conferences, Institutes, festivals, performances</td>
<td>Intra-institutional outputs</td>
</tr>
<tr>
<td></td>
<td>Support Services</td>
<td>New programs and students, Public relations for division and college or university, Greater flexibility for all students, faculty, Knowledge about experimental programs and courses, Etc.</td>
</tr>
</tbody>
</table>

1 Table 5 is based upon a similar table for regular college and university programs by McCarthy and Dineer (1972).
assumed in full by the students or their families,

fully or partially subsidized for students in particular fields or places of employment (e.g., from federal law enforcement funds or payments by individual employers), or

subsidized for students with particular needs or merits (e.g., the G.I. bill, traditional scholarships).

2) Funds received to support specific programs or services may be:

fees-for-service received from businesses, professional associations, and government agencies to underwrite the costs of training employees, members, and others or

grants from state or federal agencies or from foundations (e.g., Intergovernmental Personnel Act funds for the training of state and municipal officials and employees).

3) Institutional support may take the form of direct financial aid or of facilities and services such as classrooms, office space, libraries, and staff. Especially in the case of public institutions, payments for general support may be based on enrollment.

Although every one of these sources of income is of importance in part-time postsecondary education, as has been indicated earlier, most systems serving part-time students depend almost entirely for their incomes on direct payments.
for services and on enrollment-based subsidies.

The relationship between source of funding and perceptions of benefits was discussed earlier in the chapter. It was noted that the factors that cause students to enroll may also determine the source of funding. Employers, for example, frequently provide training programs for their employees, and it is not uncommon for a state to require and pay for classes on alcohol abuse for those convicted of drunk driving. For the programs of colleges and universities, the relationship between payments and benefits is much more complex and has been the subject of much debate. Costs and benefits will be discussed at greater length in Chapter IV.

Program Planning and the Financing of Education for Adult and Part-Time Students

Because the survival of most part-time postsecondary programs depends largely on the extent to which they meet the demands of potential students and sponsors, most such institutions take a market or service approach to program planning. As has just been indicated, the market for adult education is made up not simply of students who are willing to pay the full cost out of their own pockets, but includes students who receive a variety of kinds of assistance. A market approach to program planning tends to prevail in an educational organization when a significant part of its income depends on student fees, on contracts for services,
on competitive grants, or on enrollment-based appropriations (B. Clark, 1958).

A market approach to program planning requires the kinds of analyses that are commonly used in business enterprises. The analyses may include market forecasts and the projection of profits or losses as well as the kinds of enrollment projections and resource analysis needed for planning and budgeting for traditional programs.

**Future Directions in the Financing of Programs for Part-Time Students**

Patterns of financing adult and part-time education are changing. Recognition of the importance of lifelong learning has been accompanied by changing attitudes towards the funding of programs for adults. Although, in the past, public policies encouraged full-time study immediately after high school and rarely provided incentives for deferring postsecondary education or for returning to school on a full- or part-time basis, several recent proposals are intended to encourage continuing and recurrent education (Carnegie Commission, 1973c; Committee on the Financing of Higher Education for Adult Students, 1974). Proposals include:

-- equal treatment of part-time and full-time students with regard to tuition, fees, and financial aid.

-- various systems whereby citizens would be entitled to receive, sometime during their lives and at public
expense, a certain minimum amount of postsecondary education ("general entitlement"),

-- job-related programs in which employees would receive payments and release time to return to full- or part-time study at certain intervals ("employment-related entitlement"),

-- loan programs tailored to the needs of adults.

These proposals would, of course, have a positive effect on postsecondary systems in that they would expand the market. From a broader perspective, they are attractive because they would help society meet its needs for trained manpower and educated citizens and because they provide greater educational opportunity for many people. The proposals are firmly based on the price system. Students would choose among competing programs and bring their subsidies with them.

In summary, although the future may bring increased support to adult education through entitlement programs and categorical aid, it is not likely that flat grant institutional subsidies will increase sufficiently to reduce the market orientation of these systems. Indications are that, although part-time postsecondary education may increase in importance in the next few decades, its funding will continue to be program and client related.
3. DECISIONS ABOUT STUDENTS, PROGRAMS AND EDUCATIONAL SERVICES IN ADULT AND PART-TIME EDUCATION

In the preceding discussion, the characteristics of the students, the delivery systems, and the financing of part-time education and the relationship of these characteristics to planning were considered. It is now possible to outline the kinds of decisions that face educational systems that serve part-time students and to review the information needs of these organizations.

Two fundamental types of decision must be made in any educational system: first, decisions about goals that is about the kinds of students served and programs offered and second, decisions about means, that is, about the instructional and supporting services that are necessary to serve the students efficiently and effectively.

Planning Programs for Part-Time Students

In education, a program is defined as the collection of all the services provided for a particular group of students. In program planning, the focus is upon the students and their goals, rather than on the institution and the services it provides. Programs are usually designed around the educational or career goals of the students they serve. Examples of this type of program include college majors, continuing education for professionals, and music
lessons. Programs may also be designed to meet the needs of groups who have characteristics other than educational or career goals in common. There are programs for the elderly, for women, and for inner city residents, for example. As was pointed out earlier, programs that serve specific population groups may focus on a particular educational, career, or avocational goal, or they may attempt to meet a combination of vocational and other needs.

Program planning in education can be viewed from two quite different perspectives: it is both a matter of public policy and a business matter. From one point of view, the problem is that of a public, quasi-public, or private agency attempting to meet the needs of society for trained manpower and educated citizens and the obligations of society to provide full educational opportunity to all.¹ From another point of view, the problem is that of a zero-profit or profit making organization responding to supply and demand. The questions of public policy require benefits analysis while the financial questions require market analysis. Clearly, both perspectives are important, and clearly there can be conflicts between them. An organization cannot decide to sponsor a program of great public benefit and

¹ Private profit-making institutions are, of course, less constrained by public policy than are public and quasi-public agencies.
little cost if the costs cannot be met, and it should be reluctant to offer highly profitable programs of doubtful public benefit in preference to low profit programs of greater value. Tradeoffs between the two objectives depend upon the financial status of the organization and the framework of laws and policies within which it operates. ¹

The basic decisions relative to students and their goals are these: What programs should be initiated, discontinued, expanded, contracted, or modified to meet the needs of adult learners? In arriving at decisions about these matters, the following kinds of questions must be asked about each program and about the system as a whole:

-- What types of students are being served, should be served, can be served?

-- What portion of the potential clientele is being reached? What portion can be reached given the resources

¹ In practice, many educational organizations establish suitability requirements and priorities to answer the question of public benefit and then operate within a market framework. In nonprofit agencies, any profits from one program may be used to support others or to support program development and the creation of new markets. General extension systems are sometimes accused of placing marketing and sales ahead of quality and suitability. While much of this criticism is caused by misconceptions about part-time students and by a lack of sympathy for nonacademic programs in institutions of higher education, there is no doubt that the desire for profit and the sheer necessity of survival have sometimes led general extension systems to compromise quality and suitability in order to increase enrollments (Penfield, 1975; B. Clark, 1958; Nolfi and Nelson, 1973).
available?

-- What are the costs of the program to the student, to outside sponsors, and to other outside agencies?

-- What is the cost to the educational organization?

What income is generated? What are the projections for future costs and income?

Planning the Delivery of Part-Time Education

When planning programs, one is concerned with meeting the needs and demands of different groups of students. But the students can realize their objectives only if appropriate learning experiences and support services are available. In practice, much of the analysis required for planning to meet the needs of the students is the analysis of educational delivery systems.

Decisions about delivery systems require both cost-effectiveness analysis and market analysis. The decision maker must determine the income, costs, and enrollments or other rates of use of the various instructional and support services and must also consider the effectiveness of the services in reaching the potential audience and in helping students acquire the skills and knowledge they are seeking. One must determine, for example, whether or not television courses or classes in a particular location will pay for themselves and whether or not they will achieve their intended goals. If the
television and classes are alternatives that are intended to serve the same students, one must decide which is less costly or which is more effective. In short, in evaluating a program, it is necessary to investigate the quality, convenience, and financing of the educational delivery as well as the relevance of the program's goals to the students it is intended to serve.

The basic questions related to the elements of the delivery system are these: Is a particular service financially feasible and does it meet needs and demands that cannot be met more cheaply or more effectively in some other way? In arriving at a decision to create, discontinue, or modify a service, it is necessary to know the present and projected levels of participation as well as income and costs. Equally important, comparisons between delivery systems must take into account differences in the scope of the services offered to the students and the differences in the students themselves.

Determining Program Costs and Income in Systems Serving Part-Time Students

As has been pointed out, program planning requires the analysis of the income and cost of each of the various elements of the delivery system. In an organization that offers two or more programs that make use of the same delivery system, computing the costs, income, and profits of programs requires knowing how much each group of students
uses each of the various services. The number of students in each program, their use of each service, the level at which each service is maintained,¹ and the fees and other income received together determine the resource requirements and income of the system and how they are apportioned among the various programs and services. The relationship is analogous to that between majors and academic departments in a traditional undergraduate college, but as was pointed out earlier, may be much more complex.

The Characteristics of Part-Time Postsecondary Education. A Summary

Now that the important features of part-time postsecondary education have been described, it is possible to summarize these characteristics and their effects on planning.

Students, programs, and educational delivery.

Part-time education is intended to serve a wide range of adult learners who may or may not be seeking degrees and who may or may not be motivated by vocational objectives. The programs may be designed around particular educational, vocational, or avocational objectives, or they may be intended to serve particular population groups.

Educational delivery systems for part-time students are

¹ Class sizes, counseling ratios, etc.
structured to meet the needs of responsible adults whose lives are centered outside the school. Courses and other learning experiences are diverse in time, place, length, and format. Supporting services vary from program to program depending upon the needs of the students. Educational delivery is varied, not only in terms of what services are offered, but also in terms of who provides the services and how they are financed. Cooperative arrangements with other agencies are common as are programs where the students are expected to seek out services on their own.

The needs of adult and part-time learners change over time and programs and services must change with them. Program development is a central and ongoing function of many educational systems that serve part-time students.

**Organization.** Some systems of part-time and adult education, including many college and university extension divisions are "facilitating agencies". They depend on part-time faculty and on cooperative arrangements with other agencies to provide instruction for their students. The instructional units of these systems have functions and goals associated with either 1) educational delivery, 2) programs for particular client groups, 3) academic or professional disciplines, or 4) some combination of the first three. Planning usually takes place outside the framework of a faculty-department structure.
Financing. The use of part-time faculty, the tradition of self-support, and the changing character of needs and programs affect financial planning in two important ways. First, because committed costs, especially for faculty and facilities, are low relative to total costs, systems that serve part-time students have more flexibility than traditional colleges and universities in planning, budgeting, implementing, and revising their programs. Second, because basic institutional subsidies are low in proportion to income from fees and special grants, income is potentially highly variable. The result is a market or service-oriented outlook towards planning and budgeting.

Planning and analysis. Planning is related both to programs for particular client groups and to educational delivery. Three basic types of analysis are required: 1) enrollment analysis, including projections and market studies, 2) budget analysis, including detailed studies of both income and costs, for programs and for services, and 3) the evaluation of outcomes. Because of the variety in students and services, it is often necessary to consider the scope of individual services explicitly. Taxonomies may be helpful for this purpose.

The next few chapters will describe the kinds of analysis used in planning and budgeting and the application of these tools to adult and part-time education.
PART II.

QUANTITATIVE ANALYSIS FOR PLANNING EDUCATIONAL PROGRAMS
PART II: INTRODUCTION AND OVERVIEW

QUANTITATIVE ANALYSIS FOR PLANNING EDUCATIONAL PROGRAMS

Overview of Part II

Part II of this paper will be devoted to a review of the several topics that are fundamental to budget analysis in part-time postsecondary education. Methods of analysis and sources of information will be considered. Emphasis will be placed on quantitative analysis.

The remainder of this chapter will be devoted to a discussion of the role of analysis in planning and budgeting.

The next four chapters will cover the following topics:

Chapter IV - The Role of Evaluation in Planning: cost-benefits and cost-effectiveness analysis; the role of goals in planning.

Chapter V - Enrollment Analysis: time-series and ratio models; the analysis of demand; judgmental forecasting; market research.

Chapter VI - Cost Analysis and Budgeting: approaches to budgeting; cost analysis; budget models.

Chapter VII - Taxonomies and the Institutional Data Base: taxonomies that are applicable to part-time programs.
the problem of describing the sponsorship and scope of service of jointly operated and independent study programs.

The applications of these tools of analysis to a particular problem, namely the development of a budget model for a division of continuing education, will be discussed in Part III.

As will soon become apparent, the division of topics among the next three chapters is somewhat arbitrary. Not only are the subjects closely related, but many models and analyses combine studies of enrollments, budgets, and outcomes. A most important case of overlap is that of manpower analysis and enrollment forecasting. Manpower analysis and cost-benefits studies will be discussed in the chapter on outcomes even though it is well known that manpower needs and perceptions of economic benefits are important determinants of demand for higher education.

To cite one example of models that address more than one aspect of educational planning, Bayesian analysis is almost always applied to problems that involve finances as well as demand. Nonetheless, judgmental forecasting will be discussed in the chapter on enrollment forecasting.

In short, it is important to keep in mind that practical applications of quantitative analysis in educational planning involve simultaneous consideration of goals, outcomes, enrollments and finances.
The Role of Analysis in Planning and Budgeting

"A budget is a plan stated in financial terms" (a traditional definition).

"Program budgeting -- basically a resource allocation system -- stresses the setting of objectives, grouping activities into programs to meet the objectives, and measuring the effectiveness of the programs in meeting the objectives. The purpose of the program budgeting effort is to provide the organized data base for the systematic selection of the preferred course of action" (Sue A. Haggart, et al., 1972).

The belief that organizations should focus on outcomes as they plan for the future is basic to most concepts of budgeting. Modern budget analysis with its emphasis on goal definition, evaluation of alternatives, and choice of best alternative, is intended to provide such a focus. In budget analysis, resource allocation is viewed as an economic problem. From this perspective, a program is justified only if it is both cost beneficial and technically efficient:

1) Benefits to society and individuals in increased production, improved earning power, a more rewarding life, etc. must be great enough to justify costs, and

2) Objectives must be reached with the least possible expenditure of resources. If either condition is not met, resources are wasted (Eckstein, 1973).

While the economic concept of budgeting -- the efficient allocation of scarce resources -- is of great importance in planning, the actual process of resource allocation in public and non-profit agencies is far more complex than a definition of budgeting might suggest.
First, the forces that affect outcomes in educational and social systems are extremely complex. The cause and effect relationships between schooling and learning and between learning and long-term social goals are only poorly understood by even the best and the brightest of decision makers. Even if these relationships were well understood, the number of alternative programs is too great to be studied in a reasonable length of time, and furthermore, the effects of uncontrollable external events cannot be predicted. In short, important outcomes are almost always uncertain.

Second, no public or non-profit agency is governed by a single set of rationally defined objectives. Rather, such organizations are governed by a variety of goals that reflect conflicting values, needs, and wants among employees, clients, and other interest groups (excellence versus equal opportunity, better working conditions versus better services versus lower taxes, immediate gratification versus future benefits,...). In a "perfect" free market system, the need for profits works towards assuring that conflicting desires and interests are resolved in an economically efficient manner. In complex systems where market forces are not dominant, there is rarely agreement on what constitutes economic efficiency.

In short, in public and non-profit agencies, the systematic and comprehensive analysis of alternatives is not
feasible. Conflicts must be resolved by negotiation (Lindbloom, 1968).

As a practical matter, the principal operative goals of educational and other non-profit systems are first, the preservation of the existing benefits of each interest group and second, the achievement of such improvements as are possible within this constraint and the constraint of available resources. Changes are usually made in small steps, for major changes would be likely to upset the balance of interests that has evolved over time. A "fair share" tradition almost always requires that increases or cuts in budgets be apportioned more or less equally among the various agencies and departments of the system (Wildavsky, 1964; 1969). Under such circumstances, the idealized process of modern budget analysis (goal definition, evaluation of alternatives, choice of best alternative) is not a sequence of activities, but a continuous process of negotiation and compromise.

Evaluation is in large measure a tool of negotiation. Each interest group uses analysis to sharpen its understanding of its own proposals and of the suggestions of others and to persuade other parties that is own proposals are in the common interest (Lindbloom, 1959; 1968; Etzioni, 1964; Baldridge, 1971).

The discussions that follow are based on this rather political view of the role of policy analysis in decision
making. This perspective may not be obvious in the general and technical explanations of the various tools of evaluation, for there it is difficult to avoid implying that comprehensive and systematic approaches to decision making are practical. The reviews of applied research, on the other hand, clearly support the contention of Lindbloom and Wildavsky that the real value of policy analysis—whether it takes the form of basic research or partisan analysis—lies in its contribution to the clarification and resolution of specific issues.
CHAPTER IV
THE ROLE OF EVALUATION IN PLANNING

1. INTRODUCTION

Two Basic Approaches to the Evaluation of Outcomes

The evaluation of the outcomes of educational programs can focus on one of two perspectives.

1) benefits, i.e., gains to society and individuals through increased production, greater earning power, a better environment, etc.¹

2) effectiveness, i.e., the degree of success with which a program meets its own objectives (skills to be learned, retention rates to be achieved, etc.).²

¹The third basic approach to evaluation will be discussed in a later chapter. The measurement of technical efficiency, i.e., the performance of functions in the best possible manner at the lowest possible cost, is related to unit costing and performance budgeting. In the language of budgeting, "efficiency" is related to "outputs" rather than "outcomes". Outputs are items produced and functions performed. Floors washed, letters typed, and student class hours taught are outputs. It is possible for an agency that is efficient in many respects to be ineffective and unbeficial.

²The difference between benefits and effectiveness is usually illustrated by pointing out that a program to train buggy whip makers can very well be effective, that is, it can meet its own internal objectives, but is unlikely provide any economic benefits.
Most of the remainder of this chapter will be devoted to a discussion of the tools of economics, systems analysis, and educational research that may be applied to the evaluation of benefits and effectiveness. Goal definition, a subject that is closely related to effectiveness analysis, will also be considered. Emphasis will be placed on the economic and financial aspects of planning; methods of assessing learning and attitudes will be considered only peripherally.

The following topics will be discussed:

**Economic Outcomes** - the evaluation of education in relation to employment and production: the basic concepts and methods of manpower needs analysis and cost-benefits analysis; the application of mathematical models to the study of economic outcomes.

**The use of goals statements in planning and evaluation:** the perspective of organizational theorists; the perspective of systems analysts; tools and applications.

**Effectiveness Analysis and Cost-Effectiveness Analysis:** direct and indirect measures of effectiveness.

**A Comment on References**

The analysis of outcomes involves a wide range of fields of study - principally economics, psychology, sociology, and management science. Reports of recent research will be found in the professional journals of these
disciplines as well as in those devoted to educational research and to adult and higher education. Much of the research on outcomes is reported in pamphlets published by various commissions, agencies, and institutions. The most important of this material is available through the ERIC Clearinghouse on Higher Education. References to specific studies will be cited in the course of the discussion that follows. General works and reviews will be mentioned at this point.


Perhaps the most extensive research on outcomes is that on the economic effects of education. Reviews and general works include those of Blaug (1971), Bowman (1966), the Bureau of Labor Statistics (1974), Norris, et al. (1977), and Kelley, et al. (1975). These works include references to the many statistical reports on manpower by the United States government.
Discussions of effectiveness include one by Feldman and Newcomb (1969), who review much of the research on the impact of college on students that was published before 1969, and two basic works by Dressel (1961; 1972).

2. ECONOMIC OUTCOMES:
MANPOWER NEEDS AND COST-BENEFITS ANALYSIS

Evaluations of the economic impact of educational programs can be made in terms of employment - using manpower analysis - or in terms of earnings - using cost-benefits analysis. This section will begin with an outline of the theoretical basis and fundamental uses of manpower needs and cost-benefits analysis. The basic tools, applications, and limitations of each approach will then be discussed. Finally, applications of mathematical techniques will be considered.

 EDUCATION AS AN INVESTMENT; THE STUDY OF NEEDS AND DEMAND

Human capital theorists consider education as an investment. They note that among individuals and among societies, education and income are positively correlated and conclude that although not all educational returns are
monetary, education represents an investment by both individuals and society; individuals seek to increase their future earnings and to improve the quality of their lives, while the society invests in improvements in production and in the standard and quality of living. The value of the investments in increased earnings and production can be analyzed in a manner analogous to the study of conventional capital investments.

It should be noted that not all expenditures on education represent investments. Education is in part a consumer good, that is, it brings personal gratification. In fact, some programs, including many designed for adults, are intended primarily to provide such satisfactions.

Although the exceptions are important, for most students and most societies, job-related goals are the principal determinants of decisions on expenditures in education. The chief concern of this section is, of course, the value of education in relation to employment.

Many countries with planned economies shape their educational plans to fit their economic plans. These countries use information about manpower needs and expected benefits to help set levels of enrollment and subsidies and
to help determine other educational policies. ¹

In the United States, manpower needs studies and cost benefits analyses have been subjects of increased attention in the past few years as public interest has shifted from traditional education to a more general concern with postsecondary studies and as the job market for college graduates has tightened. A substantial portion of the offerings of community colleges, proprietary schools, and in-house employer programs are directly related to occupational training; at the same time, decision makers at more traditional institutions have found it necessary to gain a better understanding of their students' immediate prospects for employment.

Although economic and educational planning in the United States are not centralized, economic studies do help shape policies throughout the educational system. For example, they influence decisions about federal aid to postsecondary education, federal manpower training programs, state appropriations for universities, and staffing at individual schools (Norris, et al., 1977).

¹ Blaug (1971), Benson and Hodgkinson (1974), and Norris, et al., (1977) include references to such studies. The Organization for Economic Cooperation and Development (OECD) has published many studies of this kind.
Manpower Needs Analysis

The basic ideas of manpower needs analysis are easily summarized. Manpower needs analysis is the study of supply and demand of labor. Information about trends in population, production, employment, and educational enrollments is used to estimate future manpower supply and demand. International comparisons may also be used. In contrast with cost-benefis analysis, wages and educational costs are not taken into account in classical manpower needs analysis.

The principal tools of classical manpower projection are input-output analysis and regression analysis. Needs assessment and related approaches are used for small scale studies such as those undertaken by individual postsecondary institutions. In addition, follow-up studies of former students' activities have a wide range of application to

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1 For discussions of manpower needs analysis and its applications see Benson and Hodgkingson (1974), Poignant (1967), Kelley et al. (1975), Norris et al. (1977), and the Bureau of Labor Statistics (1974).
manpower analysis. ¹

In the United States, as in most countries, the task of collecting data and preparing manpower projections is undertaken by the national government. Statistics about population, labor, and education, prepared by the Census Bureau, Bureau of Labor Statistics, and Office of Education, underlie most studies of manpower needs in America. The Bureau of Labor Statistics regularly prepares ten-year projections of manpower needs and manpower training needs and prepares many specialized reports as well. Other agencies, most notably the National Science Foundation, also prepare manpower reports for particular occupations and industries.²

Applications of Manpower Needs Analysis

Studies of manpower supply and demand have focused on four major areas: 1) general studies of needs for manpower with different levels of education, 2) studies of needs in particular occupations, 3) analyses of job opportunities for such population groups as blacks, veterans, and disadvantaged youth, and 4) studies of manpower needs in

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¹ Input-output analysis will be discussed later in the chapter. Regression analysis, needs analysis, surveys, and follow-up studies will be considered in the next chapter.

² References to such statistical reports are to be found in Benson and Hodgkinson (1974), Norris, et al. (1977), Berg and Freedman (1977), and Bureau of Labor Statistics (1974).
particular geographic areas.

**General Studies: The Value of a College Degree.** The decline in employment opportunities for college educated manpower has been the subject of many recent studies.¹ Manpower studies reveal that in recent years, increases in the numbers of professional and managerial jobs have not kept up with increases in the number of college graduates and that since 1950, the increase in job opportunities for college graduates has come from the upgrading of educational requirements for jobs rather than from any structural change in employment. Studies of jobs and training in the United States and comparisons with those in Europe suggest that up to one half of the college graduate labor force now holds jobs that can be performed adequately by persons with a high school education or less (Berg and Freedman, 1977; Carnegie Commission, 1973a; O'Toole, 1975; Rosenthal, 1974; Newman, et al., 1978).

**Specialized Studies of Individual Occupations.** The projection of manpower needs in particular occupations has been a topic of much research.² Not surprisingly, interest

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¹ Most such studies take wages and the cost of education into account. Only those based on classical manpower analysis are cited at this point.

has focused on areas such as nursing, teaching, and engineering where shortages and surpluses have been problems and where public policy affects demand. Although most such studies take the effects of wages into account, some rely heavily on classical manpower analysis. An example of the latter is Allan Cartter’s (1964) well-known study of demand and supply of college teachers. His projections of future surpluses of teachers were ignored at the time, but have proved to be basically correct.

Studies of Specific Population Groups. There has long been a concern in the United States about educational and employment opportunities of people with special needs or difficulties compared to those of able-bodied white males. Regular federal analyses, employers’ affirmative action reports, and special studies provide information about the educational and occupational status of minority group members, women, and handicapped persons.

Studies of Manpower Needs in Particular Geographic Areas. Forecasts of state, regional, and local manpower needs serve primarily as aids for educational and employment counseling and for short-range program planning. The

1 Once again, the bibliography appearing in the Bureau of Labor Statistics Bulletin 1816 (1974) is helpful. A recent work by Dorothy K. Newman and Associates (1978) discusses the relationship of educational criteria for employment to job opportunities for blacks.
studies are conducted by educational institutions, agencies of state and county government, and other groups. Many community colleges undertake such studies as part of their efforts to help meet local manpower needs. Analyses of manpower needs in specific geographic areas can be based on national studies or on local needs assessments.  

**Problems, Limitations, and Difficulties**

There are potentially serious difficulties with using manpower projections for program planning in education. The first difficulty with classical manpower forecasting is that the forecasts rely heavily on extrapolations — and complex combinations of extrapolations at that.  

Major errors occur in manpower forecasts when unforeseen technological or social changes cause shifts in needs for educated manpower and when attitudes towards public services affect demand in the public sector (Berg, 1971; Carnegie Commission, 1973; Breneman, 1975; Bezdek, 1973).  

Second, it is feared that manpower planning, because of

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1 Methods for applying national statistics to local manpower studies are explained in publications of the U.S. Bureau of Labor Statistics. A good starting point is Bulletin 1874 (1975). Among the many guides to needs assessments and reports of such endeavors are those by Johnston and Jolley (1975), Ferguson (1975), and Kyle and Sisson (1974).

2 The national projections rely on historical data about employment in various types of industry and about labor requirements for producing different goods and services (Bureau of Labor Statistics, 1975).
its focus on occupational skills, can lead to a narrow emphasis on vocational programs at the expense of those that advance skills in reasoning and expression and that enhance understanding of man and society. Limiting access to broader programs, it is argued, could diminish the quality of human intellectual experience, decrease social mobility, and could even be counter-productive in terms of the goals of manpower planning itself (O'Toole, 1975; Wood and Wilson, 1975).

Although the difficulties just mentioned are common to all approaches to the analysis of the economic benefits of education,¹ two others are peculiar to classical manpower analysis. The approach takes into account neither the effects of prices on manpower needs and efficiency nor the transitions between projected states of manpower supply.²

The exclusion of information about costs from classical manpower studies has two negative effects. First, because the projections do not take into account the effects of wages and other production costs on labor supply and demand, they cannot forecast needs in situations where these factors

1 The more complex models can anticipate certain changes that are not revealed by manpower projections, but the proportion of unexplained variation is almost always large.

2 The projections describe the work force at intervals but do not take into account multiple levels of training needs (training the people to train the people who...).
affect output or cause substitutions between educated labor and other production factors. Second, because manpower projections fail to take training costs into account, plans based on such forecasts may be inefficient.

Finally, manpower projections portray future states at specific intervals and do not take into account the intermediate stages that represent transitions from one state to another. Because of unforeseen bottlenecks, projections may represent infeasible states for the particular years specified.

It is clear that the possibilities for error in manpower projections are many. In fact, studies indicate that at best manpower projections are accurate for no more than two to three years, and that it is possible for policies based on the projections to have a destabilizing effect on the manpower market (Norris, et al., 1973).

Many of the individual problems discussed in this section will be mentioned again in the discussions of cost-benefits analysis and mathematical models. At least some of the difficulties may be alleviated by using manpower data in combination with other kinds of information.

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1 In response to this criticism, manpower experts are now working to develop methods that take wages into account. Such changes will, of course, serve to blur the distinction between manpower studies and cost-benefits analysis (Greenberg, 1975).
Cost-Benefits Analysis

Cost-benefits analysis is a method of estimating the basic economic value of a program by projecting its future benefits and comparing them with costs. In cost-benefits analysis of educational programs, only expected increases in income are estimated; other gains, such as enriched lives, reduced crime rates, and a more informed electorate, are

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1 For discussions of cost-benefits analysis and the underlying economic principles, see the following: Benson and Hodgkinson (1974), W.G. Bowen (1963), Weisbrod (1962), Reynolds (1973), and Blaug (1971).

2 In addition to cost-benefits analysis, or the direct-returns-to-education approach, there are two other methods of measuring the economic contribution of education to society: 1) simple correlation and 2) the computation of residuals (W.G. Bowen, 1963). In the simple correlation method, the levels of education and production of different countries (or of the same country at different times) are examined. As would be expected, there is usually a positive correlation between the two (Schulz, 1960). In the residuals method, the increase in economic output over time is attributed as much as possible to measurable inputs. It is assumed that much of the residual can be attributed to formal education (though other aspects of technological progress also contribute) (Kendrick, 1961; Denison, 1962). While the techniques developed by Schulz, Kendrick, Denison, and others to analyze the economic contribution of education are important historically and have the advantage of being relatively easy to understand, they have largely given way in recent years to methods that measure the economic contribution of education more directly and that can measure the benefits of education to individuals.
considered outside the framework of formal analysis. ¹

Formal cost-benefits analysis is a rather complex technique involving estimating the values of a number of variables, including direct benefits, transfer payments, discounted benefits, opportunity costs, and direct costs. These will now be explained. Applications of cost-benefits analysis to general policy studies and to institutional planning will then be considered. Finally, the strengths and weaknesses of the approach will be examined.

Direct Benefits and Transfer Payments

In formal cost-benefits analysis, one may compute individual benefits, societal benefits, or both. In any case, it is almost always necessary to consider transfer payments. These include such items as tax revenues, welfare payments, and unemployment compensation. They involve no net benefit but affect the distribution of benefits. For example, taxes are a negative benefit to the individual but a positive one to the government.

Benefits are represented by the following simple equations:

¹ In theory, personal values and tastes as well as general improvement in social conditions can be reflected in cost-benefits analysis. In fact, the state of the art is such that these factors must be considered independently from the formal analyses (Weisbrod, 1962).
Individual benefits = I - T - W + S
Social Benefits = I + S + O, where
I = increase in income,
T = increase in taxes,
W = increase in payments for welfare and unemployment benefits,
S = other benefits to the individual, e.g., improved ability to manage personal finances,
O = all other social benefits, e.g., improved community life.

It should be stressed that only certain of these variables can be estimated accurately and, therefore, can be included in formal cost-benefits analysis.

Discounting and the calculation of benefits. In cost-benefits analysis, it is necessary to compare present costs with the "present value" of future benefits, that is with the value of the anticipated returns at the time the costs are incurred. The fact that future income is of less value than present holdings can be accounted for by discounting future earnings at a given percent per year. The benefit is the amount that would produce the expected increase in earnings over the productive lifetime.

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1 At an interest rate of 10%, $110 received next year has the same value as $100 received this year, or $110 discounted for one year at 10% has a value of $100. A more realistic example is given in the next footnote.
of the individual.1

Negative Benefits - Opportunity Costs. Cost measurement will be discussed at length in Chapter VI. At this point, however, it is necessary to mention one particular kind of cost (or negative benefit), namely foregone earnings. Students usually earn far less than they would if they were not in school. The foregone earnings must be included in the cost-benefits analyses; in fact, over the years, on the average, they have constituted about half the cost to the individual of attending college. Their importance in adult education varies greatly—from near zero for the training of the unemployed to extremely high values for seminars for medical doctors (Schulz, 1961).

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1 For example, an increase in lifetime income averaging $1000 per year for forty years is equivalent to $15,000 received at the beginning of the period and invested in a simple annuity at 6% interest. If the $1000 is the increase in income gained from obtaining a master’s degree in teaching, then the $15,000 must be compared to the total cost (including opportunity costs) of the degree. If the cost is $12,000, then the benefit/cost ratio is $15,000/12,000 or 1.25 and the net benefit is $15,000 - $12,000 or $3,000. Put another way, if the $12,000 had been invested in a simple annuity at 6% instead of a master’s degree, the return would have been $800 per year. Clearly, in this hypothetical example, if a 6% annuity is the best alternative investment, obtaining the degree is to the benefit of the average teacher.
Cost-Benefits Studies in Postsecondary Education

Cost-benefits studies in postsecondary education are of two general types: 1) studies of the value of a particular level or type of education (e.g., a college degree or a master's degree in business administration) and 2) analyses of individual programs (e.g., the Job Corps). Not only do the studies differ in scope, they also rely on somewhat different methods. As is the case for manpower needs analysis, the methods used for small scale studies are, as a rule, simpler.

General Policy Studies: The Value of a College Degree.

In recent years cost-benefits studies of traditional higher education have focused on two issues: 1) the effects of tuition and subsidies on labor supply and on the distribution of costs and benefits, and 2) the effects of changing demographic and employment patterns on postsecondary enrollment and on the financial conditions of colleges and universities. Among the specific issues studied in the first area are: the contribution of subsidies to production and social mobility (Azod, 1976; Windham, 1976; Dove, 1976), the distribution of the costs

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1 Most policy studies employ a variety of analytic tools. The studies cited here all make use of the concept of economic returns to education, but the methods of analysis vary widely; at one extreme are studies that are largely qualitative and at the other are those based on complex mathematical models.
and benefits of public higher education among various income groups under existing policies (Hansen and Weisbrod, 1969; Pechman, 1970; Mallan, 1976; Rosenthal, 1977), and the effects of alternative plans for tuition, institutional subsidies, and student loans (McDonald, 1977; Carbone, 1974).

The second issue, the effect of population and employment trends on enrollments and on the economic returns of a college degree, is a matter of intense debate. Estimates of future enrollments and benefits vary widely depending upon assumptions about such factors as future educational requirements for jobs and changes in faculty salaries. Freeman's well-known recursive adjustment model assumes a direct, two-way relationship between salary differentials and enrollments. It forecasts declining enrollments and benefits during the 1980's. Wish and Hamilton (1980) tested Freeman's model using historical data and found it to be accurate at the level of individual schools within a university as well as at the university-wide, state, and national levels.

A model by Dresch (1975) is based on assumptions similar to those of Freeman, but reaches somewhat more pessimistic conclusions. In contrast, a detailed cost-benefits study by Witmer (1976) assumes a relative decline in faculty salaries and an increase in educational requirements for employment and concludes that both benefits
and enrollments will remain relatively constant.¹

**Studies of Adult Programs.** There have been many studies of the costs and benefits of adult programs. A few examples are given here to illustrate the range of possible applications.

The evaluation of federally funded training programs has been a matter of interest and debate for some time. There have been studies of the distribution of the costs and benefits among the various groups involved, i.e., individual trainees, participating companies, local communities, and the federal government, studies that attempt to relate the success of the programs to the characteristics of the participants, and evaluations of individual programs. There have also been many studies in other areas of adult education, including those of programs in distance education, vocational-technical education, adult basic education, and high school equivalency programs.²

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¹ It should be noted that Witmer’s assumptions are not inconsistent with those of several manpower studies cited earlier; Witmer assumes that the value of a college education has more to do with certification than with requirements for production.

² Among the reports on the subject is one by Steele (1971) on a wide range of adult programs. Gross (1978) has reviewed studies of distance education.
The Strengths and Weaknesses of Cost-Benefits Analysis as a Planning Tool

The greatest theoretical advantage of cost-benefits studies, as of manpower needs analyses, is that they provide information about the employment market before it would be discovered from observation alone. While the market often reacts slowly to changes in the supply and demand of educated manpower, cost-benefits studies can provide information rapidly and can alert decision makers to the need for program changes (Arrow and Capron, 1959; Benson and Hodgkinson, 1974). In addition, cost-benefits analysis has two important advantages over manpower needs projection. First, because cost-benefits analysis takes wages into account, it is more realistic than manpower studies where wages affect the level of production or the mixture of production factors.1 Second, because cost-benefits studies take training costs into account, they can identify programs that are not justified economically. For example, although in many underdeveloped countries, manpower needs forecasts have pointed to the development of secondary-level technical training programs, cost-benefits studies indicate that the

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1 According to economists, substitution, in particular, is generally high. There are exceptions, however. For example, classical manpower analysis is reasonably successful in forecasting needs for school teachers under conditions of universal mandatory school attendance.
costs of such programs are far greater than their benefits and that basic education is far more important to economic development than is technical training (Hollister, 1969; Norris, et al., 1973).

There are two major weaknesses in cost-benefits analysis. First, deviations from perfect free market conditions can cause distortions in the results of the analyses, and second, the information required for accurate projections of future benefits is often unobtainable. Although both of these limitations are specifically related to the assumptions and methods of cost-benefits analysis, many of the resulting practical difficulties are similar to problems encountered in manpower needs analysis. The two limitations will now be discussed briefly.

Only in the ideal free market system will the earnings of individuals reflect their value to society. It has been demonstrated that both discrimination and the existence of monopolies and oligopolies cause significant distortions in the labor market (Benson and Hodgkinson, 1974).

The second major difficulty is the unavailability of the data required to compute benefits accurately. Estimates of benefits are based on projections of future returns from a particular investment and alternatives to it. The most serious problem is that changes in technology and in other economic and social factors can affect salaries greatly, and such changes are difficult to forecast. Furthermore, it is
usually impossible to separate the effects on earnings of training from those of age, ability, sex, social class, type of employment, and socioeconomic conditions (Piachaud, 1975; W.G. Bowen, 1963; Benson and Hodgkinson, 1974).

Mathematical Models and the Economic Analysis of Educational Programs

Since the mid-1960's many mathematical models have been constructed as aids to the economic analysis of educational systems. Some can be classified as manpower needs models and some as cost-benefits models, while others combine elements of both. The models can be grouped into two categories - simulation models and optimization models - according to the mathematical techniques they use. ¹

Simulation Models

Mathematical simulation models are sets of equations that represent the behavior of a system. A wide variety of mathematical methods may be employed. Among the techniques used in recent years for human resources planning are input-output analysis, econometric analysis, Markov analysis, and structural flow analysis.

¹ Many of the models that will be discussed here include enrollments or resources as well as employment. Both simulation and optimization models will be discussed again in later chapters. See Chapters V and VI for general references to modeling in postsecondary education.
**Input-output analysis** is a classic tool of manpower analysis. The Bureau of Labor Statistics (1974) uses this technique among others to prepare estimates of manpower needs in the United States. Input-output models compute the resources required to produce a given output. Depending on the type of resources considered (for example, manpower, capital, or 'supply of uneducated students'), different types of problem can be studied.

Thonstad's (1967) input-output model of the Norwegian educational system was designed to help determine the number of people at a given level (teachers and non-teachers) needed to meet future targets of educated labor, exclusive of teachers. Psacharopolous (1973) has also developed an input-output model for the assessment of manpower needs. The equilibrium flow model of Oliver and Hopkins (1972) analyzes relationships at the institutional level. The

\[ y = Ax \]

In a simple input-output model, a production function takes the form: \( y = Ax \) where
- \( y \) is the unknown vector of resources,
- \( x \) is the output of the system, and
- \( A \) is the matrix of input-output requirements (Oliver and Hopkins, 1972).

Input-output tables of the national economy represent transactions between different sectors of the economy, that is, they give the dollar value of resources of different kinds required to produce each type of commodity or service. An entire set of tables represents the transactions of the economy as a whole. Manpower needs and sales forecasts for individual industries as well as forecasts at the national level can be based on such tables (Wheelwright and Makradakis, 1973).
model computes the flow of uneducated students of various types. It was designed to analyze the effects of changes in operating policy at the Berkeley campus of the University of California.

Econometric models are statistical models that describe the behavior of economic systems over time (Parsons and Schulz, 1971; Hamburg, 1970; Wheelwright and Makridakis (1973); Sengupta, 1975). The models can represent complex interactions between economic variables using information from a wide variety of sources. The approach allows a high degree of flexibility, giving model builders the leeway to develop equations based on their own assumptions about the relationships underlying the systems studied.

Among the many econometric models of educational systems are the ones of Dresch and Freeman mentioned earlier in the chapter and one by Bezdek (1974) that simulated demand for education under various assumptions about federal spending patterns.

Both Markov analysis and structural flow models can be

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1 For example, national models of the economy, such as the Brookings and Wharton models, use such sources as price and wage indexes, unemployment rates, federal, state, and local budgets, and surveys of intentions to buy by both manufacturers and consumers.
used to study the economics of educational programs. However, the models of these types that have been reported in the literature deal primarily with enrollment analysis and only secondarily, if at all, with manpower planning. They will be discussed more extensively in the next chapter.

Among the models that include manpower flows are two Markov models by Dawson and Denton (1974) that explore the effects on enrollment in manpower training programs of changes in eligibility rules and unemployment rates. Some of the structural flow models discussed in the next chapter include feedbacks of graduate students into higher education as teachers, but otherwise none includes manpower analysis. Systems dynamics has been applied to the analysis of costs and benefits in other areas of public concern (Maciariello, 1973), but to date no reports of its application to this aspect of educational planning have appeared in the literature.

**Optimization Models (Mathematical Programming)**

In recent years, mathematical programming has come into

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1 See Chapter V for a brief explanation of these techniques.

2 i.e., those models using differential equations and such related techniques a systems dynamics to represent flows over time.
increased used as a tool of educational planning. The technique has been applied to manpower planning, enrollment planning, facilities planning, capital planning, and resource allocation (McNamara, 1973). General planning models will be discussed in this section. Specialized resource allocation models will be considered in Chapter VI.

Mathematical programming is a tool of operations research and management science. Articles on methods and applications are to be found in the professional journals of these disciplines. Among the basic works on the subject is Wagner's, *Principles of Operations Research* (1969).

McNamara (1971; 1973) has published two review articles on the use of mathematical programming in educational planning and administration.

**Methods of Mathematical Programming.** Mathematical programming models find the maximum (or minimum) value of some function, given certain constraints. For example, the problem could be to find the maximum possible enrollment given limitations on funds, facilities, and qualified teachers and legal and political restrictions. Two mathematical programming techniques, linear programming and dynamic programming, are used extensively in manpower planning models.
Linear programming is the simplest and most widely used mathematical programming technique. Linear programming models optimize a simple objective function. They have two advantages over most other mathematical programming techniques. First, the models are relatively easy to construct and solve – provided that they are kept small – and second, if the simplex algorithm is used for solving the equations, sensitivity analysis is automatically included in the solution of the problems.

Dynamic programming involves the application of the

1 Linear programming models can be represented in vector notation as follows:
Maximize (or minimize) the objective function,
\[ z = c^T x \]
subject to the constraints:
\[ A^T x \leq b \text{ and } x \geq 0, \]
where
\( z \) is a scalar representing the value of the objective function,
\( x \) is a column vector of length \( m \) representing the unknown variables.
\( c \) is a row vector of length \( n \) containing the coefficients of the objective function,
\( A \) is an \( m \) by \( n \) matrix of the coefficients of the variables in the constraint set, and
\( b \) is a column vector of length \( m \) of constraints.
For example, \( x \) could be a vector of the number of students that graduate each year from each of several programs, \( c \), a vector representing the discounted earnings of each kind of graduate, \( A \), a matrix giving the number of teachers, classrooms, and other resources expended on each kind of student, and \( b \), a vector giving the total available supply of each resource.

2 The term sensitivity analysis is used to denote any study of the importance of input variables in affecting the solution to a problem. In optimization models, sensitivity analysis gives the magnitude of the change in each input variable that is possible before the optimal solution changes.
results of decisions made in each time period to define the state of the system in the next and finally determining the sequence of decisions that maximizes the long term objective function. It is a technique for determining the steps required to reach a future optimal state. The models of period-to-period sequences of decisions are considered to be realistic in terms of their representations of actual decision making processes in educational systems (Bowles, 1967; McNamara, 1973).

One of the earliest applications of mathematical programming to manpower planning was Bowles' (1967) dynamic programming model of educational needs in Northern Nigeria. The model showed that the plans of the Nigerian government could not be implemented and that secondary level vocational-technical training was not cost-beneficial. The model was later used for planning in both Canada and Greece. Other applications include a dynamic programming model of the Argentinian economy and a linear programming model of vocational-technical education in the United States that determines the maximum number of students who can be trained in occupations for which shortages exist (McNamara, 1971b).

Economic Analysis of Educational Outcomes: Conclusion

Manpower needs and cost-benefits studies, with or without the use of mathematical models, like all quantitative analyses of complex systems, require simplifying assumptions about causal relationships, they must rely on historical data that may not be relevant for the future, and time and expertise are required to develop and interpret them. Forecasts of manpower needs and economic benefits are at best only approximate and are often simply wrong. Yet it should not be concluded that manpower and benefits studies are useless academic exercises. Assumptions about economic outcomes underlie most educational plans - whether or not studies have been conducted and explicit estimates made. Although manpower and benefits studies rarely if ever provide explicit guidance for planners, they have helped improve understanding of needs and demands for programs with vocational goals and for certain public problem solving programs (e.g., those providing information about drug abuse). W.G. Bowen (1963) summarized the matter well some years ago. He pointed out that economic analyses of education will disappoint those who are looking for proof that their own preconceptions are correct and those who are seeking "purely scientific" evidence that will settle the matter one way or another. He goes on to say:
"The work done thus far will evoke a happier response from those who want, and will use, as much help as can be obtained from careful analysis, but who are prepared to invest their own efforts in interpreting the results in the context of the limitations of the methods employed and with reference to their own values." (W. G. Bowen, 1963).
3. THE USE OF GOALS AND OBJECTIVES  
IN PLANNING AND ANALYSIS

The use of goals and objectives in planning and analysis will be reviewed first from the perspective of students of organizational behavior and then from the

1 A note on definitions. Over the years, different authors have used such terms as 'goals' and 'objectives' differently. The definitions used here are those that appear to be gaining acceptance in higher education research. The following are important in the chapter:

A. Terms that describe the hierarchy of goals and objectives:

Mission - the basic purpose for which the organization exists; the aspirations that provide the framework for fundamental decisions.

Goals - general, long-term aims. The goals of agencies within the organization describe their roles in relation to the overall mission.

Objectives - short-term or more specific aims that stem from the goals and further their achievement.

B. Terms that describe goals and objectives that are intended for direct application in planning and evaluation:

Operational goals - goals that are described in terms of what results are intended, how they will be achieved, what resources will be required, and how the results will be evaluated.

Specific objectives, performance objects - objectives stated in terms of verifiable outcomes.

C. Terms that distinguish between stated and actual goals:

Official goals - the stated goals of the organization's leadership, those that appear in such documents as charters, annual reports, and public addresses.

Operative goals - the goals that actually govern the behavior of the individuals and agencies that make up the organization. Operative goals are not the same as operational goals.
perspective of systems analysts. Methods and applications will be discussed. Although, in theory, the study of goals and objectives should be important in the analysis of both benefits and effectiveness, the practical application of these studies is rather limited and is more closely related to the study of effectiveness than to that of benefits.

The study of goals and objectives and their relationship to planning and evaluation has proceeded along two quite distinct lines. Sociologists and students of organizational behavior have investigated the processes by which goals are established and the ways in which they affect organizational behavior while management systems experts and some psychologists and educators have studied methods of deciding on goals and expressing them in terms of observable outcomes. Although the assumptions underlying the two kinds of study are not necessarily contradictory, the different approaches tend to be associated with quite different views of the role of goals and objectives in planning and with quite different approaches to assessment.

The two approaches will be discussed in turn.
Goals as Seen by Students of Organizational Behavior

Official Goals and Operative Goals

Studies of organizations reveal that their goals are almost always complex and difficult to identify. Students of organizations have found that the analysis of goals and their effects on outcomes can be simplified by making a distinction between official and operative goals. 'Official goals' are the broad statements of purpose that appear in such documents as charters and annual reports while 'operative goals' are those that actually guide the decision making of the individuals and agencies who make up the organization. A congruence between official and operative goals is rare except, perhaps, in the early stages of an organization's history (Simon, 1964; Perrow, 1961; Etzioni, 1964).

Official goals serve a number of important functions. They are a source of legitimacy, they define the relationship of the organization to other organizations and to society, and — to a greater of lesser degree — they define its clientele, outputs, standards, needs, and priorities (Conrad, 1974). Although official goals are usually stated in broad terms and may be vague and even self-contradictory, they do provide a starting point for determining basic criteria for assessment. Questions about need and suitability must be answered with reference to
mission. For example, some adult programs are considered to be basic to university general extension, others to be suitable but not essential, and still others to fall outside its domain, and where university extension offers programs that are similar to those of other systems, the standards and clientele may differ.

The basic missions of organizations receive close scrutiny only occasionally. Reassessments are likely to occur during periods of stress and change. Recent interest in the goals of postsecondary education, for example, is doubtless the result of a diminution of both resources and demand (Weathersby and Jacobs, 1977).

By definition, the operative goals of an organization, be they consistent with its official goals or contradictory to them, are those that guide its activities. They can be regarded as constraints.

Goals as Constraints on Organizational Behavior

Now that official and operative goals have been defined, it is possible to return to a question that was discussed at the beginning of Part II of this paper: how is conflict between competing goals resolved in practice? At any particular moment, an organization's budget, the criteria it uses for evaluations, and in its reward system reflect a particular balance between competing needs and demand. Yet there is rarely an explicit choice among competing values. How does this come about?
Herbert Simon (1961; 1964) has suggested that, in the search for satisfactory solutions to complex problems, the various goals of an organization are actually treated as constraints rather than as aims. Consider as an example a public agency in Massachusetts that has among its principal goals: 1) to minimize fees charged to clients, 2) to minimize subsidies from tax funds, and 3) to maximize the use of its services by the public. Not surprisingly, these goals can be shown to conflict. If a contradiction is to be avoided, then the goals must be reformulated. One possibility is to seek to optimize one of the factors subject to constraints on the others. Another approach is to assign weights or priorities to each of the goals. Neither of these approaches is realistic, however, because no single goal predominates and the interrelationships between the goals are too complex to permit the assignment of unconditional priorities. In actual practice, the

1 There are a number of techniques from mathematical programming for finding optimal solutions to single and multi-goal problems. Linear and dynamic programming models were discussed earlier. There are two approaches in mathematical programming for assigning priorities among multiple goals: 1) giving explicit weights to each goal and 2) allowing a decision maker to specify choices at various stages as the problem is being solved; in this case, the weights given to the various goals are implicit in the choices of the decision maker (Wagner and Weathersby, 1972; Lee and Clayton, 1972; Geoffrion, et al., 1972). While mathematical analyses of organizational objectives is of some theoretical interest, the methods have not been shown to be of practical value for institutional decision making.
agency's administrator thinks of his annual plans in terms of constraints on all the variables. He does not seek optimal solutions but sets targets that he believes to be both acceptable and achievable. That is, he thinks of the problem in terms of maximum acceptable fees and subsidies and minimum acceptable levels of service and then proposes short-term policies and targets that meet these and other constraints. Although the administrator expects to reach the targets, he tries to exceed them only in certain limited areas. In most cases the information available to him is not adequate for determining whether or not efforts to excel in one area will jeopardize success in another.

From the perspective of the evaluation of outcomes, there is an important difference between seeking to meet positive goals and seeking to satisfy constraints. If a problem is stated mathematically in terms of a single goal or a weighted set of goals, there is in general one particular course of action that is clearly 'best', but if the problem is stated in terms of constraints no optimal solution exists. In the latter case, there is, instead, a

1 The fair share principle mentioned earlier is one such constraint.

2 It is possible (in fact, it is quite easy) to formulate problems that have no solution. There also exist problems that have an infinite number of equally good solutions.
set of solutions (called a Pareto optimal set) with the property that, for each of the solutions, no improvement can be made towards one goal except at the expense of another. It is impossible to rank the solutions in the Pareto optimal set without introducing additional constraints. Real problems are, of course, usually more difficult to solve than the mathematical ones. In practice most problems are too complex to be stated formally and the Pareto optimal sets remain unknown. In short, policy makers in complex organizations cannot find solutions that are 'best'. They must settle for solutions that are satisfactory, usually without knowing whether or not better ones exist.

Summary: Goals as Seen by Students of Organizational Behavior

Students of organizations agree that organizational goals are complex and that the goals of the different segments of any system differ from each other and from official goals. It is possible to gain an understanding of institutional goals and their relationship to outcomes by observing the behavior of the individuals and agencies that make up an organization. In this way, planners can learn both what is desired and what is possible within available resources and other constraints. While an understanding of an organization's goals is helpful in planning, the role of goals in evaluation is in general indirect.
The Use of Statements of Goals and Objectives in Formal Evaluation

The second area of research on goals, formal goals analysis, has been part of a more extensive effort involving one particular approach to assessment, namely evaluation by the explicit comparison of intended and actual outcomes. In their studies of goals, management systems experts and many educators have concentrated on operational goals statements. They have developed: 1) criteria for goals statements, 2) taxonomies of goals, objectives, and other variables related to outcomes, and 3) procedures for determining goals and for relating them to outcomes. These topics will be discussed after a very brief review of the literature on formal goals analysis.

Sources of Information

There is relatively little published research on the development of goals and objectives for postsecondary education. Overviews of the subject are presented in recent issues of ERIC/Higher Education Research (Lawrence and Service, 1977) and New Directions for Higher Education (Fenske, 1978). Much of the work in the field has been done by two groups, the Educational Testing Service (ETS) and the

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1 Operational goals are goals stated in a way that makes them suitable for direct use in evaluation. (See the definitions at the beginning of this section).
National Center for Higher Education Management Systems (NCHEMS). Descriptions of their efforts are to be found in their own publications (Peterson, 1970; Micek and Wallhaus, 1973). In addition, one important general work, Bloom's taxonomy of cognitive and affective objectives, is used in postsecondary as well as in primary and secondary education (Bloom, 1956; Krathwohl, et al., 1956).

Finally, there is considerable overlap between research on effectiveness and that on goals and objectives. The former may or may not involve the explicit consideration of goals and objectives, but many of the methods of describing, classifying, observing, and measuring outcomes are the same in either case. Research on effectiveness will be considered later in the chapter.

Criteria for Statements of Operational Goals and Objectives

Researchers with differing perspectives have outlined criteria for operational goals statements. Their suggestions vary depending upon the level of goals or objectives they are considering and the emphasis they place on the measurement of outcomes.

Paul Dressel (1961) recommends that goals and objectives at any particular level within an educational system should be:

- reasonable in number,
- consistent with one another,
- at approximately the same level of generality or
specificity,
- distinct,
- verifiable, and
- achievable.

Lawrence and Service (1977) state that it is imperative to explain clearly how goals are to be accomplished and what levels of achievement are to be reached. They emphasize the importance of "specific, tangible" descriptions of intended outcomes and urge that statements be quantified.

Hodgkinson (1972) is skeptical of the value of highly specific and measurable objectives on the one hand and of that of consensus about broad and vague goals on the other. He suggests that not all results need be measured and that often opinions are the most important aspect of an evaluation.

Evans developed a set of criteria to be used, along with a Delphi survey, to rank proposed goals at Portland State University.¹ The criteria included compatibility with the institution's mission and with financial and other constraints placed on the system.

The above lists give a fair sampling of the approaches to the problem. Although the criteria differ somewhat in

focus and scope, the greatest difference among them is in the underlying assumptions about measurement. At one end of the range, Lawrence and Service (1977), who have both worked on the NCHEMS outcomes project, emphasize quantification and measurement, while at the other, Hodgkinson (1972) believes that measurement is not a necessary part of many evaluations. In spite of the differences, there is a clear, common thread running through all the approaches. It is agreed that operational goals statements must specify what is to be achieved, how it is to be accomplished, by whom, and how it is to be evaluated, and that the goals statements must be consistent with financial and other constraints.

**Taxonomies**

The development of taxonomies of goals and objectives has been part of the effort to systematize planning and assessment in education. The inventories are intended to provide frameworks for statements of goals and objectives, to establish a common vocabulary, and to provide tools for comparative studies (Micek and Wallaus, 1973).

Although the term taxonomy suggests an approach to classification analogous to that used for plants and animals, inventories of educational goals, objectives, and outcomes do not meet the standards for scientific categorizations. The items that make up the taxonomies of goals are neither collectively inclusive nor mutually exclusive, nor are the classifications universally
applicable. The hierarchies and aggregations of goals and objectives depend upon the missions, organizations, and environments of the systems they represent (Micek and Wallhaus, 1973). It appears likely, therefore, that taxonomies developed for traditional higher education will be of limited value for most systems that serve part-time students. There are no published accounts that would confirm or disprove this supposition.

Among the better known taxonomies for traditional programs are several developed by the Educational Testing Service (ETS) and two by the National Center for Higher Education Managements Systems (NCHEMS). The inventories of goals and values developed by the Educational Testing Service \(^1\) are intended as aids in defining institutional missions, in comparing goals with perceptions of present conditions, and to compare the priorities of institutions serving different clienteles.

The NCHEMS projects, on the other hand, are directed towards detailed measurement of outcomes. The Inventory of Outcomes Variables and Measures, which is based on Bloom's taxonomy, represents an attempt to assemble and categorize by outcome a comprehensive list of tests, surveys, and other

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1 These include the Institutional Goals Inventory, the College and University Environmental Scales, and the Institutional Functioning Inventory (Peterson, 1973; Hodgkinson, 1972).
instruments that may be helpful in evaluation (Huff, 1971). A second inventory of NCHEMS is that of the Outcomes Study Procedures of the Institutional Exchange Procedures project. This list of outcomes is limited to information that can be obtained from standardized institutional records and a student questionnaire (Byers, 1975).

Among the few efforts directed towards part-time programs are the Evening College Characteristics Inventory (ECCI) and a study by Gooler. The ECCI includes such variables as aspiration level, academic climate, and group life (Dressel, 1972).

Gooler’s (1977) work does not take the form of a detailed taxonomy. Rather he has identified the major categories and issues related to the assessment of nontraditional programs and analyzed the criteria for determining success within each category. His research is focused on the programs of the University of Mid-America, an institution involved primarily in educational television. Gooler identifies the following broad areas for the evaluation of such programs: access, relevancy, quality, learner outcomes, unit costs, institutional impact, and generation of knowledge. His discussions highlight issues like quality of production and impact on instructional methods that are especially important in the evaluation of either distance education or experimental programs.

In summary, research on taxonomies has taken two
general forms: 1) the development of frameworks for defining and evaluating institutional goals and values, and 2) the development of explicit lists of measurable outcomes. Reports in the literature indicate that the first type of study has proved useful to many institutions. There are no similar indications that efforts to use comprehensive and explicit criteria for evaluation have proved fruitful.

Finally, it should be noted that taxonomies can be useful aids to evaluation when goals and objectives are not defined explicitly. Many applications of the inventories of the Educational Testing Service are of this type (Peterson, 1970). In an application to a specific program, Kegan (1977) used Bloom's taxonomy as a framework for examining the outcomes of individual student-designed projects where the goals varied among the individual projects and usually were known only to the students themselves. In practice, the greatest value of taxonomies may be in applications that are independent of goals statements.

**Procedures for Developing Goals Statements and for Relating Goals to Identifiable Outcomes**

Formal goals are usually established in hierarchical fashion with the goals of each level of an organization providing the framework for those of the level below it. For the goals to be realistic, the process must insure that the important aspirations and constraints of the various agencies and constituencies of the organization are taken
into account. Formal goal setting procedures have been
developed to help assure thorough discussion and review.
The formal methodologies and the many ad hoc procedures
developed by individual institutions differ widely in who
is consulted, when, on what issues, and by what methods.
The needs and attitudes of the various groups are usually
determined through regular organizational activities, i.e.,
observation, informal discussions, formal interviews,
meetings of both staff and general policy committees, and
exchanges of draft documents and commentaries. Surveys are
often used to supplement information from these sources
(Lawrence and Service, 1977).

Surveys provide an added dimension to the development
of goals statements because they facilitate systematic
consultation with a wide range of constituencies including
trustees, administrators, faculty, students, alumni, and
employers. Many studies have used the Institutional Goals
Inventory and other instruments developed by the Educational
Testing Service (Peterson, 1970; Britell, 1973)

The Delphi technique has been applied in a wide range

1 Surveys will be discussed in the next chapter.

2 Delphi is a method for seeking consensus through repeated
surveys. The technique is explained in Chapter V.
of studies of institutional goals. Uhl\(^1\) used the Institutional Goals Inventory as the basis for a Delphi exercise. An institution wide goals committee of Portland State University used the results of a Delphi survey as one of the elements determining the ranking of goals for that school.\(^2\) While the two surveys just mentioned used highly structured questionnaires, an open-ended Delphi survey was used by Governor's State University to query a wide variety of community leaders about goals for the institution. Although the results was an unstructured list of overlapping goals statements, the approach had the advantage of giving a diverse group of respondents the opportunity of stating their values in terms of their individual frames of reference (Engbretson, 1972).

There are no accounts in the literature of goals studies specifically directed at part-time education.

The goals statements that result from the kind of procedures just outlined are operational only at a very general level. There has also been extensive research, most of it by NCHEMS, directed towards the development of

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2 See reference on page 114.
procedures for translating general goals into measurable outcomes (Lawrence and Service, 1977). As indicated earlier, this research does not appear to have been fruitful in terms of practical methods of evaluating outcomes.

Applications of Goals Analysis in Part-Time Education

Although the explicit use of goals and objectives for evaluation is in general no more common in part-time education than it is in traditional systems, there are two areas where the approach or closely related ones are used fairly often. First, extension programs of colleges and universities are making increasing use of needs assessment and market analysis for program planning, and second, many single purpose public problem solving programs, such as those for employment training, lend themselves to the analysis of intended and actual outcomes. References to studies of the latter kind were cited in the section of benefits analysis. In the main, however, for full-time and part-time postsecondary systems alike, the value of goals statements to planners is not so much that they define explicit criteria for assessment, but that they contribute to the general understanding of the workings of the systems studied and thereby help to provide frameworks for evaluation.

1 Needs assessment and market analysis will be discussed in the next chapter.
Goals, Objectives, and the Evaluation of Outcomes:

Conclusion

Various aspects of the study of goals and outcomes have been reviewed. It has been seen that understanding the goals and objectives of an organization requires the study of the system and its operations. Many institutions have used periodic reviews of goals to help clarify key policy issues and to analyze specific problems. By and large, however, the efforts of the late 1960’s and early 1970’s to develop and apply comprehensive statements of measurable objectives have been abandoned.

Methods of evaluation that do not require prior explicit determination of objectives will be discussed in the next section.
4. THE ANALYSIS OF EFFECTIVENESS AND COST-EFFECTIVENESS

The treatment of effectiveness and cost-effectiveness studies will differ somewhat from that of other subjects considered in this paper. Because the technical aspects of the subject (for example, test design, evaluation methodology, and learning processes), lie outside the domain of the budget analyst and institutional planner, they will not be considered.

The discussion will begin with an outline of the major factors that must be included in assessments of a program's effectiveness. Measures of effectiveness and recent studies will then be considered.

Analyzing Effectiveness and Cost-Effectiveness: Major Issues

"Effective ... 2. Producing a definite or desired result ..." (Webster's New World Dictionary).

The 

123
success in meeting its objectives. The concept is qualitative rather than quantitative. A program can be said to be more cost-effective than another if it is less costly and at least as effective, or it it is more effective and no more costly. In general, it is not possible to rank two programs where the better one is also the more expensive although reasonable judgments can be made if the disparities between the differences in costs and differences in effectiveness are great.

For example, it is not possible to assign meaningful "effectiveness units" to a program's success in improving students' reading skills,¹ but one might be willing to call a program cost-effective if great improvements were achieved with very slight increases in costs.² As in the case of cost-benefits analysis, only certain costs and effects can be included in a formal analysis. Many important factors (for, example, costs in staff morale) must be weighed separately by decision makers (Meeth, 1974; Selden, 1978).

¹ Note, however, that it is possible to rank many programs as being more or less beneficial. For example, if reading ability is highly correlated with earnings, reading programs can, in theory, be ranked by rates of return.

² Cost-effectiveness is sometimes confused with cost savings. For example, programs with high faculty workloads are sometimes thought of as cost-effective regardless of whether the relationship between faculty workload and effectiveness has been examined (Meeth, 1974).
As was already indicated, the effectiveness of a program is measured in terms of its goals and outcomes and the characteristics of the students it serves. Studies of educational processes and systems provide indirect measures of effectiveness.

Many questions must be asked:

**goals**
- what needs are to be met? what is to be accomplished?

**inputs**
- who are the students? what are their ages, sex, ...?
- what is the nature, quality, and quantity of resources available?

**access**
- are there social, economic, or physical barriers to attendance?
- is information about the program available to those who need it?

**products and performances**
- are the products and performances (lectures, films, texts, ...) well done technically, pleasing, and attractive?

**process and atmosphere**
- how are objectives achieved?
- how do students and teachers interact?

**outcomes**
- what is achieved? by which students?

**environment**
- what are the needs generated, constraints imposed, support provided by external political, social, and economic forces?

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1 This outline is derived in large part from Gooler (1977).
Many of these issues and questions have been discussed earlier or will be considered in the chapter on budget analysis. The duplication is not unexpected; it has already been seen that most aspects of program planning in education are interrelated. Student characteristics, outcomes, and indirect measures of effectiveness will be discussed following a brief comment on references. The remaining topics are discussed elsewhere.

**Sources of Information**

The literature on effectiveness analysis is extensive. The primary sources of information are educational journals and the ERIC Clearinghouse on Higher Education. Feldman and Newcomb's (1969) review and Dressel's (1961; 1972) general works were mentioned earlier. Meeth (1974) and Lawrence and Service (1977) both provide extensive bibliographies. Specific studies will be cited in the course of the discussion.

**Student Characteristics**

Information about student characteristic is essential for the evaluation of any program's effectiveness. Data about such attributes as prior education, ability, and socio-economic status are needed, not only for assessing the impact of a program on the average student, but also for
determining its effectiveness in serving students with differing needs and styles and for comparing programs with similar objectives. Whether a study focuses on outcomes, access, or some other aspect of effectiveness, student characteristics must either be considered explicitly or taken into account by using control groups or by matching programs according to student attributes (Meeth, 1974).

**Measures of Effectiveness**

In theory, a full evaluation of the effectiveness of an educational program requires knowing what the students will do and can do after completing the program, what they would and could do if they took no program at all, and what they would and could do if they took other programs designed to achieve similar goals. The understanding of the students' behavior would not be restricted to the areas encompassed by the goals of the program but would include its unintended effects as well. In actual practice, the information required and that can be obtained depends on the particular situation. At this point possible measures of effectiveness will be outlined.

Assessing conditions at the end of a program is relatively straightforward. It should be noted, however, that the choice of methods and measures for assessing final outcomes often depends on the kind of information that is available or that can be gathered about intitial conditions.
and other programs. In general, a trade-off must be made between obtaining information that is of specific interest for the program being evaluated and obtaining data that are useful for comparative purposes (Meeth, 1974; Byers, 1975).

Students' learning, growth, and achievement are measured by examining their knowledge, skills, understanding, values, and attitudes and by finding out what they do after completing the programs (Lawrence and Service, 1977; Micek and Wallhaus, 1973). Studies show that both teachers and policy makers place great value in information of the latter kind (Lawrence and Service, 1977). Possible measures of outcomes include:

- normatives test, such as graduate record examinations and the college level examination program (CLEP),
- criterion-referenced tests, i.e., achievement tests, and other instruments designed to measure the students' success in meeting the specific objectives of the program,
- standardized and individually designed tests of attitudes and values,
- placement records of initial job offers and acceptances to programs of more advanced study,
- follow-up studies of job satisfaction, employer satisfaction, success in advanced programs, earnings, etc.

Knowledge about conditions at the beginning of a program may be acquired through measurement (e.g., by administering 'pretests') but usually is based on more
general information about the population served (e.g., admissions requirements for the program and the norms of normative tests). Whether or not specific information is needed about the initial competencies of the students actually enrolled in the program depends, of course, on what is actually known about the population served.¹

In general, then, choices must be made about the kind of data needed to compare initial and final conditions and to compare alternative programs. At one extreme, detailed knowledge may be required and pretests and post-tests administered, while at the other, an examination of the final outcomes of the program under study may be sufficient. The major factors to be considered in choosing a method of evaluation are time, costs, the availability of usable 'ready-made' comparable data, and the need for detailed information about the program under study (Selden, 1978).

**Indirect Measures of Effectiveness**

The study of processes, the environment, and other factors that affect a program's outcomes is essential in most evaluations. It might be argued that these indirect measures of effectiveness are not relevant. (The proof of

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¹ For example, twenty years ago, no pretest would have been needed to determine what students knew about computer programming at the beginning of an introductory course in FORTRAN. Now it would.
the pudding is in the eating, is it not? In fact, however, there is good reason for supplementing data about outcomes with information about less direct measures of effectiveness. First, educational experiences are important in their own right; information about the process and atmosphere helps in assessing the quality of the experience. Second, indirect measures add to what is almost inevitably incomplete information about both intended and unintended outcomes. Finally, such information provides feedback about a program's effectiveness before data about outcomes can be obtained. Studies show that, in fact, faculty, administrators, and trustees consider information about processes and attitudes to be particularly important for evaluating programs (Selden, 1978; Lawrence and Service, 1977; Peterson, 1971).

Among the many indirect measures of effectiveness are:

1 standardized and in-house evaluations of student satisfaction,

2 Depending on the services provided by the system under study, some of these variables may represent resources as well as outcomes. Where this is true the variables must be studied from both perspectives.

2 Depending on the program's objectives, these instruments can also be used to measure outcomes (Micek and Arney, 1973).
students' self-reports of behavior,
- the number of applicants,
- the number of repeat customers among students and program sponsors,
- attitudes in the community,
- attendance
- failure and drop-out rates,
- student-faculty ratios, class sizes,
- student-counselor ratios, activities of counselors,
- faculty activity analyses,
- the accessibility and quality of libraries and other academic support services,
- the quality of physical facilities and equipment.

Recent Studies of Effectiveness and Cost-Effectiveness

The following brief sampling of studies of effectiveness and cost effectiveness illustrates a variety of possible applications. The purpose of the examples is not to survey the literature, but rather to illustrate possible applications of the techniques. Analyses include evaluations of policy issues (e.g., access), of particular instructional methods (e.g., instructional television), and of individual educational programs.
Credit by Examination

The general examination program of the College Level Examination Program (CLEP)\(^1\) has been the subject of two recent studies. Stecher (1977) reviewed the contents of the examinations and the norming procedures used. He concluded that passing the tests required only knowledge normally possessed by college-bound high school graduates.

Losak (1979) reviewed the junior and senior year achievement of students who had received credit through the program as freshmen and found that they did as well as students who had not participated in the CLEP program.

Access

Rosenthal's (1977) study of participation in adult education showed that since 1969 there has been a rapid increase in enrollments in educational programs for adults but a steady decline in attendance rates by blacks, people of low and moderate income, and people with less than a high school education.

Instructional Technology

Wells (1976) reviewed studies of the effectiveness of various instructional technologies (television, radio,....

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1 The basic CLEP program is made up of one examination in each of five subjects. The knowledge and skills tested in the five examinations are intended to represent the equivalent of a year of general studies at the college level.
programmed instruction, and computer assisted instruction). He found that, although overall, there is no consistent pattern of differences among the various approaches or between them and more traditional methods, in many two-way comparisons of individual programs, one of the methods proved to be superior. Studies also indicate that in many cases students with lower ability receive greater benefits from the newer techniques.

Cost-Effectiveness

Meeth (1974) studied the effectiveness of three pairs of colleges where each of the pairs was matched for size, type of student, and goals. He examined the criteria used by accrediting agencies (faculty salaries, proportion of the faculty holding doctorates, number of volumes in the library, ...), the results of a follow-up survey of the alumni that investigated their later education, employment and attitudes towards the school, and finally, the results of the Institutional Functioning Inventory. He could find no significant relationship between costs and any of the usual measures of effectiveness (e.g., graduate's earnings, their success in graduate school, faculty satisfaction, and student satisfaction).

1 The Institutional Functional Inventory is one of the several instruments of the Educational Testing Service for measuring values and attitudes.
Conclusion: Effectiveness and Cost-Effectiveness Analysis

This very brief discussion of effectiveness and cost-effectiveness analysis can give only a very general idea of the scope and the uses of such studies and of the problems and difficulties that may be encountered in this kind of research. It should be stressed that although the analysis of effectiveness is a standard tool of evaluation, cost-effective analysis has more limited application. The latter topic will be discussed again in Chapter VI.

THE ROLE OF EVALUATION IN PLANNING: CONCLUSION

Two major aspects of evaluation have been reviewed in this chapter: 1) the analysis of economic outcomes, and 2) the analysis of effectiveness. It has been seen that both are specialized topics of research. It is rare that an institutional planner has the time and training to undertake more than the simplest of analyses of either kind. As is the case with other kinds of research discussed in this paper, the study of outcomes is usually of greatest value for the background knowledge and the understanding that can be gained from a familiarly with the professional literature.
CHAPTER V

ENROLLMENT FORECASTING

1. INTRODUCTION

Overview

This chapter will focus upon the prediction of demand for educational services. The problem can be approached from either a qualitative or quantitative perspective.

Research is undertaken:

-- to discover new programs and program changes that will improve the ability of the system to serve its target audience (potential market), and

-- to predict the enrollments of educational systems or their components - either under a given set of conditions or under alternative policies and circumstances.

Although emphasis will be on quantitative prediction, the problem of identifying unmet needs will also be considered.

The first part of the chapter will be devoted to an overview of forecasting methods and their applications. Then three kinds of analysis will be considered in detail: 1) traditional extrapolative models, 2) the analysis of demand, and 3) quantitative tools for judgmental forecasting. The final section of the chapter will be devoted to methods of gathering information through needs analysis and market research.
Although the focus of this discussion is on approaches that have direct application to enrollment forecasting, methods of analysis that have contributed to understanding the forces that affect enrollment will also be discussed – even when the techniques cannot be applied directly to institutional forecasting.

A Comment on References

The discussions in this chapter draw from a wide range of sources. References to individual studies will be cited in the course of the chapter. Among the more important general references are the following technical works and review articles:


Among the journals that have been particularly valuable for this study are the following: *Journal of Higher Education, Research in Higher Education, Higher Education, Research in Education,* and *Current Index to Journals in Education.*
2. FORECASTING METHODS AND FORECASTING PROBLEMS

The choice of method for forecasting enrollments depends upon the nature of the system and the purpose of the analysis. The most important factors to be considered are:

1) the amenability of the problem to quantitative analysis,
2) the availability of the required data,
3) the constraints on time and other resources,
4) the ease with which the model can be understood and the results interpreted,
5) the information desired, and
6) the nature of the variables that affect enrollment.

**Amenability of the Problem to Quantitative Analysis**

Educated judgment is the primary tool of enrollment forecasting. Judgment can be supplemented by surveys and other studies and by mathematical models. Regardless of whether mathematical analysis is undertaken, surveys and qualitative studies are usually valuable for enrollment forecasting. These topics will be discussed in later sections. The questions addressed here are:

1) When are quantitative models likely to be of value?
2) How does the nature of the underlying problem affect the choice of model?
The decision to use quantitative analysis depends on the time and talent available and on the benefits expected from the effort. Quantitative models are, of course, most useful if they yield accurate and reliable forecasts. But they may also be of value if they simply narrow the range of the forecast or if they provide insight into the forecasting problem.

The type of model, if any, that will produce a useful forecast depends on two factors: 1) whether or not trends are stable over time, and 2) whether or not the major underlying causal variables can be identified and quantified.

Traditional enrollment forecasting methods are extrapolative. Models of this type are used successfully in primary and secondary education and in many situations in postsecondary education. They provide accurate results when

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1 A single model may, of course, use more than one of the basic techniques described here. Furthermore, forecasts are usually based on information from a variety of sources, possibly including the results of more than one model.

2 Basic extrapolative models are of two types:
1) time-series and other curve-fitting models in which the only independent variable is time;
2) constant-ratio models, i.e., any of a variety of models which assume a constant ratio between enrollment and some population variable (i.e., \( s/n = \text{constant} \), where \( s \) is the enrollment to be forecast and \( n \) a known enrollment or population figure). The methods include the simple-ratio technique, the cohort-survival method, Markovian models, and the Induced Course Load Matrix (ICLM).
trends are stable and frequently provide a starting point for forecasting in situations where these conditions do not apply. Extrapolative models vary greatly in complexity, in their assumptions about the nature of underlying trends, and in their sensitivity to changes in trends.

A second class of analytic tools, explanatory demand models, compute enrollments as a function of underlying causal variables. They relate such factors as unemployment levels, job opportunities, tuition, and financial aid to the demand for places in different schools and programs among different groups of students. The models make use of a variety of mathematical tools including multiple correlation and regression, econometric analysis, and differential equations. Given the complexity of the forces that act upon educational systems and their students, it is hardly surprising that the greatest value of demand models is in determining the importance of individual causal variables. Demand models are used only rarely to predict institutional enrollments.

Finally, there are several quantitative methods for forecasting under a high degree of uncertainty, that is, for predicting enrollments in situations where neither trend analysis nor causal studies yield reliable results.
Approaches include:

— techniques that deal explicitly with uncertainty by providing estimates of the costs, profits, and risks of alternative decisions. These include pay-off tables and linear programming.

— techniques that deal systematically with subjective judgments or that combine subjective judgment with quantitative analysis. These include Delphi, Bayesian analysis, and interactive mathematical programming.

Formal techniques for forecasting under conditions of uncertainty are used in market analyses by many businesses. They are not commonly used for enrollment forecasting, but appear to be suitable for this purpose.

The tools of quantitative forecasting will be discussed in detail in later sections of this chapter.

**The Availability of Data**

The availability of relevant data is an important factor in determining the choice of forecasting method. Depending upon the type of model, data may be needed about historical trends, about the system itself, about potential or actual students, or about external events that may affect enrollment.

Lack of data, however, does not necessarily eliminate the possibility of using a particular model. Sometimes the necessary data can be gathered, sometimes subjective estimates can be substituted, and sometimes surrogate data representing other institutions or situations can be used. Often the greatest value of a model is that it helps
decision makers to identify their information needs.

Constraints on Time and Other Resources

The forecasting method most appropriate for a particular situation depend upon the time, money, staff, computer support, and other resources that are available. Large-scale investment of resources may be warranted if a model can be used many times or if costly decisions are to be made. At the other end of the scale, forecasts must often be made on short notice and with very limited expenditures of resources. Whether a particular technique can be applied within the constraints of a given situation depends upon the data demands and the inherent complexity of the technique. Also important is the availability of established methodologies or models that can be applied to the problem. Standard computer programs for statistical analysis, for example, are of great value in enrollment forecasting. Although some enrollment models that have been developed for traditional systems may be adapted for use by systems serving part-time students, few models or methodologies have been developed specifically for this purpose. Until further research is done in this area, decision makers may, except where considerable time and resources are available, be forced to rely upon the least demanding kinds of analysis.
Ease of Understanding

It is well known that the usefulness of models and analyses depends upon how well they are understood by decision makers (Hoos, 1971; Pool, et al., 1971). Unless a decision maker has some "feel" for the underlying assumptions of the model, understands what it can do, and can interpret the results without difficulty, the model will not be used as a decision making tool. The general acceptance of simple, time-series analysis, for instance, can be attributed to the ease with which the techniques and the results can be understood by people who have little or no technical training. As a practical matter, the choice of model must always be influenced by the ability of the decision maker to interpret technical analyses and the ability of the analyst, given the resources available, to present the information at the appropriate level of understanding.

Regardless of the technical sophistication of the analyst and the decision maker, forecasting models should be kept simple, that is, the number of variables should be kept to the minimum and the relationships between them made as simple as possible consistent with the nature of the system. It is well known that there is no positive correlation between the complexity of models and their accuracy, and that, in fact, the reverse is sometimes true (Dresch, 1975);
Updegrove, 1978). An important advantage of simplicity is that, since the underlying assumptions are understood easily, sources of possible error are identified readily.

The Information Sought

The method of analysis depends upon the information needed in the particular situation which, in turn depends on the purpose of the research. Forecasts can be made of:

-- short or long term enrollment trends,
-- enrollments at the national, state, institutional, program, or course level,
-- new enrollments or total enrollments,
-- enrollments for one period or for more than one period, and
-- openings or applicants.

Information about any of these aspects of enrollment trends may be required in planning programs for part-time students. Most often short-term projections at the institutional, program, and course levels are required. Usually both new and total enrollments must be considered. Whether the number of openings, the number of applicants, or both must be considered depends upon the relationship between the capacity of the system and the demand for services.

The information needed also depends upon which variables affect the institution's enrollment.
The Basic Variables Affecting Enrollment

Enrollment in educational systems depends on four interrelated factors (Poignant, 1967):

-- the characteristics of the population,
-- the perceived needs of the different groups, within the population,
-- the social and economic environment, and
-- the educational systems (capacity, programs, prices, etc.)

These four factors together determine the supply of and demand for educational services. Depending upon the nature of the system, upon the problem to be solved, and upon the data available, enrollment forecasts may be based on one or more of these factors or on historical trends.

The following brief algebraic description should help clarify the relationships. First, enrollment is a function of demand and capacity.¹

¹ The analysis of capacity will not be considered in this chapter. It is interesting to note, however, that the few capacity models reported in the literature are all mathematical programming models that maximize enrollments given constrained resources. They include one by Menges and Elstermann (1970) of German higher education and one by McNamara (1971) of vocational-technical training in the United States. The problem of representing capacity limits in resource models will be discussed briefly in Chapter XI.
\[ s_i = \min (q_i, k_i), \] where
\[ s_i = \text{enrollment in program } i, \]
\[ q_i = \text{demand for program } i, \]
\[ k_i = \text{capacity of program } i, \]

that is, either demand or capacity determines enrollment, depending on which is smaller. But demand is a function of demography and of the attitudes of each population group:
\[ q_{ij} = n_j \times d_{ij}, \] where
\[ q_{ij} = \text{demand for program } i \text{ by group } j, \]
\[ n_j = \text{population of group } j, \]
\[ d_{ij} = \text{fraction of group } j \text{ that will enroll in program } i, \] in the absence of capacity limits. The term fractional demand is used here to denote the variable \( d \). Finally, fractional demand is a function of a number of environmental and system variables including the state of the economy, job opportunities, program fees, promotion, etc.

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1 As Dresch (1975) points out, this is a simplification; demand and capacity are actually related to each other in a complex fashion.
As was mentioned earlier, approaches to the forecasting of demand can be categorized according to how underlying causal factors are treated. Forecasts can be made:

-- by analyzing historical trends,

-- by examining the relationship of enrollment to population and fractional demand — without analyzing the factors that affect fractional demand (constant-ratio methods), and

-- by dealing explicitly with the relationships between demand on the one hand and environmental and/or system variables on the other.

Techniques applicable to each of these approaches will now be considered as will the kinds of situation in which their use is appropriate.
3. THE TRADITIONAL TOOLS OF ENROLLMENT FORCASTING

Traditionally, enrollment forecasts have been based on extrapolation. Either 1) the enrollments themselves have been projected directly using time-series analysis, or 2) population projections have been combined with projections of enrollment ratios using constant-ratio methods (Wasik, 1971). Although the traditional methods have significant limitations, they remain among the most valuable approaches to enrollment forecasting. Projection and ratio methods will now be described as will modifications and adaptations that can increase their value for forecasting in situations where trends are unstable or difficult to identify.

Simple Averages and Time-Series Analysis

Projecting Enrollments on the Basis of Historical Data

Undoubtedly the most common, and in many cases the most useful, approach to enrollment forecasting is the direct projection of future enrollments on the basis of historical data (Chisholm and Whitaker, 1971). Sometimes very simple
techniques can be used. The most common assumption is that the enrollment in the next period will equal that in the current period. Often, one of a variety of simple curve-fitting models is appropriate; they include simple averages, moving averages, and exponential smoothing.\(^1\) In these models, constant enrollment is assumed. More complex curve-fitting models may be used to represent linear variations, cyclical patterns, and other non-constant trends. Among the models of this type are double exponential smoothing, higher order smoothing, polynomial models, logistic growth curves, Gompertz functions, and

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\(^1\) In the \textit{simple averages} method, enrollments are projected by averaging past enrollments. In the calculation of a \textit{moving average}, the oldest observation is dropped from the series as each new observation is added. In \textit{exponential smoothing}, each measurement is multiplied by a weighting factor, with more recent data receiving greater weights.
decomposition methods. Other approaches, e.g., adaptive filtering and the Box-Jenkins method, have been developed to aid in forecasting when the pattern of the time series is

1 The double moving averages and double exponential smoothing methods assume a linear trend in the time series. In the double moving averages method, a moving average is computed, and then a moving average of that moving average is calculated. If a linear trend exists, the error of the double moving average will be about twice that of the single moving average. The difference between the two is used to compute a correction factor which is then applied to the single moving average to produce the actual forecast. The basic concept behind the double exponential smoothing method is similar to that of the double moving averages method (Wheelwright and Makradakis, 1973).

Higher order smoothing models can be used to represent non-linear time series (Wheelwright and Makradakis, 1973).

In polynomial models and related techniques, regression analysis is used to obtain the best fit of the historical data to the particular curve selected to represent the time series. Methods include:

- **first order polynomial models**: \( E = a + bt \),
- **higher order polynomial models**: \( E = a + b_1t + b_2t^2 + \ldots \),
- **exponential models**: \( E = a^bt \),
- **logistic growth curve (s-shaped) models**: \( E = k/(1 + e^{-a+bt}) \),
- **Gompertz function (s-shaped) models**: \( E = ka^bt \), where
  - \( E \) = enrollment ratio,
  - \( k \) = the limiting value of \( E \), and
  - \( a, b, b_1, b_2 \) are the parameters to be estimated by regression analysis (Wing, 1974; Pittinger, 1975).

The decomposition method is a classic forecasting technique in which it is assumed that the time series is a combination of a linear trend, an annual cycle, and a long-term cycle (Chisholm and Whitaker, 1971).
difficult to identify in advance. In practice, simple averages, moving averages, exponential smoothing, first order polynomial models, logistic growth curves, and decomposition methods have all been shown to be valuable for enrollment forecasting (Wing, 1974; Pittinger, 1975; Salley, 1979; Weiler, 1980; Orwig, et al., 1972; Finch and Smith, 1974). Many of the models use historical projections for estimating enrollment ratios rather than for the direct estimation of enrollments, that is, the historical projections are incorporated into constant-ratio models.

Two recent models, one by Salley and one by Weiler, deserve comment. Salley (1979) used the decomposition method to analyze enrollments at a large urban university. The study revealed a long-term trend, a shift in the trend, seasonal variations, and cyclical variations that were inversely related to the employment rate. Salley suggests that the cyclical variation may account for much of the error in national annual forecasts that are based on

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1 Adaptive filtering is a method of adjusting the weights attached to each member of the time series to minimize the error of the "forecast" of the most recent observed value (Wheelwright and Makradakis, 1973).

The Box-Jenkins method is a complex, iterative, statistical approach that uses the autocorrelation coefficients of the data values in the time series to identify the pattern underlying the data (Wheelwright and Makradakis, 1973).
straight-line projection techniques.

Weiler (1980) fitted historical data on the annual cycle of applications, admissions, and enrollments in various segments of a university to logistic growth curves and Gompertz curves, choosing the curve that gave the best fit in each situation. He used the model to forecast fall enrollments at intervals during the previous year. Not surprisingly, projections made close to the beginning of the semester proved to be very accurate.

The chief advantages of the less complex time-series methods are: 1) ease of understanding, 2) ease of development and use, 3) low cost, and 4) availability of data. One of these methods, used alone or in conjunction with a constant-ratio model, is often the best choice for enrollment forecasting for ongoing programs. In many everyday applications, formal analysis is not even required. Simply glancing at tables or graphs is often adequate and indeed the only 'quantitative' method whose use can be justified given the time and resources available.

Unfortunately, time-series models have significant limitations. First, they provide little insight into the underlying factors that affect enrollment. Second, many of the commonly used time-series methods, being nonstatistical,

1 Salley's decomposition model illustrates one exception to this rule.
do not provide estimates of error. Third, these models
cannot be used at all for estimating enrollments in new
programs or under circumstances of radical change, and even
where trends exist, the simpler time-series methods are slow
to respond to changes in the trends (Lyell and Tool, 1974).
These limitations have been the cause of major errors in
national enrollment estimates (Mangelson, et al., 1974;
Folger, 1974).

There are two possible approaches to using time-series
models when changes in trends are expected:

First, some time-series methods, including exponential
smoothing, adaptive filtering, and the Box-Jenkins method,
do respond quite quickly to changes in trends. It should be
noted, however, that although use of the more complex
methods sometimes permits more accurate representation of
complex or changing trends, the advantages that characterize
the simpler methods tend to be lost as the complexity of the
models increases. The more complex statistical models and
the Box-Jenkins method, in particular, require large amounts
of data and are difficult and costly to use.

Alternatively, it is possible to begin with a
time-series study and adjust the results for anticipated
shifts in enrollment patterns. It is common to make such
adjustments on the basis of information from surveys,
consultations with informed persons, and published
information (Centra, 1980).
In summary, time-series methods—whether used alone or along with constant-ratio models—are among the most useful tools for forecasting the enrollments of ongoing educational programs. Because the models cannot anticipate changes in trends, the quality of forecasting is often improved when the models are combined with educated judgment about possible shifts in enrollment patterns.

**Constant-Ratio Models**

Constant-ratio models have been applied to a wide variety of forecasting problems for traditional education. They are used, for example, in such major analytic systems as CAMPUS (Mowbray and Levine, 1971) and the models of the National Center for Higher Education Management Systems (Lovell, 1971; D. Clark, et al., 1973). In fact, after direct projections of historical data, constant-ratio methods are the most extensively used tools for enrollment forecasting.

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1 For all these so-called constant-ratio methods, including Markov analysis, the requirement that the ratio remain constant over time may be relaxed. Permitting the ratio to change from one time period to the next in a multi-period model does not affect the basic concept underlying these techniques, but it may greatly increase the complexity of the calculations.

2 For discussions for these methods and their application to enrollment forecasting in the public schools, see Buxman (1979) and Camp (1979).
All constant-ratio models compute enrollment estimates as linear functions of population:

\[ s = n \cdot d, \text{ where} \]

\[ s = \text{enrollment}, \]

\[ n = \text{population}, \]

\[ d = \text{constant (fractional demand).} \]

Constant-ratio models may be classified according to three major characteristics that together determine their cost, ease of use, accuracy, and reliability:

1) the type of ratio method used,

2) the method of estimating population, and

3) the method of estimating fractional demand.

These topics will be considered in turn.

The Ratio Methods

There are four types of constant-ratio method: the simple-ratio method, the cohort-survival technique, Markov analysis, and the induced course load matrix (ICLM). Two other approaches, constant and variable work models, do not take the form \( s = n \cdot d \), but are fundamentally similar to

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1 The variables \( n \) and \( d \) may be scalars or elements of vectors or matrices, and \( s \) a scalar or an element of a vector. For example, one might predict freshman enrollment as a fraction of the population aged eighteen to twenty-three, using a scalar equation, or one might predict the enrollments of all four classes on the basis of several factors, including present enrollment in each preceding class, promotions, retentions, in-migrations, and dropouts, using a matrix equation.
constant-ratio models. The six methods will be discussed; the basic concepts and strengths and weaknesses of each will be outlined, and applications that are particularly relevant to program planning for part-time education mentioned.

The simple-ratio method. In the simplest of the constant-ratio methods, the ratio method, enrollments are estimated directly as fractions of the appropriate population groups. For example, a certain fraction of the emergency medical technicians in a county might be expected to enroll in an annual refresher course. The method is widely used for forecasting enrollments in colleges and universities, especially for predicting freshman enrollment as a fraction of the number of recent high school graduates (Wing, 1974; Mangelson, et al. 1974).

The simple-ratio method has several advantages that make it particularly suitable for forecasting in many situations encountered in part-time postsecondary education (Wing, 1974; Lyell and Tool, 1974):

- it is easy to understand,
- computations are simple and direct,
- it is inexpensive to use.

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1 Most of these advantages depend in part upon the method used to compute the constant of proportionality (fractional demand). The advantages listed are to be found in traditional applications of the simple-ratio method.
- data requirements are minimal,
- it can be used to estimate enrollments in new and developing programs (provided that the target audience can be identified and enumerated), and
- it is especially suited to programs that are intended for specific audiences (e.g., the elderly or members of specific professions).

The principal disadvantage of the simple ratio method is a difficulty common to all ratio models. Frequently, inadequate attention is given to the estimation of fractional demand, especially to the factors causing variations in the ratios. This problem will be discussed later in the section.

The cohort-survival method. The cohort survival or grade-progression method is based on the concept of a group (cohort) moving through a series of stages. The progress of the cohort from one stage to the next is predicted on the basis of survival ratios. The method is used to forecast both initial and total enrollments of colleges and universities and is the accepted method for enrollment forecasting in elementary and secondary education. Although somewhat more complicated than the simple-ratio method, it is relatively easy to understand and use and, for some applications, is more accurate than the simple-ratio method. Two limitations of the technique should be noted. First, cohort-survival models are dependent upon extensive
hisitorical data bases. Second, the models yield highly aggregated results.

Many cohort-survival models are reported in the literature (Wing, 1974; Lyell and Tool, 1974; Finch and Smith, 1974). The Johnson County, Kansas model by Finch and Smith is of particular interest. This model uses a comprehensive data base that characterizes each section or neighborhood of the county by its housing, land-use zoning, and school attendance rates as well as the age and sex of the population. A modified cohort-survival method is used to simulate births, deaths, and migrations to, from, and within the county. The model can be used to forecast future population using information about birth rates, death rates, and rates of growth. It also allows parametric analysis; for example, the effects of changes in the economy, birth rates, or zoning laws can be simulated. The model has proved valuable, not only for enrollment forecasting, but also as a planning tool for a variety of governmental and social agencies.

Markov analysis. Markov transition models, like cohort-survival models, can describe the flow of students through an educational system on the basis of retention, drop-out, transfer, and other rates. Markov analysis is a formal mathematical technique that describes such transitions in terms of matrix algebra in a manner that permits extensive and rapid analysis of flows over one or
more time periods (Kemeny, et al., 1966); Wasik, 1971).  

Like the cohort-survival method, Markov analysis is most commonly used for forecasting enrollments in systems where students progress through a sequence of stages. Among the typical examples of Markov enrollment models are those of Gani (1963), The National Center for Higher Education Management Systems (Johnson, 1974; Lovell, 1971), Grace and Bay (1974), and Evans (1975). Markov models can represent relatively complex student behavior like the "in, out and stopout" patterns that characterize many community colleges (Evans, 1974), and using parametric analysis, the models can simulate alternative circumstances and decisions (Grace and Bay, 1975).

In addition to representing flows through a series of stages, Markov models can be used to forecast the outcome of a single set of transitions. For example, Orwig et al. (1972) developed a model to estimate the number of majors in different fields on the basis of students' attributes and their stated intentions. Markov models are superior to the simple-ratio technique for this purpose where more than a few population groups or program choices are under scrutiny.

1 The term "Markov model" is sometimes used quite loosely. Models using matrices of fractional demand to represent student flow are called Markov models regardless of whether or not they use the formal methods of Markov analysis. Other terms used to describe this type of model are "linear fractional flow model" and "student flow model".
Markov models have other advantages: they are conceptually simple, the data necessary for their use are usually available from existing historical records, and, because matrices are used to represent the flow of students, the models can be expanded at will to yield highly disaggregated results. This third feature is an advantage for planning and budgeting models because it allows budgets and unit costs to be developed for each cost center of the educational system. Increased detail is achieved at a price, however. Data requirements, computation time, and the volume of output all increase as the matrices are expanded.

Other than the problems that may be caused by the size of the matrices, the principal difficulty associated with Markov analysis is the instability of the matrices over time (Lyell and Tool, 1974). Not only has it proved difficult to forecast changes in the matrices, but also, permitting their values to vary with time increases the complexity of the analysis. These problems of estimating fractional demand will be discussed in a later section.

The extensive use of Markov analysis in enrollment forecasting for traditional higher education is a testimonial to the value of the method. In part-time postsecondary education, Markov analysis can be used for forecasting enrollments in sequential programs (e.g., degree and training programs) and for forecasting demand as a
fraction of population as in Orwig's model. The technique can also be used to model the flow of students into, out of, and within systems of postsecondary education - for example, to and from community colleges, four-year schools, evening schools, and employment. Models of this last type can improve the understanding of students' needs, but are unlikely to be sufficiently accurate for forecasting enrollments directly (Evans, 1975; Wing, 1974).

**Constant and variable work models.** Constant and variable work models are similar to cohort-survival and Markov models in that they compute enrollment as a function of the initial size of each cohort and a number of constant transition probabilities. In these models, however, enrollment is also dependent on the amount of work (for example, the number of semesters) required to complete the course of study.

Marshall and Oliver (1969) developed a constant work model that forecast enrollments on the basis of the initial size of each freshman class, the number of semesters required to complete a degree, the probabilities of continuing, taking a semester off, and dropping out after each semester, and the conditional probability of successfully completing a semester. The model was an extremely simple one, but represented enrollment at the Berkeley campus of the University of California quite accurately. A variable work model was developed by
Balachandran (1973) to forecast enrollments at the course level.

The induced course load matrix (ICLM). The ICLM is a matrix that describes the relationship between program enrollments and the demand for services in various segments of an educational system (or, to put it another way, between "clientele" and "delivery systems").¹ In traditional colleges and universities the elements of the matrix are the numbers of credit hours taken in each department (school or course) by a typical student from each major.² Thus once the number of students in each major is known or has been

¹ Note that the basic difference between a Markov matrix and a load matrix is that the latter represents students' behavior in a single time period.

² $s_{ij} = n_j \times d_{ij}$, where

$n_j$ is the number of students in major $j$ (e.g., economics majors).

$d_{ij}$ is the number of credit hours taken by a typical student of major $j$ in department $i$ (e.g., history); $d_{ij}$ is an element of the ICLM and a measure of fractional demand.

$s_{ij}$ is the number of credit hours taken by students of major $j$ in department $i$.

Note that in practice it is usual to include level (lower division, graduate, etc.) in the definitions of both client groups and delivery systems.
estimated, the enrollments in the various departments can be forecast. The ICLM or some similar device is used in most resource allocation models for traditional higher education (Mowbray and Levine, 1971; Hussain, 1976).

In many programs for part-time students there are relationships between client groups and delivery systems that are analogous to the major-department relationship of traditional higher education. For example, in some programs, such categories of client group as police officers and housewives might be used in place of categories like economics majors. And categories of delivery systems other than departments might be used; for example, the elements of the matrix could represent demand for courses at a particular location or for such services as academic advising, student counseling, and instructional computers. The possibility of using the ICLM in this manner is mentioned by Clark, et al. (1973), but no reports of such applications appear in the literature. Table 27 illustrates matrices of this type prepared for LEARN.

The ICLM is subject to the same major problems as Markov matrices. First, in many models, the matrices are extremely large; they demand much computer space and time and yield results that, because of the amount of detail, are overwhelming in terms of the time and effort required to interpret them (Hopkins, 1971). Second, tests have indicated that elements of the ICLM do not remain
constant over time; as a result, forecasts are often inaccurate (Huff, et al., 1972). Among the possible approaches to minimizing problems with the ICLM are 1) the use of more highly aggregated classifications to reduce the amounts of input and output of the models, and 2) careful attention to the methods used to estimate the elements of the matrices. Fractional demand will be discussed later in this section.

**The use of constant-ratio models.** To summarize, constant-ratio methods answer two kinds of need. They can be used:

-- to represent flows through various stages, either in sequential programs or in other situations where behavior over a period of time must be considered, and

-- to estimate participation in programs and activities on the basis of information about one or more population groups.

Although both kinds of situation occur in part-time postsecondary education, the second is more common. Constant-ratio models should be especially valuable in part-time postsecondary education for analyzing new and

1 It should be noted that the enrollment in the educational system itself may sometimes be considered to be a population variable. For example, freshman enrollment may be treated as a population variable for the purpose of forecasting sophomore enrollment the following year.
developing programs and those that serve identifiable target audiences.

**Population Projections and the Analysis of Demographic Data**

The size of the population and its distribution by age, occupation, previous education, etc. affect the demand for different educational services and in some cases actually determine enrollments. The study of population at a given time (static demography) and of changes in population over time (dynamic demography) are both important to educational planning (Châu, 1969).

Given the magnitude of public and private investment in education, it is not surprising that the demographic analysis of enrollments has been the subject of extensive effort for many years. The basic population estimates used in educational enrollment forecasts are derived from projection and ratio models of the type already described (Pittenger, 1976; Centra, 1980). These techniques will not be reviewed here. Instead, examples of recent research will be reviewed to illustrate the application of demographic analysis to enrollment forecasting.

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1 Obviously, enrollments can be forecast on the basis of "population alone" only if other factors remain constant.
Population studies. O’Keefe used data published by the National Center for Educational Statistics to analyze participation by adults in educational programs. He found that the most rapid growth in adult participation occurred prior to 1972 and that during most of the 1970’s the number of adult participants continued to increase more rapidly than the adult population. Given that the number of people aged twenty-five to thirty-four, the prime participants in adult programs, will begin to decrease in the mid-1980’s, it is likely that the number of adult participants in education will remain constant or increase only slowly during the rest of the century.

Levin and Slavit (1970) analysed population data for Massachusetts to determine the pool of potential clients for several kinds of state-aided adult education, including adult basic education, high school equivalency programs, and occupational education for the handicapped.

Dresch’s (1975) study of the relationship of the demand for higher education since 1920 to birthrates, labor supply, and manpower needs was discussed briefly in the last

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chapter.

Others who have examined the relationship between changes in population characteristics and changes in enrollments are Carroll and Morrison (1976), and Finch and Smith (1974). The dynamic model developed by Finch and Smith of population trends in Johnson County, Kansas was mentioned earlier. ¹

A model developed by Pool, Abelson, and Popkin (1971) used a somewhat different approach to constructing a demographic information base. In this model, forty-eight "synthetic states" were constructed to represent the demography of the forty-eight contiguous United States. Four hundred eighty socio-economic classifications were used. For example, one group was eastern, metropolitan, lower income, white, female, protestant democrat. Once the synthetic states were constructed, the results of existing surveys were used to forecast people's behavior under various circumstances. This model was developed to simulate the reactions of voters to various positions and strategies proposed in the 1960 Kennedy campaign for president. The value of Pool's method is that the behavior of a sub-population can be simulated using national, state, or

¹ See Shulman (1976) and Centra (1980) for additional references to work of this kind.
regional statistics. Such data are usually more readily available than is information about a smaller geographic area or a single institution.

Models with extensive demographic data bases — such as the Johnson County and Pool models — can be of value in enrollment forecasting in many situations encountered in part-time postsecondary education — especially for evaluating the markets for new and changing programs. But the cost of constructing the data bases and developing and validating simulations appropriate to a variety of forecasting situations is very high. The cost-effectiveness of such models is a matter of scale; only a system that can use the model extensively can afford the costs of development. Such situations may occur in community colleges and in other large systems of postsecondary education with a variety of programs and a commitment to adapting to changing needs. The Johnson County experience also points to the possibility that a sufficiently general model can be used by a variety of public service agencies, thus opening up the possibility of cost sharing.

Sources of Information. The U.S. Bureau of the Census is the major source of population statistics in the United States. Also important are the annual reports published by the Department of Education giving enrollments, degrees awarded, projected enrollments and other statistics for two- and four-year colleges and for vocational schools. An
excellent bibliography is to be found in Bulletin 1816 of the Bureau of Labor Statistics (1974). References to sources of statistics are also included in the papers of Shulman (1976), Mangelson, et al. (1974), and Centra (1980). Finally, individual educational systems maintain extensive records of current and past enrollments. Several studies based on institutional data were cited earlier.

Problems and limitations. The interpretation and use of demographic information requires a certain amount of caution. Because of variations in definitions and data bases, serious difficulties may be encountered in comparing different studies. At the national as well as at the institutional level, research is based on a variety of methods of counting. (For example, methods of defining full-time students, full-time-equivalent students, and higher education all vary.) The problem is compounded by the failure of most researchers to report their underlying definitions and assumptions (Mangelson et al., 1974; Folger, 1974). Efforts are being made to standardize definitions and methods of reporting. These will be discussed in Chapters VI and VII.

Fractional Demand: Estimating the Constants in Constant-Ratio Models

The quality of the estimates of fractional demand often determines the value of a constant-ratio model. Many techniques are used to estimate fractional demand; they
include both time-series and non-extrapolative methods. Wing (1974) describes several constant-ratio models that use time-series methods for estimating fractional demand; the methods include simple and moving averages and exponential smoothing. Perhaps the most common approach to estimating fractional demand is the first-order polynomial model. This method is used in RRPM to compute the elements of the ICLM and in the NCHEMS Student Flow Model to calculate the elements of the transition matrices (D. Clark, et al., 1973; Johnson, 1974).

Among the models that are not simply curve-fitting are those of the Carnegie Commission (1973c), Jewett (1972) and Orwig, et al. (1972). In the Carnegie Commission study, alternative projections were made by simulating the effects of changes in policy (e.g., shortened degree programs and increases in adult participation). Jewett used multiple correlation and regression to develop a probability function of enrollment in terms of the individual's sex, test scores, and ability to pay and tuition at various institutions. Orwig, et al. used survey data (students' intended majors) along with institutional records to develop estimates of fractional demand for different majors. They took this approach in two models, one using simple ratios and the other using Markov analysis. Refinement of the models using data about family income, scholastic ability test scores, and high school grade point average was considered, but
preliminary analysis indicated that no significant improvement in the predictions could be expected from the inclusion of these data. Orwig, et al. also estimated enrollments using two simple projection models. The results from the models using survey data were not as good as those from the projection models. In this case at least, an attempt to detect deviations from historical trends was not successful.

The accuracy and reliability of estimates of fractional demand vary. As has been indicated, many such estimates have been highly inaccurate, especially during periods of fundamental change in enrollment patterns. There is no doubt that the inaccuracy and unreliability of many constant-ratio models can be traced to the inappropriate use of historical projections. The problem is particularly serious for the larger Markov models and for models that use large induced load matrices. Data and computational requirements for these models are such that using any but the simplest methods of estimating fractional demand is difficult. Unfortunately, experience has shown that, because of the high degree of variability of fractional demand, linear regression and other simple time-series methods are rarely appropriate for estimating the elements of the matrices.

In short, a major cause of past difficulties in enrollment forecasting in postsecondary education was that
researchers concentrated on the structure of analytic models and neglected the problem of estimating fractional demand (Lyell and Tool, 1974). Although greater emphasis is now being placed on the quality of the data, there is a continuing need for research on the demand for both full-time and part-time education. Techniques from institutional research, business forecasting, and market research are now being explored by many researchers. Among the more promising approaches are statistical demand analysis and surveys. They will be considered in the next few sections of this chapter.

**Constant-Ratio Forecasting Methods: Conclusion**

In spite of their limitations, traditional constant-ratio models are valuable tools of enrollment forecasting. These models produce accurate forecasts in situations where trends are stable over time (Evans, 1975; Orwig, et al., 1972). Their simplicity and the availability of the necessary data make many of the constant-ratio models useful for a wide variety of practical applications. Furthermore, improvements in the data bases and the use of surrogate data can be expected to increase the value of this approach to enrollment forecasting (Wheelwright and Makradakis, 1973; Pool, et al., 1971; Dresch, 1975).
4. THE ANALYSIS OF DEMAND

Until recently, most enrollment forecasting has been based on the assumption that, for most programs, demand is a constant function of some appropriate population statistic and that supply can be expanded at will to meet demand. Traditional enrollment analysis considers neither the needs of actual and potential students nor the relationships between these needs and educational programs. As was pointed out earlier, the failure to consider such critical factors as changes in manpower needs, changing preferences among students, the character, cost, and capacity of programs, and the actions of competing schools has resulted in serious errors in enrollment projections (Dresch, 1975; Peak, 1975). An understanding of changing needs and opportunities is especially important for enrollment forecasting in part-time postsecondary education - first, because enrollments in such programs tend to be very sensitive to these changes and, second, because systems serving part-time students often have the flexibility to respond quickly to changing demands and conditions.

Before methods of research and analysis are discussed, the basic environmental and systems variables affecting enrollment will be listed.
Environmental and Systems Variables

Summary of the Problem

The algebraic statement of the problem will now be expanded. First, enrollment is equal to either supply or demand, whichever is smaller:

\[(1) \quad s_i = \text{minimum} (q_i, k_i), \quad \text{where}\]

- \(s_i\) = enrollment,
- \(q_i\) = demand,
- \(k_i\) = capacity.

Demand depends on population and perceived need:

\[(2) \quad q_{ij} = n_j \cdot d_{ij}, \quad \text{where}\]

- \(n_j\) = population of group \(j\)
- \(d_{ij}\) = the fraction of group \(j\) that is expected to enroll in the program \(i\), if there are no capacity limits.

Finally, fractional demand depends on environmental and systems variables:

\[(3) \quad d_{ij} = f(t_i, t_k, c_i, c_k, l_i, l_k, i_j, p_{ij}); \quad \text{and}\]

\[(4) \quad p_{ij} = p_i + p_{uij}, \quad \text{where}\]

- \(t_i, c_i,\) and \(l_i\) are the price, product, and place of program \(i\).\(^1\)

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\(^1\) The term product comes from marketing and refers to what is being sold. It is used here for lack of a better word. The term place is used very broadly to include the site of instruction, the meeting time, and other factors affecting convenience of access.
$t_k, c_k, \text{ and } l_k$ are the price, product, and place of related programs that are either competitive with or complementary to program $i$.

$i_j$ is the income of group $j$.

$p_{ij}$ represents the preferences of group $j$ for program $i$, as influenced by both tastes and perceptions of benefits.

$p_{cij}$ represents the component of the preferences that are controlled by promotional activities.

$p_{uij}$ represents the uncontrollable component of personal preference.

Of the independent variables in the above equations, $t_k, c_k, l_k$ (i.e., the characteristics of other programs), $i_j$, and $p_{uij}$ (characteristics of the potential students),

1 These four equations can be reduced to three by eliminating the variable $d_{ij}$, that is, by eliminating fractional demand and considering only total demand:

$$s_i = \min(q_i, k_i),$$

$$q_{ij} = f(n_j, t_i, t_k, c_i, c_k, l_i, l_k, i_j, p_{ij}),$$ etc.

The statement of the problem given in Equations 1-4 is useful where enrollment forecasts are based on one of the ratio methods. Otherwise, the statement given here is more appropriate.
and \( n \) (the population)\(^1\) are environmental variables, and \( t_i \), \( c_i \), \( l_i \), and \( p_{c_i} \) (characteristics of the system and its programs) are systems variables. Depending upon the situation and decision to be made, the systems variables may or may not be controllable. All environmental variables are uncontrollable, by definition.

**Environmental Variables**

The political, social and economic environment affect both the supply of and demand for education. Decisions about what educational programs are offered, about enrollment ceilings, budgets, subsidies, etc. are partly determined by decision makers' perceptions of the relative social and economic benefits of different educational programs and of the benefits of education versus those of other public programs. This matter was discussed in the last chapter. The willingness and ability of members of various population groups to enroll in different types of educational programs is also affected by conditions and events outside the system. The major environmental factors affecting enrollments fall into three categories:

1) demographic variables, i.e., the characteristics of students and potential students (financial resources, age,

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\(^1\) Population, \( n \), is an environmental variable except where the relevant population is current enrollment.
educational level, attitudes towards education, etc.)\(^1\)

2) the political, social, and economic environment, including:

- political and social movements that affect attitudes of various groups towards education (the civil rights movement, the women's movement, etc.)

- the availability, desirability, and initial and continuing education requirements of various types of employment that might result from further education, and

- the availability and desirability of non-educational alternatives (jobs, the draft, hanging around),

3) the educational environment, i.e., the availability, quality, and cost of competing educational opportunities.

**Systems Variables**

The major institutional factors that affect enrollments are:

- capacity,

- standards for admissions and success,

- educational programs (subject, level, time, place, etc.),

- other programs, services, and activities (including counseling, sports, dormitories, etc.),

- characteristics of the student body (abilities, sex, etc.),

- price (including the effects of financial aid),

- publicity and promotion.

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1 Because of its importance in constant-ratio modeling, the matter of population characteristics has already been considered; there will be some additional discussion of the topic in later sections.
It should be recognized that systems variables affect each other as well as demand.

**Methods of Analysis**

Depending upon the problem and the situation, the analysis of demand can involve the use of quantitative models, qualitative studies, surveys, and subjective judgment.

Quantitative models can take any of a variety of approaches:

--- they may deal primarily with systems variables, primarily with environmental variables, or with both,

--- they may be predictive, descriptive, or prescriptive,

--- they may be comprehensive or deal with only part of the problem, and

--- they may use any one of a large number of mathematical techniques.

In practice, two general types of model have been used in the analysis of supply and demand: demand models and resource models.

Demand models will be considered at this point. Other methods of studying demand will be discussed later in the chapter. Institutional variables and resource models will be discussed in Chapter VI.
Demand Models

The principal value of demand models has been in furthering understanding of the forces that affect enrollments. It will be seen that, with few exceptions, these models cannot be expected to replace traditional enrollment planning models.

Demand models use multiple correlation and a variety of other techniques to relate demand for places to: 1) the attributes of the students, 2) external economic factors and other outside influences, and/or 3) tuition and other policies of the institutions. Four relatively recent review articles summarize and evaluate different aspects of research on demand models.

Jackson and Weathersby (1975) considered empirical models that are based on the human capital approach to demand analysis. Dresch's (1975) article evaluating national planning models included discussions of demand models. Both Wasik (1971) and Lyell and Tool (1974) discussed demand models in review articles that were devoted primarily to projection techniques.

In the discussion that follows, an effort will be made to include a broad representation of methods of analysis. The review will not be comprehensive, however. As should
become clear, an immense variety of analytic tools is applicable to enrollment forecasting. It is not possible in this brief summary to describe all the approaches that are reported in the literature.

**Multiple Correlation and Regression Models**

First among the demand models in number and in their value for planning are those using multiple correlation and regression. Several more-or-less typical examples will be mentioned.

Among the many studies of the relationship of attendance to tuition and income are those of Campbell and

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1 In a multiple correlation and regression model, enrollment is estimated as a function of one or more independent variables:

\[ y = b_0 + b_1 x_1 + b_2 x_2 + \ldots, \]

where

- \( y \) = enrollment,
- \( x_1, x_2, \ldots \) may be any real or dummy variable associated with enrollment, (e.g., time, personal income, age), and
- the coefficients \( b_0, b_1, b_2, \ldots \) are estimated by the least squares method.

In the basic equation given here, all the independent variables appear in first order terms. Complex relationships can be represented by substituting higher order terms, exponentials, trigonometric functions, etc. for the first order terms.
Siegel (1967), Hoenack, and Corazzini, et al. (1972). The model of Campbell and Siegel relates enrollment to tuition, household income, and the number of nineteen to twenty-four year olds with high school diplomas who are not in the military. The study showed that for the period covered (1919-1964), attendance among people from low income families was highly sensitive to the level of subsidy. Hoenack’s model for higher education in California used separate demand functions for each campus of the state systems. Factors included were the cost to the student and the median family income, number of high school graduates, rate of unemployment, and wage rates in the district of the school. Corazzini, Dugan, and Grabowski used Project Talent data in a study of students’ choice of type of institution (junior college, teacher’s college, private university, public university). The factors considered were achievement, average state level of fathers’ educations, wages of production workers in the state, and tuitions.

1 Jackson and Weathersby describe this study and cite: Hoenack, S. "Private Demand for Higher Education in California." Berkeley, Office of Analytic Studies, University of California, 1967.

2 Project Talent was a comprehensive national survey of high school students. For more information about that project, see Flanagan (1964).
Handa and Skolnic (1975) examined the relationship between unemployment, expected returns, and demand for a university education in Ontario. The independent variables were direct cost, opportunity cost (including the probability of being employed), income returns for completing a degree, and the eligible population. They found that increases in unemployment affected enrollments slightly and positively and the expected future wages had a strong positive effect on enrollment.

Bishop and Van Dyk (1977) studied college enrollments among married individuals aged twenty-five to thirty four. They found that the proximity of a low tuition two-year college was a prime determinant of attendance. No characteristics of four-year colleges were significant. Being a veteran increases the likelihood of going to college significantly.

Several statistical models analyze various aspects of competition between schools. Jewett's (1972) model was developed to study the effects of financial aid on enrollment. The model computes the probability of a student's enrolling at Ohio Wesleyan University on the basis of the individual's sex, SAT scores, and ability to pay, and the fee structures of Ohio Wesleyan and competing schools. Kizinski and Moss (1974) conducted a detailed analysis of the effects of competition between schools. They pointed out that postsecondary systems operate in an environment of
monopolistic competition (many sellers of a differentiated product). Their preliminary model was based on a survey of a random sample of students with SAT scores over 1100 and their application to 442 secular, four-year colleges. Applications to each college were used as an index of demand. The following institutional variables were included: 1) academic quality - median SAT scores of entering freshmen, student/faculty ratios, percentage of Ph.D.'s on the faculty, sponsored research, 2) social aspects of the college experience - size of the freshman class, sex ratio of the student body, ratio of residential capacity to total enrollment, 3) characteristics of the market in which the school operates - the number of students from the same state as the college and the number of students from high income families, 4) cost. Among the conclusions of the study were that the academic ability of the students already enrolled had a strong influence on demand and that increases in tuition were important only when the tuition deviated significantly from those of competing schools.

Finally, multiple correlation and regression models have been applied to the study of persistence among students already enrolled. Trueswell (1973) analyzed persistence and drop-out rates in Canadian manpower programs with respect to economic conditions and the places of residence, employment status, and personal characteristics students.
Multiple correlation and regression models are valuable tools for enrollment analysis. Although they are somewhat more costly and complex than simple time-series models, they are relatively easy to understand and interpret and have a relatively good record for accuracy in business and industrial applications. ¹ In studies of enrollment, multiple correlation and regression models have been used primarily for general analytic studies. As the examples cited here indicate, they have been of value in helping determine the relative importance of various factors that affect enrollments. Their potential for direct application in enrollment forecasting depends on whether or not models can be devised that include all the major variables that are relevant in a particular situation. In spite of the variety and complexity of the forces that affect demand in postsecondary education, there are probably situations where multiple correlation and regression models are suitable for forecasting enrollments over short and medium time periods (Wheelwright and Makradakis, 1973).

Econometric Models

Econometric models were discussed in the last chapter. It was noted that Freeman's (1976) model relating demand for

¹ There is inadequate evidence on the accuracy of multiple correlation and regression models for enrollment forecasting; as has been indicated, most such models have been developed as research rather than planning tools.
higher education to manpower needs has proved accurate (Wish and Hamilton, 1980). In general, complex statistical models have proved useful and accurate in market studies and business forecasting (Wheelwright and Makradakis, 1973; Parsons and Schulz, 1976). Although many individual institutions do not have the time and talent to construct their own econometric models, the results of national econometric studies and those of special research projects are likely to prove valuable at the institutional level. This possibility will be discussed shortly.

**Choice Theory Models**

Choice theory models are based on the assumption that students are utility maximizers. Decisions by the students to apply for admission and to enroll are represented on the basis of assumptions about their preferences.

In a model developed by Radner and Miller (1970), students consider cost, the average ability of the students attending each type of school, and their own abilities and income levels. Kohn, et al. (1974) developed a model in which the student maximizes utility at each of three stages in the selection process. The student must choose whether or not to commute, what college to attend if he or she goes at all, and whether or not to go to college. Students' applications and college offers of admission are collapsed into a single decision. Institutional variables are tuition, room and board charges, average student ability,
field breadth, and per student revenue. Variables describing students' characteristics are family income, distance between home and college, ability, and parental education.

**Structural Flow Models**

Models using differential equations, difference equations, and systems dynamics are well suited to the representation of complex flows of students, teachers, and others to, through, and from educational systems. Feedback elements can represent the relationships between flows. Models of this type can be helpful for analyzing the relationships between elements of a system and for forecasting the directions and patterns of change. Resource models that use systems dynamics will be discussed in Chapter VI.

Wasik (1971) cites several examples of structural flow models of postsecondary education, including two using difference equations, one by Bolt, et al. and one by

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1 *Structural flow models* employ the calculus to compute subsequent values of variables given their initial values and rates of change. (For example, they may be used to calculate enrollments at a future date from present enrollments and rates of admission, dropping out, and graduation.) *Systems dynamics* is a methodology and system of notation that facilitates the development and solution of highly complex systems of differential equations (Kaplan, 1959; Forrester, 1961).
Reisman and Taft and a systems dynamics model by Reisman.  

The Bolt model depicts the flow of doctoral degree holders in science and engineering to and from higher education. The Reisman and Taft model represents all four sectors of traditional higher education (undergraduate, masters, doctoral, and postdoctoral). It includes flows of American and foreign nationals and considers the psychological, social, and economic factors that influence movements between the various academic sectors and to and from higher education. The Reisman model is of intermediate complexity.

The three structural flow models are of interest for their contribution to the study of methods. There is no evidence that models of this type have actually been used to forecast demand or as practical planning tools.

One potential disadvantage of systems dynamics models should be mentioned. Perhaps more than any other analytic technique, systems dynamics is conducive to the development

1 The citations by Wasik are:


of models of social systems in the absence of an adequate understanding of the forces that affect them. While systems dynamics has contributed to the understanding of social phenomena, it is also true that researchers have sometimes been blinded to their own oversimplifications and erroneous assumptions by the impressive charts and tables produced by the models and by the appearance of accuracy that is only a reflection of adjustments to agree with historical data (C. Freeman, 1973; Simmons, 1973).

The Use of Economic Forecasts in Preparing Enrollment Forecasts

Forecasts in business and industry are often based on the relationship between general economic conditions and sales in a particular industry or firm. The general approach in this method of forecasting is to begin with some indication of trends in the economy as a whole, to use this information as the basis for predictions about a particular industry, and finally to make a forecast for a particular firm. Forecasts for the individual firm may be based on the assumption that the firm will continue to obtain a constant share of the market, or this assumption may be modified as a result of information from other sources (McCarthy, 1960).

In principle, the general economic forecasts can be based on models that use econometric methods, input-output analysis,
or barometric indicators; in practice, input-output analysis is not widely used for this purpose in the United States.

Although quantitative applications of this method to enrollment forecasting are not discussed in the literature, colleges and universities do use economic forecasts in less formal ways to adjust enrollment forecasts.

Applications of Demand Analysis

Up to this point the discussion of demand analyses has centered on the techniques used. Many forecasting problems have also been mentioned. Two factors, namely competition and persistence, require further discussion. Finally, the special problems of part-time postsecondary education will be mentioned.

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1 Barometric forecasting is based on series of indicators published regularly by the U.S. government. Certain of the indicators (e.g., the average work week in manufacturing, changes in manufacturing inventories, changes in consumer installment debt, and orders for plants and equipment) tend to lead the general economy. There are also lagging indicators. An analyst who understands the relationship between the various indicators and sales in a particular segment of the economy can adjust forecasts on the basis of the indicators. Barometric forecasting is a valuable tool for anticipating the direction of changes, but the indicators give little clue as to the magnitude of the changes or the duration of the trend in a particular direction (Chisholm and Whitaker, 1971).
Competition Among Educational Systems

Depending upon the balance between supply and demand, the enrollment in a particular program can be greatly affected by actions of competing systems. Actions by other institutions can be critical in systems serving part-time students, where competition is usually intense (Nolfi and Nelson, 1973). Several models that analyze factors affecting competition have already been discussed. They include the multiple correlation models of Jewett (1972) and Kicinski and Moss (1974) and the choice theory model of Kohn, et al. (1974). Other studies analyze various factors that affect the choice of school. A statistical study by Leister (1975) differentiates between the clientele of different schools. A model by Leslie and Fife (1971) examines the effects of financial aid on enrollments. Studies have been made of the relationship between location and demand (Schofer, 1975; Stewart, 1941). Some of the models mentioned earlier included location (Bishop and Van Dyk, 1977; Kohn, et al., 1974).

Studies in Persistence

The demand for education among those already enrolled is a major determinant of enrollments. The analysis of

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1 Clearly, both financial aid and the location of schools affect total demand as well as the competitive position of the individual schools.
persistence is particularly important in part-time education, where drop-out rates tend to be high (Doherty, 1974).

A study by Trueswell (1973) was mentioned earlier. Tinker (1975) and Pascarella and Terenzini (1980) have reviewed studies of college attrition. It has been found that most factors that affect the initial decision to attend also affect persistence. The most important of these are tuition, employment opportunities, and the students' financial resources. In addition, the students' interactions with their peers and with the faculty are important determinants of decisions to remain in school.

Lightfield (1974) examined the characteristics of students who eventually returned to a New Jersey community college after having dropped out. He used the college's student records and the results of a survey of drop-outs for his analysis.

Other Issues in Part-Time Postsecondary Education

Although in general the factors affecting demand are the same in full-time and part-time education, certain variables are of special relevance in part-time education. Two of these, competition and persistence, have just been considered. There is also a need to analyze the demand for part-time, career-oriented education including degree, continuing education, and retraining programs. The demand for career and degree-oriented education among those past
the normal age of college attendance – especially those who have begun but not completed college – is particularly important. Finally, the demand for education that is neither career-oriented nor degree-oriented needs further analysis.

Although all of these topics have been the subjects of many studies, the research has rarely used quantitative techniques. The dearth of quantitative studies can be attributed to the inadequacy of enrollment statistics for part-time postsecondary education and to the relative recency of interest in the topic (Lyell and Tool, 1974).

Limitations and Difficulties

The major limitations of demand forecasting are those inherent in the application of quantitative techniques to the study of complex social systems. First, the application of demand analysis is limited by data problems that are much more severe than those associated with conventional enrollment forecasting – for in addition to information about the educational systems and the population, these models require data about underlying social and economic factors. Such information is often difficult and costly to obtain; sometimes essential information such as the details of future federal student aid programs is unknowable (Mangelson, 1974). Second, efforts at analysis are limited by difficulties in isolating the effects of individual variables. Attempts to measure price elasticities of
demand, for example, have been frustrated by difficulties in separating the effects of tuition from those of financial aid (which depends, in turn, upon income and ability) and by the more fundamental problem that both tuition and demand are affected by the value placed on education by a particular society at a particular time (Dresch, 1975a).

In short, the inherent complexity of educational systems is a major obstacle to the development and application of demand models. Not only are meaningful planning models difficult to construct, but also serious difficulties may be encountered when attempts are made to use models or their results outside the context of the original analysis.

**Demand Models: Conclusion**

A wide variety of approaches to demand forecasting has been mentioned in this section. It has been stressed that demand models rarely provide direct answers to practical enrollment forecasting problems and that most demand models have been constructed for research rather than for planning. The value of these models has been first, that they have provided frameworks for individual research projects and second, that they have yielded information about the relative importance of the various factors that affect demand.
5. JUDGMENTAL FORECASTING

It is common in enrollment forecasting that the data required for quantitative forecasts are unobtainable. The two most common strategies for planning under uncertainty have already been discussed: most frequently decisions are made on the basis of the best available information without any effort at quantitative analysis; alternatively, quantitative tools such as time-series analysis may be used and the results adjusted subjectively.

A third approach is to use one of several formal methods for decision-making under uncertainty. Three approaches, decision trees, Delphi, and Bayesian analysis, have potential value as tools of enrollment forecasting (Wheelwright and Makradakis, 1973; Johnson and Hse, 1973; Pratt, Raiffa, and Schaffer, 1965; Johnson and Holzman, 1975).

**Subjective Estimates of Expected Value Using Decision Trees**

The use of decision trees and expected values ¹ is a straightforward procedure for choosing a course of action under conditions of uncertainty. The basic steps of the

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¹ Each branch of a decision tree represents the consequences of a decision. Expected value is the pay-off of a particular result adjusted for the probability that it will occur.
procedure are 1) drawing the tree showing all possible courses of action, 2) determining the value of each end result, 3) assigning probabilities to uncertain events, and 4) folding back the tree to determine the best solution (Wheelwright and Makradakis, 1973).

A key determinant of the success of the procedure is the ability to estimate values and probabilities. Business analysts have devoted much effort to devising procedures for this purpose.

Decision trees are used as aids to making such decisions as bids on construction projects and whether or not to embark on new ventures. Johnson and Holzman (1975) developed a decision theory model for college admissions. The technique appears to be suitable for analyzing alternative plans in other areas of education.
Delphi

Delphi is a specific method of systematically soliciting and collating informed judgment on a particular subject. Its basic features are feedback and anonymity. The technique was originally developed by the RAND Corporation as a forecasting tool.  

In a Delphi exercise, a panel of informed persons is asked to react to a particular problem, preferably to a series of specific statements that require brief, usually numerical, answers (e.g., estimates of dates, costs, and enrollments). Individual responses, which may include commentary, are collected, collated, and redistributed to panel members. The process is then repeated. Usually, the responses converge to a consensus in two or three rounds, although there is no requirement or guarantee that this will occur.

Delphi can be conducted as a paper and pencil exercise but is easily computerized.

The technique was designed for forecasting in situations where no one individual is likely to possess more

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1 Delphi can be used for purposes other than forecasting; as noted in the last chapter, the technique is often used to help define organizational goals.

2 The subjects of the inquiry (e.g., students) may be included among the informed persons on the panel.
than a small part of the knowledge required to solve the
problem. Experts from different fields (e.g., education,
market research, manpower analysis, and legislative affairs)
can be asked to make forecasts. In the course of several
rounds, a combined judgment may be reached. In general,
Delphi can be of value in the solution of complex problems
where meetings and conferences have one or more of the
following disadvantages: the number of people involved is
too large for an effective meeting; disagreement or
hostility among the participants is too great for effective
interaction; there is no history of communication between
the groups involved, and therefore, no model by which a
dialogue could be established quickly; or time, expense,
and distance make arrangements for a face-to-face meeting
impractical.

Although Delphi may appear to be at once rather
cumbersome and rather simple-minded, under the appropriate
circumstances it is an effective method of applying the
combined talents of experts in many fields to complex
problems. The principal weakness of the technique is the
ease with which it can be applied inappropriately —
particularly by those who are unduely impressed with
"computerized decision making". In many situations, Delphi
may produce little in the way of useful information, while
in others, similar or better results can be obtained more
cheaply or more quickly by other means. Alternatives to
Delphi include library research, individual consultants, conferences, seminars, and conference telephone calls (Turoff, 1971).

In education, Delphi has enjoyed some popularity as a tool for identifying goals, but has been used only rarely as a forecasting tool (Skutsch and Hall, 1973). Among the few published articles on the use of Delphi for enrollment forecasting is a report by Coakwell (1975) of an attempt to forecast enrollments for Muskingum Area Technical College in Ohio using a modified Delphi approach. The results were highly unsatisfactory; actual enrollment of part-time students was almost double the number forecast.

Bayesian Analysis

Bayesian analysis is a statistical tool that can be used as an aid in forecasting with surveys. Its primary appeal in demand analysis is that it permits the incorporation of subjective estimates into forecasts. When the technique is applied properly, the final results are often much more accurate than are those obtained using either subjective estimates or statistical information

1 Bayesian analysis, like decision trees, is part of the broader field of statistical decision theory. Other tools of decision analysis are also used in program planning and budgeting.
alone. In Bayesian analysis, an initial estimate is adjusted on the basis of additional information. Three kinds of information are required:

- an initial estimate. (In demand studies, this is usually a subjective "best guess" of the final outcome.)

- the results of a survey, test, or experiment. (In demand studies, a survey is most often used.)

- information about the past accuracy of the test or survey.

No applications to planning educational programs are reported in the literature. The following purely imaginary and highly simplified example illustrates the type of application possible.

An administrator who is considering offering a series of courses makes a subjective estimate of the chances of the series breaking even during its first year on the basis of what is known about such factors as the quality of the program, local perceptions of need, and the success of similar programs elsewhere. A survey is commissioned. Finally, an estimate is computed using both the survey
results and the subjective estimate.  

Bayesian analysis can be used to help decide whether or not it is worthwhile to seek additional information before making a decision. The expected gain of obtaining the additional information can be computed using estimates of expected gains or losses of various outcomes and working through the decision strategies that would be followed with and without additional information (Hamburg, 1970).

Bayesian analysis is not difficult to carry out.

1 Bayesian analysis is based on Bayes' theorem:

\[ P(A_1/B) = \frac{P(A_1)P(B/A_1)}{\sum_{i} P(A_i)P(B/A_i)} \]

where:
- the probability of any event \( X \) is denoted by \( P(X) \), and the conditional probability of an event \( Y \), given \( Z \), is denoted by \( P(Y/Z) \).
- Suppose the administrator in the example estimates the chances of breaking even at 60%, the survey points to success, and past surveys have predicted the success of successful programs 95% of the time and the success of unsuccessful programs 30% of the time.
- \( P(A_1) \), the initial probability of success, is .60, \( P(A_2) \) is .40, \( P(B/A_1) \), the probability of a positive survey, given success, is .95, \( P(B/A_2) \), the probability of a positive survey, given failure, is .30.

\[ P(A_1/B) = \frac{.6(.95)}{.6(.95) + .4(.3)} = .83 \]

An array of possible results shows:

<table>
<thead>
<tr>
<th>favorable survey</th>
<th>unfavorable survey</th>
</tr>
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<tbody>
<tr>
<td>chances of success:</td>
<td>.83</td>
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<tr>
<td>chances of failure:</td>
<td>.17</td>
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</tbody>
</table>
Interactive computer programs can allow decision makers and analysts to test various strategies. Unfortunately, data about the quality of survey results are rarely available for in-house studies. For this reason, Bayesian analysis is usually infeasible unless a system makes large numbers of surveys or has its survey work done by an agency who does so.
6. MARKET RESEARCH AND NEEDS ASSESSMENT

The emphasis up to this point has been on quantitative models that project enrollments or that analyze demand. But mathematical analysis is not the only tool of research for enrollment forecasting. Market research\(^1\) and needs analysis play important roles, especially as aids in planning new programs and as supplements to extrapolative models in situations where programs or external circumstances are changing rapidly.

The basic goals of market research are to uncover unmet needs and to discover what product characteristics, places of sale, prices, and promotional techniques will yield the desired sales and profits. It must be stressed that the use of market research does not involve any assumption that education is primarily a consumer good. Although the language of market research may imply otherwise, the usefulness of the techniques is independent of the reasons for offering the products or programs.

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1 Market research includes the entire spectrum of tools for the analysis of demand; this chapter could well have been entitled, "Market Research in Postsecondary Education." This section of the chapter, however, deals only with techniques for gathering information.
Needs assessment is closely related to market research. The technique was developed for use in the public and not-for-profit sectors and is primarily a tool of problem definition.¹ The basic question of needs assessment, "Who needs what according to whom?" is applied systematically in the analysis of opinions, previous research, records, and other information. Emphasis is placed on the development of operational definitions of problems by those who are directly involved.

There is a large body of literature on market research and needs assessment. Basic works on market research include those of McCarthy (1960), Palda (1971), Kotler (1967), and Smith et al. (1968). Works oriented specifically to market research in the not-for-profit sector and to needs assessment include those of Kotler and Zaltman (1974), Lee and Gilmour (1977), Hertling and Greenberg (1974), and Lucas (1979). Reports on the use of particular methodologies and techniques have been made by Coffing and Hutchinson (1974), Ferguson, et al. (1975), the New Jersey Department of Education (1974), Nurnberger (1974), Kyle and Sisson (1973), Gaither (1979), and Larkin (1979). The

¹ The term "needs assessment" is sometimes used quite broadly to cover a wide range of activities — including problem definition, planning, and the evaluation of outcomes. Here, the term is used more narrowly to refer to the processes of defining problems and identifying unmet needs.
principal professional journal in the field is the Journal of Marketing. Studies specific to postsecondary education are frequently published in the Journal of Higher Education, Adult Leadership, and other educational journals.

Sources of Information and Tools of Research

Market research and needs assessment rely upon a variety of sources of information and on a wide range of research methods. Sources of information include:

-- published research - including general qualitative studies, quantitative studies, published statistics, etc.

-- institutional records,

-- informed opinion, and

-- direct measurement, i.e., observation, surveys, and experimentation.

The methods of research range from informal situation analysis through formal, non-quantitative studies to highly formal quantitative analysis. They can be divided into three general categories: general exploratory research, measurement, and quantitative analysis. The last subject has already been discussed at length. The first two will now be considered.

General Exploratory Research

In general, any study of demand must begin with the identification of needs and the definition of the problem.
Most research on enrollment is conducted at this level, and, in fact, most problems are solved - or found to be insoluble - without more formal analysis.

It should be noted that when decisions are made as a result of non-quantitative research, some sort of enrollment estimate is actually implicit, that is to say, decision makers base their actions on assumptions about the probability of success and about the risks that are involved in the undertaking.

General exploratory research involves two kinds of activity: previous research and the records of past and current activities of the organization may be reviewed, and the problem may be discussed with colleagues, consultants, and others who may be expected to have information and insight about the situation (McCarthy, 1960; Palda, 1971).

Assessments by students, counselors, faculty members, administrators, opinion leaders, representatives of civic organizations, employers' groups, and employees' associations are used extensively in planning programs for part-time students. Institutions participating in an NUEA (National University Extension Association) survey placed a high value on information provided by all the groups mentioned, but especially on that from specific target

1 The use of surveys will be discussed in the section on measurement.
audiences and from employer and employee groups (Hertling and Greenberg, 1974). Lee and Gilmour (1977) note that the opinions of the community leaders, staff, and students are important for generating ideas for program changes, while those of community leaders and students are valuable in estimating demand. Buchanan and Barksdale (1977) point out the importance of informal market research in determining what the competition is doing and what the clients are thinking.

The Use of Direct Measurement

The popular concept of market research is that of surveys and opinion polls, but market researchers make three kinds of direct measurement: systematic observation of consumer behavior, surveys, and experimentation. ¹

Observation

The use of direct observation (as opposed to the examination of institutional records) is relatively uncommon in enrollment forecasting: the availability of institutional records and the nature of the service tend to make observation both unnecessary and unproductive. However, the technique may occasionally be of value for gathering certain kinds of data (class attendance, for

¹ The use of these tools for evaluating outcomes was mentioned in Chapter IV.
example) quickly and efficiently.

Surveys

Intention surveys are widely used in business and industry to aid in forecasting sales. Consumer's Union, the Census Bureau, and other groups conduct annual surveys of people's intentions to buy consumer durables, and many market research organizations and individual producers conduct more specialized surveys (Chisholm and Whitaker, 1971). The methodology of forecasting on the basis of surveys is well advanced. At the same time, a number of basic weaknesses in the approach have been identified. One of the most serious difficulties is the fact that many consumers do not plan ahead for even major purchases (Chisholm and Whitaker, 1971). Another obstacle is the time and money that must be expended in developing and validating each new type of survey. But despite these handicaps, surveys are frequently the most reliable and least costly method of acquiring information about people's intentions to enroll in postsecondary programs. Market testing, which is often the most economical and effective technique for measuring the demand for inexpensive mass market items, is rarely feasible in education, and the analysis of demand based on causal interpretations of historical data, although of value in providing general background information, can rarely be used directly for making quantitative forecasts. Thus under many circumstances, surveys are the best
available tool for the estimation of demand.

In part-time postsecondary education, surveys of intent are of particular value for estimating the demand for new and developing programs and for detecting shifts in the demand for ongoing programs. Hertling and Greenberg (1974) investigated the use by university extension systems of surveys and other tools of needs assessment. They found that almost all extension systems conduct surveys of students and potential students. Surveys are made of present students, former students, particular groups, and the general population. Those of currently enrolled students and of particular target audiences were ranked as the most valuable by the participating institutions.

Reports of surveys, survey methods, and survey results abound in the literature. Only a few representative examples can be mentioned. They should give some indication of the potential value of the survey as a simple, cost-effective method for improving enrollment forecasting for part-time programs.

Extensive work in the development of surveys and student information systems has been done by MacIntosh (1971) for the British Open University (BOU). During the early development of BOU, information was gathered from applicants and students in order to resolve such issues as television broadcast hours and the student acceptance rates required to insure the desired enrollment mix. Particular
effort was made to design application and registration forms that captured the information that was considered essential for basic institutional research and to design surveys and forms for ease of use and processing.

Larry Benedict and others have designed and implemented a simple, efficient system for conducting telephone surveys and analyzing and reporting the results. "Project Pulse" was designed for use by the Student Affairs Office of the University of Massachusetts at Amherst, but has also proved to be an effective tool for academic program planning. The success of the project has been aided by ready access to nonconfidential student records (name, student status, etc.), by the availability of low-cost student help (work-study), and by the use of standard computer programs for data analysis (Benedict and Luciano, 1975; Luciano and Benedict, 1975).

Among other discussions of survey methods are two general handbooks, one by the New Jersey State Department of Education (1974) and one by Kyle and Sisson (1973).

Market surveys are conducted for a variety of purposes. Recent studies have been conducted to measure potential audiences for particular types of programs (Corporation for Public Broadcasting, 1972), to determine what attracts students to a particular school (Gorman, 1976), and to discover alternatives students might prefer to existing programs (Zelan and Gardner, 1975).
Several nationwide surveys have been conducted. Among the most recent is one by the Educational Testing Service. It examines adults' present and anticipated participation in educational programs (Cross, et al., 1974).

Other nationwide surveys include those of Johnstone and Rivera (1965) and Kay (1974).

A particularly important kind of survey is the follow-up study. The studies are of value not only for enrollment analysis but also for the analysis of outcomes. They provide information about such factors as satisfaction, employment, and earnings.

Although most follow-up surveys are tailored to individual studies, standardized instruments for measuring attitudes and other characteristics may be used. For example, Bower and Myers (1976) of NCHEMS have developed a model survey for studies of attrition.

Sullivan and Litten (1976) used a follow-up survey in an analysis of the market position of a particular institution. They surveyed students who had written for materials about the school but failed to apply as well as those who applied and were accepted at the school.

Several of the studies of persistence mentioned earlier relied in part on follow-up surveys.

The information gathered in surveys may, of course, be used directly in estimating enrollments. It may also be used to modify estimates made from other sources and can be
incorporated into mathematical models. It is possible to use the results of surveys conducted by outside agencies or at the national level for surrogate data. The use of survey data in ratio models and statistical demand models was discussed earlier in the chapter.

**Experimentation**

Finally, the market researcher can attempt to measure demand by means of laboratory tests, field tests, or trial-and-error.

**Laboratory and field tests.** Businesses use market tests extensively to study the demand for commercial products. Prices, promotional programs, and places of sale are controlled in order to test the price and income elasticities of demand and the effects of promotional strategies, location, etc. on sales (Palda, 1971). In education, legislative policies, small volume, high unit costs, and considerations of fairness all tend to restrict the use of market testing. Large agencies like the Cooperative Extension Service and major proprietary institutions can occasionally operate test or pilot programs and measure both market potential and program effectiveness (Doherty, 1974), but in general, educational systems must rely on less formal kinds of experimentation.
Trial and Error. Most organizations (educational and other) use a variety of experimental methods that come under the general heading of trial-and-error (Palda, 1971). For example, a system that has varied its prices several times in a short period of time can develop a rather crude measure of price elasticity of demand.

Courses, locations, and promotional techniques can be subjected to the trial-and-error process. One particular technique has become almost standard for systems of continuing education: courses are routinely advertised with the expectation that they will be given only if a certain predetermined minimum enrollment is achieved.

Although all organizations make use of trial-and-error, the success of such efforts in leading to improved forecasts and in preventing the repetition of costly mistakes depends on the skill and knowledge of the practitioners — and on their ability to combine the information gained from trial-and-error with the results of other research.

Market Research: Conclusion

In summary, market research and needs assessment are valuable for estimating enrollments where programs or circumstances are new or changing. Because of the commitment of many systems serving part-time students to meeting the changing needs of adults, these tools are particularly important in this sector of postsecondary education.
Among the tools of market research that are particularly valuable for enrollment forecasting is the survey. Probably of even greater value is the intelligent use of informal approaches - library research, reviewing past experiences, and consultations with knowledgeable people. These traditional tools of analysis, while they may seem less scientific than surveys, experiments, and models, remain among the most useful methods of applied research in the social sciences.
In this chapter the literature on enrollment forecasting has been reviewed, methods of analysis and sources of information have been considered, and an attempt has been made to discuss the major variables affecting enrollment. Techniques of analysis have been discussed in relation to the types of problem for which they are particularly well suited. It is hoped that this format has not obscured the fact that most problems lend themselves to more than one method of analysis and that conversely, most methods can be applied to a variety of problems.

Of the many possible approaches to enrollment forecasting, a few stand out for their present or potential value as planning tools. These are informal investigation, surveys, simple time-series analysis, and constant-ratio models. Certain other methods of analysis, especially multiple correlation and regression, have special value for research directed towards understanding the forces underlying the demand for postsecondary education.

In conclusion, it must be emphasized again that enrollment forecasting is not and never will be an exact science. Except in the case of stable, ongoing programs, the margin of error is usually large. In most cases, research projects and models can do no more than help decision makers understand the problems better.
1. FINANCIAL ANALYSIS FOR PLANNING AND BUDGETING

Having discussed most of the individual topics of research for planning and budgeting, we now turn to the budget itself. Three major topics will be considered: 1) budgeting, 2) cost analysis, and 3) budget models.

1. BUDGETING

Budgets, as was said earlier, are plans stated in financial terms. The primary focus of budget analysis is on

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1 General discussions of budgeting and cost analysis in higher education are to be found in works by Balderston (1974) and Bowen and Douglass (1971). Reviews of the state of the art have been published in a special issue of New Directions for Institutional Research edited by Hopkins and Schroeder (1977), in two ERIC/Higher Education Research Reports, one by Lawrence and Service (1977) and one by Caruthers and Orwig (1979), and in two brief ERIC/Higher Education Research Currents, one by Richardson (1977) and one by Linney (1980). Caruthers and Orwig include an extensive bibliography.

The literature on budget models is extensive. General overviews and reviews have been prepared by Casaco (1970), Weathersby and Weinstein (1971), Schroeder (1973), Correa (1975), and Mason (1976). Critical discussions of planning models in general include those by Ackoff (1967) and Hoos (1971). Naylor and Schauland (1976) surveyed users of corporate planning models. Critical analyses of models in higher education include those of Hopkins (1971), Bell (1972), and a survey of users by Plourde (1976).

2 The information summarized in this section can be found in most standard works on budgeting in the not-for-profit sector. See, for example, Davis (1969) and Caruthers and Orwig (1979).
program planning and the study of the financial consequences of alternatives for meeting institutional objectives. However, the institutional analyst must recognize that budgets are not simply planning tools; they are also instruments for limiting and controlling expenditures and for managing and controlling operations.

As tools of financial control, budgets help assure that expenditures are limited to the amounts prescribed, that they are legal, and that they are made for the objects and activities specified by those in authority. While financial control is the most basic function of the budget, it is rarely of direct interest to planners.

The second control function of the budget is to help assure that operations are efficient. It will be seen that budget analysis for planning does include the study of matters related to efficiency and that much recent research has been devoted to this issue.

There are many formal methods of preparing budgets. They differ in their approaches to planning and control and in their emphasis on each of the major functions of the budget. The methods used in recent years are:

1 Financial control is of indirect interest to planners because the information needed for planning often differs from that needed for control. Since financial control is essential, cost data organized according to lines of financial responsibility must be readily available. Any compromise must be made at the expense of data for planning.
1) incremental budgeting, 2) performance budgeting,
3) formula funding, 4) program budgeting, and 5) zero-base budgeting. Each of these methods has many variations. In actual practice, it is rare for an institution to rely exclusively on a single formalized system. Rather, organizations borrow tools from all the methods depending upon their needs at the time.

The following brief account outlines the concepts underlying each of the approaches.

**Incremental Budgeting**

The oldest and most widely used budgeting procedure is the type described by Aaron Wildavsky as 'incremental' budgeting. As was explained in an earlier chapter, incremental decision making is based upon what Wildavsky and others call 'political rationality' to contrast it with 'economic rationality' (the efficient allocation of scarce resources). The fundamental assumption of incremental budgeting is that the current allocation of resources is based upon a long history of experimentation and bargaining and, as a result, is a reasonably good compromise between

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1 Wildavsky has discussed incremental budgeting in a number of works (1964; 1969). His earlier work is based on his studies of the U.S. Congress and budgeting in the federal government. Crecine (1969) found a similar pattern in municipal budgeting.
conflicting values and interests. The traditional budgeting procedure is to allocate to each unit the amount it received the previous year plus or minus a proportionate share of the change in total available funds; adjustments are made for changes in programs or circumstances, but the 'fair share' principle is paramount. The practical advantages of the approach are great. Implementation is straightforward, the time and energy required are minimized, and conflict across department lines is kept to a low level. In addition, because adjustments for changes in programs and circumstances are made by negotiation, there is no need for a comprehensive understanding of the system and the many interactions among its various components and between them and the outside world.

The primary danger of incremental budgeting is that reliance on negotiation increases the likelihood that resources will be allocated on the basis of power rather than need. There is no doubt that the danger is real. A study by Pfeffer and Salancik (1974), for example, indicated that the budgets of academic departments are directly related to the departments' political power.

Nonetheless, because incremental budgeting takes into account limits on time, money, and human intellect and because it relies on the idea of 'fair share' and on discussions of specific problems, it has appeal at all levels of the decision making process. There is little doubt that
incremental budgeting will continue to be the basic tool for resource allocation in most educational systems.

**Performance Budgeting**

Performance budgeting is related closely to the goal of efficient management. The budgets are based on 'standard' or 'efficient' costs, which are determined by performance criteria. For example, the efficient cost per page typed is based on standards for typists' performance, for the purchasing of supplies, and for the maintenance of equipment as well as on current wages and prices. The emphasis in performance budgeting is on the output of individual activities rather than on objectives and program outcomes.

Performance budgeting has had wide application in business, where outputs and outcomes are often closely

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1 The term performance budgeting is generally credited to the 1949 Hoover Commission on efficiency in the federal government. The concept goes back as least to the beginning of the century and to the early era of 'efficiency experts'. The use and abuse of measurements of efficiency in education is discussed at length by Callahan (1962).

2 Standard costs and other concepts of cost accounting will be discussed in the next section of this chapter.

3 In recent years, however, the term performance budgeting has been applied to variants of program budgeting that stress the evaluation of outcomes (Folger, 1976).
related. This would be true, for example, of a secretarial service. Although formal performance budgeting is not used in the analysis of educational programs, the concepts and tools of the approach have been incorporated into systems of formula funding and, to a lesser degree, into program budgeting and zero-base budgeting.

Formula Funding

Formula funding is used by a majority of state

1 In business accounting, the term flexible budget is used to describe budgets that set performance standards. See Horngren (1970) and Anthony (1970) for examples of this kind of analysis.

2 It can be assumed that flexible budgeting is used for managerial control of certain kinds of support services and auxiliary enterprises at some schools.

3 Meisinger (1976) and Moss and Gaither (1976) review current practices in formula budgeting and the strengths and weaknesses of the various methods and formulas. Allen and Topping (1979) report on four case studies. There has been considerable research on specific aspects of formula budgeting and of topics related to the formulas. Carlson, et al. (1974), Van Alstyn (1977), and Johnson (1979) all discuss the use of formulas to determine tuition. Economies of scale and the related issue of average versus marginal costs are matters of concern in the present period of declining enrollments. Studies by the Carnegie Commission (1972a) and McLaughlin, et al. (1980) on economies of scale reveal that they exist but that the effects of size are small compared to those of the complexity of the systems and their curricula. Several efforts to devise formulas that use marginal rather than average costs are reported by Caruthers and Orwig (1979). Monical and Schoenecker (1980) have recently designed a system for using marginal costs that they believe to be both understandable and fair.
governments as an aid in budgeting for postsecondary education. The application of the technique varies considerably among the states. The formulas may be used to determine total appropriations, to allocate funds among various institutions, and to determine tuition levels. Formula funding is not a tool for the development of detailed budgets.

In formula funding, each institution receives its 'fair share' of funds based upon enrollments and standardized unit costs. The formulas may be based directly on costs per full-time equivalent student, or staffing may be set according to enrollment and then funds allocated on the basis of staffing. The formulas may be used to determine total institutional appropriations or to compute changes from the previous year. Formulas vary greatly in complexity and may take into account level and type of study and such factors as location, type of school, compensation schedules, and historical differences among schools. Nearly all the formulas are based on average as opposed to marginal cost. It is common for appropriations to be adjusted to include factors not included in the formulas.

There has been considerable interest in formula funding in the past few years. The formulas make institutional budgets more understandable to legislators while permitting institutions to plan ahead on the basis of expected appropriations. Equally important in times of shrinking
enrollments and reduced appropriations, formula funding reduces conflict among institutions. In short, formula funding has many of the advantages of incremental budgeting and has the additional benefit that it reduces the extent to which political influence determines appropriations.

The disadvantages of formula budgeting are its rigidity and its leveling effect. The formulas that have gained acceptance with legislatures and institutions do not take into account the start-up costs of new programs, economies of scale, or changes in technology and relative prices. Efforts to implement more complex formulas have failed because, on the one hand, they too omit important factors affecting needs, and on the other, they are harder to understand and their effects more difficult to predict.

Because the formulas treat all institutions of a similar kind alike, formula funding tends to reduce the quality of the best institutions in a system. In contrast, under traditional incremental budgeting, stronger schools usually receive proportionally greater appropriations (Feasley, 1980).

In spite of its disadvantages, formula funding, like incremental budgeting is likely to remain popular. The appeal of both methods is in their simplicity, predictability, and tendency to minimize conflict.
Program Budgeting

The methods of financial planning that have been discussed so far have their roots either in the concept of the budget as a tool of political accommodation or that of budgeting for control. Program budgeting and zero-base budgeting, on the other hand, are both derived from the economic concept of budgeting, that is, the efficient allocation of scarce resources.

Program budgeting stresses the setting of objectives and the evaluation of outcomes. The best known technique is the Program, Performance, Budgeting System (PPBS) that was developed for the Department of Defense under Secretary Robert S. McNamara. Modifications of that system have been used in other federal agencies, in state governments, and in

1 Two classic works were written by the originators of PPBS; one is by Hitch and McKean (1960) and the other is by Novick (1965). Haggart (1972) and Hartley (1968) present two different positions on methods of program budgeting for education. Balderston and Weathersby (1973) discuss methods of program budgeting for higher education. Studies of applications of program budgeting are reported by Wildavsky (1969), Benacerra, et al. (1978), and Dressel and Simon (1976).

2 Performance in PPBS refers to effectiveness and the evaluation of outcomes. In performance budgeting, on the other hand, the term refers to the efficiency of individual activities.
education. Program budgeting systems have four elements in common: 1) explicit consideration of objectives, 2) consideration of multi-year costs, 3) the analysis of alternative means of achieving objectives, and 4) evaluation of outcomes.

The first step in program budgeting is the development of objectives stated in measurable terms and of alternative programs to meet them. A program is a course of action designed to accomplish certain objectives. For example, a developmental reading program for adults may be designed to bring students up to a certain minimum level of reading achievement, and a series of vocational education courses may be intended to provide students with marketable skills of a particular type.

In the course of defining objectives and developing alternative plans to meet them, programs may be divided into subprograms and program elements according to the level and type of student served. For example, an adult secondary education program could be divided according to students’ current levels of performance and their abilities. The detailed objectives and measures of achievement associated with the program elements may differ according to the needs of the specific groups of students served. The breakdown is intended to assure that the program budgeting system can provide the data necessary to evaluate the costs and effectiveness of programs that serve a diversity of
students.

As was pointed out in an earlier chapter, programs for adults may focus on educational, vocational, or avocational objectives, or they may be designed to serve a broad spectrum of needs of a particular group. The structure of the programs and program elements would, of course, differ depending on whether the objectives focused on the acquisition of specific knowledge and skills or more generally on the needs of a special group like the elderly.

Once objectives have been stated and alternative programs designed, the programs are analyzed and evaluated. Analysis and evaluation form the heart of program budgeting. Cost-effectiveness studies are a major aspect of this procedure. 1

The program budget document displays the plan chosen for implementation. The budget is organized to show costs by program; the document includes specific details of revenue and expenditure for one fiscal year and estimated figures for the following five years. The program budget is intended to be a complete statement of the system’s objectives, plans, and expectations.

1 See Chapter IV for a discussion of the evaluation of outcomes.
The planning, programming, and budgeting procedure is repeated each year; the process is a continuous one of stating or restating objectives, defining and modifying programs, analysis, and documentation.

For program budgeting to succeed, complex objectives must be stated in measurable terms and be subjected to quantitative analysis; successful implementation also requires an extensive data base, a sophisticated management information system, and a major commitment to institutional research. Because these requirements have not been met, formal program budgeting has been a failure.

Although efforts to implement program budgeting systems in education were based on unrealistic expectations about the possibility for quantitative analysis of complex goals and systems, the basic idea of analysis and evaluation of outcomes continues to underlie efforts to develop models and other tools for policy analysis (Caruthers and Orwig, 1979).

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1 This problem was discussed in Chapter IV.
Zero-Base Budgeting

Zero-base budgeting represents an effort to meet the objectives of program budgeting while avoiding its impractical aspects. The key feature of the technique is the requirement for developing and ranking decision packets representing sets of activities that meet groups of objectives and that can be added or deleted from the budget as necessary.

Ideally in zero-base budgeting, as in program budgeting, all programs and expenses are analyzed and justified anew each year. In practice, the basic decision packets for each organizational unit represent 1) the minimum level at which it can operate and 2) the level required to fulfill the basic commitments of the agency. The remaining packets represent the actual choices available to decision makers.

There have been very few efforts to implement zero-base budgeting in postsecondary institutions. Students of budgeting believe that widespread adoption of the technique by educational institutions is unlikely; there are practical

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1 Pyhrr (1973) is generally credited with the development of zero-base budgeting. Surveys of the literature by Caruthers and Orwig (1979) and Feasley (1980) reveal that little has been published about the use of zero-base budgeting by systems of postsecondary education.
obstacles to breaking up educational activities into decision packets and, even if this could be done, to assigning a specific rank to each packet.

There is some evidence that the use of decision packets can be helpful when major retrenchment is necessary. Reports of the use of zero-base budgeting at MacMaster University as well as of less formal approaches to planning retrenchment tend to support this view (Caruthers and Orwig 1979).

**Methods of Budgeting — Conclusion**

Five major approaches to budgeting have been developed over the course of the twentieth century. Each represents a different balance between the three major functions of budgeting, that is, between financial control, managerial control, and program planning. It is important to recognize that each of the approaches was developed in response to needs at a particular time — needs that were related to growth, consolidation, or retrenchment. It is not surprising that the program planning approach, so dominant in the period of growth in the 1950’s and 1960’s has been displaced in the present period of retrenchment by the tools of performance budgeting and formula funding.

When viewed in terms of their practical application, it is seen that two of the five approaches, namely incremental budgeting and formula funding, have proved useful as tools
for developing annual budgets. The other three approaches have been of value for the techniques or ideas that they have contributed to budget analysis: the evidence suggests that the efficiency measures of performance budgeting and the program packages of zero-base budgeting may be useful as tools for planning consolidation and retrenchment, and that, although the practice of program budgeting has largely been abandoned, its central concept of outcomes-oriented analysis and evaluation continues to have wide application.

If this assessment is correct, it can be expected that cost accounting will continue to play a central role in budget analysis and that partisan analysis and other kinds of ad hoc policy studies will also play important roles in decision making. It will be seen later in the chapter that contemporary approaches to financial modeling are consistent with this view of institutional planning.
2. COST ANALYSIS AND MANAGERIAL ACCOUNTING

We now turn to a number of tools of managerial accounting and cost analysis. The techniques have been designed as aids for program planning and for control of performance. The former use is of primary interest in this discussion.

Modern cost analysis was developed in the early 1950's to aid in the development of weapons systems for the United States Air Force. Throughout a period of several years, the technique was modified and refined in the interest of clear representation of cost information. Such problems as the handling of 'sunk costs', which represent resources on hand, the distinction between investment and operating costs, and the prorating of support costs were resolved by the discovery of approaches that provide meaningful information for the decision maker. The general methodology of cost

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1 Massey et al. (1972) provide an excellent and thorough explanation of cost analysis and its history. Among the standard texts on managerial accounting are those of Horngren (1970) and Anthony and Welsch (1974). Various aspects of the classifications and methodology of cost analysis and cost accounting in postsecondary education are outlined in works prepared by the National Association of College and University Business Officers (NACUBO, 1973) and the National Center for Higher Education Management Systems (NCHEMS, 1977; Gulko, 1972; Collier, 1975). For references to details about the accounting and classification systems, see the works listed above.

Meeth (1973) and Bowen and Douglass (1971) report on practical applications of cost analysis in higher education.
analysis has been relatively well standardized for some time (Massey, et al., 1971).

The application of cost analysis to postsecondary education is a more recent phenomenon. In the past few years, the National Center for Higher Education Management Systems (NCHEMS) and the National Association of College and University Business Officers (NACUBO) have developed standardized structures and definitions for this purpose.

**Concepts and Tools of Cost Analysis**

**Benefits Foregone**

Cost analysis has its base in economics rather than financial accounting. Dollar costs are not seen as exact sums to be reported on balance sheets, but as abstract measures of resource requirements; they represent opportunities lost, benefits foregone. Resources, such as instructors' time and available materials, are inherently limited; if one program is adopted, opportunity for another is lost, or perhaps (if tax revenues rise) benefits in the private sector are foregone. Cost analysis, if properly used, can help clarify questions about the allocation of limited public resources.

**Investment versus Operating Cost**

It is necessary in cost analysis to distinguish between one-time investment costs on the one hand and recurring or operating costs on the other. Usually investment costs are
divided into two separate categories, 1) development costs, and 2) initial investment costs. Since most educational agencies have separate capital and operating budgets, the breakdown is, in some respects, a natural one to educational administrators. However, the parallel is by no means exact. For example most development costs and such initial investments as new audio-visual equipment may appear in the operating budget.  

While investment costs are included in the analysis of alternatives, sunk costs or funds already expended are not; these costs remain unchanged regardless of the option chosen and whether or not the resources they represent are used in the future.

In order to assure that initial costs are properly accounted for, program costs are always estimated for a period of at least five years.

One of the earliest contributions of cost analysis was the discovery that failure to separate investment from operating costs and failure to consider long-range costs were causing serious distortions in the interpretation of

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1 As was noted in Chapter II, program development is an important function in many systems serving part-time students. Very often the personnel costs of research and development are significant. Although these costs are usually charged to general overhead in the annual budget, for planning purposes they must be included in the costs of alternative new programs.
military procurement data (Massey, et al., 1972). Three type of error may occur as a result of considering costs on a year-by-year basis only. First, by looking only at start-up costs, the decision maker may fail to recognize the extent of the future commitment to operating costs. (This phenomenon is known as 'nose-in-the-tent' budgeting; it is a widely practiced art.) Second, in looking at initial capital costs, the decision maker may fail to recognize the eventual need for maintenance and replacement. (The current crisis in maintenance of the college and university buildings that were constructed in the 1960's is a striking example of this problem.) Third, errors can occur in the opposite direction; a decision maker may be discouraged from undertaking a desirable and basically economical program because of its high initial investment costs. (It has already been noted that formula funding has been

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1 The issue of including capital costs in the regular accounting systems of postsecondary systems is a matter of some debate. It is argued by some that the depreciation of the existing capital inventory should be included in financial statements as would be done in business organizations, and that this approach would encourage better planning and budgeting of capital and maintenance expenditures. The prevailing opinion as reflected in actual practices is that incorporating investment costs into annual financial statements is not worth the effort because of the way funds are raised for capital improvements (i.e., by special appropriation or fund raising) and the absence of tax write-offs for nonprofit agencies. There is general agreement that both operating and investment costs must be included in analyses of major program changes (NCHEMS, 1977).
criticized for its failure to allow for start-up costs; much of the criticism of this aspect of formula funding comes from those interested in nontraditional education.)

Where large investments are being considered, discounting may be necessary. As explained earlier in a different context, discounting is a method of taking into account the fact that future costs are usually preferable to current ones. Future costs are discounted at the going interest rate. (At a 10% discount rate, $100 spent this year is equivalent to $110 spent next year). In business, discounting is straightforward; the discount represents the interest that could be obtained if the amount were invested. Although the principle of discounting is equally applicable in the public sector, in practice choices are less likely to be based on the results because of the way in which funds are raised and because of limitations on borrowing and investing.

Because discounting complicates analysis, it is used only where substantial investments are involved and the alternatives differ greatly in the time pattern of the costs. For example, the procedure would be required if one of the alternatives were a traditional program that required the construction of new classrooms and the other a television series using an existing broadcast station but requiring the development of programs and materials.
Full Costing

In analyzing the costs of alternative programs, it is usual to consider a base case and the incremental costs of the various alternatives. The base case is most often a continuation of the present program with future costs projected on the basis of historical data.

Economists agree that comparisons should be made on the basis of full costs.\(^1\) To determine total operating costs it is necessary to include both direct and indirect costs. In the simplest case, direct costs are those incurred solely for the particular program while indirect costs are a prorated share of expenditures for support services and general overhead. Often, however, a single organizational unit has responsibility for two or more programs. Academic departments provide both instruction and research, for example. The joint costs of these activities must be prorated in order to compute the direct costs of each.\(^2\)

Unfortunately, even the best methods of allocating costs are essentially arbitrary. Analysts avoid the

\(^1\) Nolfi and Nelson (1973) and Arenson (1979) point out that the failure of some colleges and universities to account properly for overhead costs has led them to assume that continuing education programs were profitable when, in fact, they sustained significant losses.

\(^2\) The induced course load matrix (ICLM) may be regarded as a tool for allocating joint instructional costs.
procedure where possible:

In many cases where alternative programs are being considered, support and overhead costs are unaffected by the choice; the costs represent commitments that must be met as long as the system continues without major structural change. In other cases, support costs are such a small part of the total that they can be ignored.

Support costs and joint costs can be taken into account without prorating by including the total expenditures for these items in the calculations.

Where support costs and joint costs are a significant part of total costs and the relationship between programs is complex, prorating is usually necessary. The method of allocation depends upon the nature of the individual resources. Examples of resources that lend themselves to different types of allocation are: janitors' wages - per square foot, administrative costs - per student, registrar's budget - per student credit hour, and typists' wages - time.

Some institutions use internal pricing to allocate certain support costs.¹ For example, secretarial services, custodial services, and print shops can operate as if they

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¹ Internal pricing can be an effective method of managerial control, both of the unit providing the support service and of the unit using it. Harvard University, for example, actually permits individual schools to choose between its own custodial services and those offered by outside contractors.
were small businesses and charge other departments for their work.

From the most general point of view the concept of full cost includes nonmeasurable and external costs as well as those that appear in an organization's operating and capital budgets. These include such items as students' time, staff morale, and community good will. As was mentioned in an earlier chapter, the cost of students' time is significant both in the short-term (time wasted standing in line, for example) and in the long-term (delay in beginning full-time employment). Community good will, which may affect funding, is of great importance. For example, because private colleges in Massachusetts have expressed the fear that their financial health may be threatened by the the expansion of public evening programs, at least one public institution has abandoned its efforts to bring its programs into certain parts of the state.

**Managerial Accounting: Cost-Volume-Revenue Analysis**

Cost-volume-revenue analysis, or variable budgeting, is a simple tool for studying alternatives when volume (enrollment in the case of education) is subject to variation. The cost terms of the equations form the basis of traditional financial planning models. Although the income terms are less frequently used, there is no obstacle
The basic variable budget equation in its simplest form is:

\[
\text{NET INCOME} = (\text{SALES VOLUME} \times (\text{PRICE-UNIT COST}) - \text{FIXED COST}.
\]

Where there are multiple sources of income and multiple cost categories, the equation becomes:

\[
\text{NET} = \sum_i A_i \text{FI}_i - \sum_j B_j \text{FC}_j + \text{VOL} \left( \sum_k C_k \text{VI}_k - \sum_l D_l \text{VC}_l \right),
\]

where

- \( \text{NET} \) = net income (cost)
- \( \text{FI}_i \) = fixed income of type \( i \)
- \( \text{FC}_j \) = fixed cost of type \( j \)
- \( \text{VI}_k \) = variable income per unit of type \( k \)
- \( \text{VC}_l \) = variable cost per unit of type \( l \)
- \( A_i, B_j, C_k, \text{and } D_l \) are constants for allocating income and costs.

The equation can be put into more general form by leaving the nature of the relationship between unit costs and total costs unspecified. The most common nonlinear relationship is the step function. (A step function could represent an additional instructor for every fifteen students, for example.) Some models use complex statistical relationships.

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1 Cost-volume-revenue analysis has its origins in business accounting where both costs and income must be considered. Cost analysis and the early cost models, on the other hand, began in the public sector where costs are of primary concern.
to estimate the costs of various items.¹

The application of cost-volume-revenue analysis requires that costs be divided into fixed and variable components. The division between the two usually depends on the time span and scale of the analysis. Costs that are independent of volume in the short-run and over a narrow range may well be variable in the longer term or if extreme variations in enrollments occur.²

Estimates of fixed and variable costs are usually based on historical data. Alternatively, standard costs can be substituted for variable unit costs. Standard costs represent what variable per unit costs would be under ideal situations of maximum efficiency. In practice, as explained earlier, standard costs have limited application in the analysis of postsecondary education.

¹ Such techniques are required for the analysis of programs involving complex problems of procurement and timing (space programs, for example). They can usually be avoided in educational planning.

² The matter of fixed versus variable costs is directly related to the problem of average versus marginal costs in formula funding. For this reason, the difference between short- and long-term relationships is of great concern to educational institutions.
Dealing with Errors in Cost Analysis: Sensitivity Analysis

Because estimates are liable to inaccuracies, it is almost essential in cost analysis to include means of determining the importance of possible errors. Sensitivity and contingency analysis are used for this purpose. The two techniques are similar, but sensitivity analysis deals with errors of estimation, while contingency analysis deals with changes in external circumstances. The analyses will answer such questions as: for what range of values of input variables will the least costly alternative remain in that position, and if certain assumptions are changed, will the alternative remain the least costly. In carrying out this type of inquiry, a fortiori analysis is often helpful. In a fortiori analysis, all assumptions are weighted against the the alternative preferred by the decision maker; if this alternative remains the cheapest one, then the case in its favor is greatly strengthened.

In making decisions on the basis of cost analysis, small differences in costs are ignored. First, cost projections are inherently imprecise and second, cost is only one of many factors that must be taken into account in reaching decision. Unless differences is costs are significant, other considerations will usually determine the course of action.
Comparing Alternatives Using Cost Analysis

Comparisons Using Equal Cost Cases and Equal Effectiveness Cases

The value of cost analysis to decision makers is usually greatest if estimates of cost can be held constant for all the alternatives so that only the effects of the programs need be compared. The use of equal cost studies reduces the danger of undue stress on costs. Massey et al. (1972) argue that for areas like instruction where goals are complex and outcomes impossible to quantify, cost-effectiveness analysis should always be presented in the form of constant cost cases.

Equal effectiveness studies can be undertaken in the analysis of certain support services and capital projects where effectiveness can be clearly defined and measured. In this case, the least costly alternative is selected.

Although it is often necessary to consider alternatives that differ both in costs and outcomes, it must be recognized that in such situations the alternatives cannot be ranked on the basis of cost analysis.¹

¹ It is not possible to say whether or not a ten million dollar library with 200,000 books is more or less cost-effective than a five million dollar library with 100,000 books without other information about goals and resources. See Chapter IV for additional discussion of cost-effectiveness analysis.
Comparisons Using Unit Costs

Unit costs are commonly used in comparing alternative programs within an educational system and in comparing the programs of different institutions. As has just been indicated, such measures have little value by themselves; they can be used successfully only when they are combined with value judgments and a thorough grasp of the educational programs being studied.¹

Not only do unit cost comparisons suffer from the difficulty in ranking just mentioned but in addition, even under the best of circumstances such units as full-time equivalent students, student credit-hours, and degrees granted are very poor proxies for the effectiveness of educational programs. Even in traditional education, class hours, degree requirements, and the work demanded of the students vary among institutions and departments. The usefulness of unit costs in analyzing traditional college and university programs is the result of the fundamental similarity of the programs and the familiarity of educators with the traditions and variations of the systems.

The interpretation of unit costs of part-time programs is much more difficult and requires even more care

¹ This is true of all cost studies, but it should be clear that equal cost and equal effectiveness studies rest on a firm theoretical base, while unit cost comparisons do not.
and caution. Part-time postsecondary education is characterized by a great diversity of services and frequently, by the fractionization of the traditional package of instructional services among more than one organization. Consequently, in analyzing and comparing nontraditional programs it is necessary to deal explicitly with the kinds and levels of services provided with each alternative. It is not sufficient to record the number of credit hours earned or some other measure of participation. One must also give some indication of what services were provided and who provided them: Do the credits represent the passing of a CLEP\textsuperscript{2} examination (certification of learning)? Do they represent independent study (advising, evaluation, and certification of learning)? Or do they represent a traditional course (instruction, evaluation, and certification)? The number of possible combinations is large, and many of them are represented by actual systems.

\begin{footnotesize}
\begin{enumerate}
\item Lyman Glenny (1974) has stated that unit costs can rarely be used in comparing part-time programs. This is certainly true unless supplementary information is also available. It is argued here that such information can be provided and that unit costs are valuable tools for allocating resources.
\item CLEP is the College Level Examination Program of the Educational Testing Service. CLEP and similar examinations are used by some institutions as a basis for awarding credit for prior learning.
\end{enumerate}
\end{footnotesize}
The need to define the levels and types of instructional and other services and their relationship to costs and fees applies to noncredit as well as credit activities. Conferences, workshops, and short courses, for example, are quite frequently jointly sponsored; certain supporting services may be offered by the educational agency while a business organization or some other agency may provide the instructional services.

Many of the outcomes of education are indirect or difficult of observe. For example, courses by television, by correspondence, and in a classroom may have identical objectives, but the first will reach a wide audience of non-students, and the last provides an opportunity for personal interaction. The existence of these secondary effects increases the importance of qualitative assessment and individual judgment in the evaluation of alternatives.  

In short, if part-time programs are to be analyzed and compared, clear answers must be available to three key questions: **What** services are provided? **Who** provides them? **For whom** are they provided? Much of the information required to supplement cost data can be provided through narrative description. In addition, a taxonomy of activities giving information about the scope and

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1 The inclusion of unintended outcomes in evaluation was discussed in chapter IV.
sponsorship of the services provided might well be of value in preparing narrative descriptions and in supplementing them. This possibility will be discussed in Chapter VII.

Cost Analysis - Conclusion

Cost analysis and managerial accounting form the base for financial planning and for financial planning models. Cost-volume-revenue analysis is likely to be particularly useful for planning part-time programs, where both income and costs are usually of concern.

It is important to recognize that although cost analysis and managerial accounting are well developed tools, they are by no means cook-book techniques. Deciding what costs and income to include, how to account for startup costs, joint costs, and overhead costs, which costs are fixed and which are variable, and how to estimate costs when data are unavailable requires ingenuity and judgment. Only if this can be done well can cost analysis and managerial accounting provide decision makers with simplified but accurate representations of the financial consequences of various possible courses of action.
3. BUDGET MODELS

Developing and Using Budget Models

Although budget analysis can be performed on an ad hoc basis, it is often most effective when based on a model. Budget models can provide the means to examine the income and costs of alternative plans and circumstances for new and existing programs. With a general budget model an agency can examine a wide range of alternatives in a consistent manner. A budget model, particularly if it is at least partially computerized facilitates the performing of sensitivity and contingency analysis.

Models are intended to represent the particular aspects of a systems that are relevant to the analysis and to make it possible the study them quickly and inexpensively. Because the goals, organization, and financial structure of a system affect its information needs, a budget model must almost always be tailored to the individual agency under study.¹

The two major criteria for a model are simplicity and validity. On the one hand, if a model does not simplify calculations greatly, these will be cumbersome and time consuming; the model may provide no advantage over

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¹ Efforts to construct general budget models will be discussed later in this section.
developing complete alternative budgets. On the other hand, if the model is oversimplified or incorrectly designed, it will not produce useful results. Unfortunately, the criteria of simplicity and validity often conflict.

**Specifying Variables**

A budget model is, of course, a mathematical model. Variables represent such quantities as salaries, cost of materials, fees, and numbers of students. For simplicity, variables are aggregated; for example, average instructors' salaries are used rather than those of individual instructors, and costs of supplies are specified on a per student basis rather than item by item.

While the criterion of simplicity dictates the use of as few variable as possible, every aggregation reduces the generality and flexibility of the model. For example, if instructors' salaries are classified only by faculty rank, the model may misrepresent the cost of a program that uses teachers from professional schools where pay is high. Similarly if enrollments are not broken down by such categories as age, sex, past education, and socio-economic status, then the model may not be able to predict the costs of programs attracting a large number of a particular kind of student. Devising aggregations that permit the analysis of programs designed for specific groups of students is an important aspect of model design.
Input and Output Variables

Models of educational systems include the following types of variable:¹

1) **Predetermined variables** - those over which the system has no control. Price is a predetermined variable. Enrollments may or may not be predetermined.

2) **Decision variables** - those directly determined by the policies of the agency. Fees, salaries, courses offered, and rules for determining class size and staff workloads are usually decision variables.

3) **Internal variables** - those determined indirectly once policies have been set. The number of instructors and support personnel and the budget are internal variables. The program's budget is the target variable, or output of the model.

It should be recognized that the division between predetermined, decision, and internal variables is a simplification necessary for modeling. For example, in many models, enrollments are treated as predetermined variables and charges and course offerings as decision variables, but in reality, enrollments are usually dependent upon prices and course offerings.

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¹ This particular categorization of variables is taken from Haggart (1972).
Accuracy of Detail

In building a model it is essential to give specific accounting of the rules for cost allocation so that double counting and inconsistencies do not arise. However, since the purpose of the model is not to satisfy the needs of accountants and auditors, but to meet those of planners and decision makers, financial data need not be exact. Care should be taken to estimate personnel costs reasonably accurately because these are the major component of educational program expenses. But it is counterproductive to make highly accurate estimates of costs that form only a minor part of the total; doing so raises the cost of developing and using the model and sacrifices simplicity needlessly.

Computing Estimated Budgets

Once the variables have been specified, expressions must be developed that permit the calculation of output variables. As explained earlier, this usually means specifying fixed and variable income and costs and the units of variation. For example, the cost of instructors depends upon the number of instructors and their average salary. The number of instructors is an internal variable that is computed from the number of students and information about class size.

The actual methods of computing variables depends upon the mathematical techniques used. Several approaches have
been used successfully in the construction of budget models for postsecondary education.

**Financial Models in Postsecondary Education**

Many models have been built as aids to financial analysis in postsecondary education. This discussion will concentrate on general budget models. Models of space use, capital construction, enrollment, faculty flow, and other special aspects of institutional operation will not be considered.¹ Four types of model will be discussed:

1) general budget and cost estimation models. 2) optimizing models, 3) systems of simultaneous equations, and 4) structural flow models. Methods of modeling have been considered in earlier chapters and will not be reviewed here.

**Cost Estimation Models**

General resource models compute costs by making a series of estimates much in the same fashion that a manager would put together a budget. The core of this kind of model is a sequence of calculations in which: 1) basic resources (e.g., number of instructors) are computed from enrollments and such policy variables as class size, 2) costs of various

¹ Enrollment models were discussed in Chapter V. See Casaco (1970), Weathersby and Weinstein (1970), Schroeder (1973), Correa (1975), and Richardson, et al. (1977) for discussions of both general and specialized models.
kinds are computed from the basic resource requirements and unit variable costs — as well as any fixed costs. 3) total costs and unit costs are computed from the individual cost items and enrollments, and 5) program costs are computed by allocating joint and overhead costs.

In most of the models, enrollments are specified by program (e.g., college major), and course enrollments are computed using an induced course load matrix (ICLM). The ICLM’s are also used to prorate department costs in computing program costs.

During the late 1960’s and early 1970’s there was a major effort to construct general resource models for traditional higher education. Several large models were developed with the expectation that they would be useful for a wide range of colleges and universities. Most of them included enrollment forecasting elements and calculations of space needs. Some had other special features, including, for example, the calculation of estimated income. Among the major models are HIP, a German model (Hussain, 1976); a model by Koenig (1967), CAMPUS (Mowbray and Levine, 1976);

1 In most of the models, course enrollments are aggregated by level and academic department (e.g., upper division political science).

2 See Chapter V for a discussion of the ICLM.
Hussain, 1976), RRPM (Clark, et al., 1973), and SEARCH.¹

By far the most complex of the models is HIP, which includes among other features, provisions for optimizing enrollment under conditions of limited capacity. Neither HIP nor Koenig's model has been implemented, largely because of difficulties in assembling the necessary data. The remaining four models have been tested and used.

The major cost estimation models have serious drawbacks as planning tools: 1) They require vast amounts of data and the maintenance of extensive information systems. 2) They use historical data to estimate enrollments at low levels of aggregation, but enrollments are not stable at these levels. 3) They produce vast amounts of computer printout that are difficult to analyze and interpret. 4) Since the models are nonstatistical, an nonoptimizing, repeated runs are required for sensitivity and contingency analysis, thus adding to the difficulty and expense of using the models and interpreting the results² (Hopkins, 1971; Bell, 1972).

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¹ Lawrence and Service (1977) give the following reference for SEARCH:

² At least one of the models, a version of CAMPUS, is interactive. This reduces the difficulty of conducting sensitivity and contingency analysis.
Plourde (1975) surveyed users of the large cost estimating models and found that they enjoy only limited use as tools of policy analysis. The National Center for Higher Education Management Systems continues to support efforts to use its cost estimation model to compare the use of resources among postsecondary institutions (NCHEMS, 1977). Comparative data about historical costs are, of course, useful aids for the development of state budgets and funding formulas for postsecondary education. On the whole, however, efforts to use the major cost estimations models as tools for annual budgeting have been abandoned along with the program budgeting systems that they were intended to support.

On the other hand, smaller, more highly aggregated cost estimation and budget models that are constructed for individual institutions or for the analysis of specific problems may be of considerable value for financial planning. One of the few such models described in detail in the literature was developed by RAND for the evaluation of a nontraditional elementary school program (Rapp, 1971). Because such models have received little attention in the literature, it is not possible to estimate the extent of their use. The potential value of this approach will be discussed again later in the chapter and in Part III of this paper.
Optimizing Models

The late 1960’s and early 1970’s, when the major cost estimation models were being developed, was also a period of experimentation with more sophisticated mathematical techniques for planning in higher education. Among the approaches that were tried were mathematical programming, Markov analysis, systems of equations, and structural flow models. The first of these techniques was particularly popular for the construction of financial planning models.

Mathematical programming or optimizing models can be used to find economical solutions to complicated problems that can be stated in terms of a single goal and a series of constraints. They have been used successfully in educational institutions to plan menus that meet basic nutritional requirements at minimum cost, to find transportation routes that minimize distance travelled, and to solve certain kinds of scheduling problems. Financial planning models that use mathematical programming must take multiple goals into account. Objectives may include, for example, specific faculty-student ratios, levels of

1 The various techniques are discussed in Chapter V. Markov analysis is not used for budget analysis.

2 McNamara (1971) provides an excellent general review of the application of such models to educational systems.
enrollment, and faculty salaries. Multiple goals can be included in mathematical programming models by weighting objectives or setting priorities among them; a variety of techniques can be used for this purpose. Among the attempts to apply mathematical programming to problems of financial planning are a goal programming model of Lee and Clayton (1972), an interactive model in which the decision maker specifies weights for pairs of objectives (Geoffrion, Dyer, and Feinberg, 1972), a linear programming model for determining appropriations for community colleges (Bruno, 1969), and a dynamic programming model that finds the solution closest to the decision maker’s weighted targets (Wagner and Weathersby, 1972).

Although the mathematical programming models are of some theoretical interest, it has not proved possible to quantify and rank the complex goals of educational program in ways that permit the practical application of this method to program planning in postsecondary education.  

Other Methods, The Stanford Model

Among other mathematical tools that have been applied to budget analysis are systems of simultaneous equations and

1 If these various objectives do not conflict, the problem can be restated in terms of a single objective (usually cost minimization) and a series of constraints. However, such situations rarely occur in the planning of educational programs.
structural flow models. The network equilibrium model of Oliver, Hopkins, and Armacost (1970) falls into the first category. The model requires data about technological requirements (e.g., teacher-student ratios) and about the students in the various programs; the user must provide information about the number of students in each program, the length of study required, and what happens to students when they leave, (i.e., whether they continue at the institution in some other capacity or leave the system entirely). The model does not include time dependencies, but simply computes the long-term consequences of the policies and assumptions specified. Although it was anticipated at one time that decision makers would find the model attractive as a planning tool (Bell, 1972), there is no evidence in the literature that it has been used.

Among the structural flow models \(^1\) constructed in the last fifteen years are three using systems dynamics to analyze institutional finances in very general terms. A model by Thompson (1970) includes student and faculty flow and capital construction. It is based on quite simple and direct assumptions about the rates of growth of these three elements and the relationships between them. Chew (1975)

\(^1\) Structural flow models are those that use differential equations or the related techniques of difference equations and systems dynamics. They are described in Chapter V.
developed a model to explore the long-term relationships between graduate education, undergraduate education, and university finances. The third model (Fey and Knight, 1971) is highly speculative. It includes, for example, a student violence sector that forecasts campus disturbances on the basis of complex causal relationships. While the Fey and Knight model cannot be deemed a practical planning tool, the others demonstrate the potential value of structural flow methods for the analysis of long-range financial needs. The technique lends itself well, for example, to the representation of the relationship between capital construction and long-term requirements for maintenance and repairs.

The Stanford model deserves special attention because it is one of the few that has been used successfully as a practical planning tool. The model was developed over a period of years by Hopkins and Massy (1977) specifically for Stanford University. It makes use of both structural flow techniques and simultaneous equations.

The Stanford model has three components: 1) a long-range financial forecasting model, 2) a dynamic equilibrium model, and 3) a transition to equilibrium
model. The long-range financial forecasting model projects the impact of current estimates of income and expenditures (e.g., tuition, return to endowment, faculty salaries, and maintenance) on the future values of these variables. The variables are interdependent. For example, price elasticities of enrollment and the relationship between tuition and financial aid must be specified.

The dynamic budget equilibrium model uses difference equations to find long-range equilibrium values of levels and growth rates of the variables. Since the model has fewer equations that unknowns, it is necessary to specify the values of some of the variables. Various trade-offs can be examined depending on which of the variables are treated as unknowns.

The transition to equilibrium model consists of a series of simultaneous equations that can be solved to find the adjustments in the initial estimates of the financial variables needed to bring the system into equilibrium at the end of a specified time period.

The Stanford model and various parts of it have been used as aids for planning a capital fund drive and for

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1 The model has gone through a number of revisions. The 1977 version is described here. That version, for example, projected financial figures for a period of five years; later versions provide projections for up to ten years (Updegrove, 1978).
developing long-term plans for expenditures from endowment and tuition. The model has been adapted by several other institutions for their own use. Although other schools have found the model useful, each has had to make modifications in order to represent its own decision making structure and approach to planning (Updegrove, 1978). Parts of the model have been used in the construction of EFPM, the EDUCOM financial planning model. EFPM will be discussed shortly.

Recent Approaches to the Development of Financial Planning Models

After several years of experimentation with a variety of approaches, analysts have concluded that, to be of practical value, a model must be tailored to the institution and situation for which it is to be used: First, financial objectives must be taken into account; these may include a need to minimize risk, maximize net revenue, minimize cost, or maximize enrollment. Second, limitations and constraints must be considered: it is possible that any of a number of factors may limit capacity, that demand may determine enrollment, or that both capacity and demand may be important. Finally, the organizational level at which the particular issues are addressed must be taken into account.

In short, the expectations of the early model builders have proved incorrect; it has not been possible to build general models that can accommodate the many differences among
intitutions in financial goals and constraints and in approaches to planning. Model builders have come to appreciate the warnings of people like Lindbloom and Wildavsky and to recognize that practical planning almost always takes the form of finding particular solutions to particular problems and particular times and places. The term adaptive planning has come into fashion to describe institutional analysts’ efforts to help solve the specific problems that are identified by decision makers (Wiseman, 1979; Porter, et al., 1979; Updegrove, 1978; Diran, 1978).

Computer Models as Tools of Adaptive Planning

There are several possible approaches to the design of computer models for the analysis of specific problems:

1) Basic programming languages like Fortran and APL can be used to construct the models.

2) General models like RRPM or institutional models like the ones developed by Stanford can be adapted for the conditions at hand.

3) Model building systems can be used as aids to

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1 This fact has long been recognized by practicing consultants and institutional planners (Massey, et al. 1972). Many of the early model builders, however, were graduate students or young professionals with technical expertise, but without experience in administration and planning. As Updegrove (1978) points out, although they failed to devise practical planning tools, they did lay the groundwork for the recent, successful planning models.
constructing the models.

Many institutions construct new models from scratch as the need arises. It is sometimes feasible and economical to build a model to solve a specific problem, use it once or twice, and set it aside (Porter, et al., 1979). As the Stanford models illustrate, it is also possible to build quite elaborate models that can be applied to such recurring problems as setting tuition and managing and endowment.

There are two major disadvantages to building new models from the ground up. First, this approach requires analysts who are highly talented both in terms of their understanding of planning and management and in terms of their technical skills; such talent is rare. Second, the approach is often more expensive than working from an existing base.

Existing models can be adapted for new uses, but extensive modifications may be required even where the transfer is made between institutions with apparently similar goals and financial needs (Updegrove, 1978). It is not possible to determine the extent to which this approach is used or the frequency with which major modifications must be made; adaptations of existing models are rarely reported in the literature.

According to Updegrove (1978), until recently educational institutions have been deterred from using financial planning languages because of their high cost. In the last few years, however, a model building system called
EFPM, or the EDUCOM Financial Planning Model, has been widely adopted (EFPM Newsletters, 1979). EFPM, as was indicated earlier, is based in part on the Stanford models; it is intended for long-range financial planning, especially by institutions that are dependent on endowments.¹

The system permits the users to define their own variables, the relationships between them, and constraints on their values. Given the appropriate information, the model can compute forecasts for up to ten years, the feasible values of a single variable, and trade-offs between two variables. The model building system is operated by EDUNET and resides on the Cornell University computer. Users maintain their own individual models on the Cornell system. They can write Fortran subroutines and use their EFPM model in conjunction with other models.

EFPM has been used to build student and faculty flow models, financial planning models for student housing and for building and grounds departments, and general institutional financial models (Knodle, 1979). Although there are no reported applications to divisions of continuing education, EFPM appears to be well suited for representing the wide variety of possibilities and constraints that characterize these agencies.

¹ Although most of the institutions using EFPM are private, several state institutions are finding the model useful.
It must be stressed that EFPM is not a completely general model building system. It is intended to serve as a tool for constructing highly aggregated models. Among its limitations are that EFPM has no statistical functions and is not intended to handle matrices such as the ICLM.

Financial Planning Models in Postsecondary Education:

Conclusion

It has been seen that the period of active experimentation with general cost models and with the application of complex mathematical techniques to educational planning was followed by a period of reevaluation as it became apparent that the large models and the complex mathematical schemes had failed to meet the needs of institutional decision makers. Recent assessments of the efforts of the late 1960's and the early 1970's as well as of smaller scale planning efforts have led to the conclusion that financial models can be of value in many areas of institutional planning, but that the models must be both easy to understand and compatible with the planning methods of the individual institutions.

Three approaches are used for building models that address specific problems. These are: 1) using basic programming languages to build entirely new models, 2) adapting existing models or borrowing their components, and 3) using financial planning languages or model building
systems to construct new models. Although the first two approaches have been used for some time by educational institutions, the last has come into use only recently with the adoption of EFPM by some colleges and universities.

It remains to be seen whether the current apparent success of EFPM will be sustained, whether that system will be expanded to allow for the construction of additional kinds of models, and whether other model building systems will be developed to supplement or to compete with EFPM.

In Part III we will discuss LEARN, a model for financial planning for adult and continuing education systems that was constructed for a particular institution, but that may also provide a starting point for a simple model building system.
CHAPTER VII
TAXONOMIES AND THE INSTITUTIONAL DATA BASE

Introduction

Research on institutional data systems can be divided into three areas: 1) the development of definitions and classifications that permit comparisons and combinations of records within and among systems of postsecondary education, 2) the development of computerized storage and retrieval systems, and 3) the development of general management information systems. Only the first topic will be considered in this chapter.¹

¹ Much of the work discussed in this chapter took place in the late 1960's and early 1970's. For reviews and discussions of this work, see Johnson and Katzenmeyer (1969), Schroeder (1971), and Mason (1973). For information about the HEGIS taxonomy and the Program Classification Structure (PCS) see Drews and Drews (1969) and Gulko (1972). For descriptions of the Extension Management Information System (EMIS), see reports by Wrisley and Turner (1974), and Young (1973). Uniform annual reporting forms on university general extension are prepared by the National University Extension Association jointly with the Association for Continuing Higher Education (University of Massachusetts Division of Continuing Education, 1974). Much of the work towards uniform accounting and reporting systems that has been done since the early 1970's has been sponsored by the National Center for Higher Education Management Systems (NCHEMS, 1977; Collier, 1975). Issues directly related to cost analysis were discussed in Chapter VI.
All schools keep records of enrollments, grades, payrolls, departmental accounts, and many other items. Historically the records have been developed in isolation from each other in response to specific needs that were directly related to operations. Because the many record systems of different schools and departments have developed independently, students, services, and budgetary accounts are all classified in many different ways. And because the records have been designed to meet specific operational needs, they are often destroyed once they have served their original purposes. As a result, data for planning are often either unavailable or obtainable only at prohibitive cost, and data from different administrative units and from different schools cannot be combined or compared. For example, definitions of part-time status may vary, enrollments may be counted at different times during the semester, and certain costs may be charged to instruction in one system, research in a second, and administration in a third. As a result, such statistics as the total number of part-time students or comparative unit costs may have little meaning (Mason, 1972).

Since the mid-1960's, the availability of computers for data management and the demands of state and federal agencies for accountability have worked together to stimulate efforts to improve and standardize institutional information systems. Two systems for reporting information
about postsecondary education are of particular interest for part-time programs. These are the Program Classification Structure (PCS) of the National Center for Higher Education Management Systems (NCHEMS) and the Extension Management Information System (EMIS) of the United States Cooperative Extension Service. Because the systems are the results of federal efforts to encourage uniform reporting, it appears likely that most educational institutions will find it necessary to adopt taxonomies that are compatible with one or both of them. While each has certain limitations, both include most factors that are necessary for the description of part-time programs. The most serious limitation of both with respect to systems that serve part-time students is that the taxonomies do not make adequate provision for describing programs that involve independent study or shared sponsorship and responsibilities.

The Program Classification Structure and the Extension Management Information System will now be described as will two systems for classifying programs by sponsorship and scope of service.

The Program Classification Structure

The Program Classification Structure (PCS) is a comprehensive taxonomy of the activities of traditional postsecondary education. An outline of the structure is shown in Table 6. The primary purpose of the PCS is to
### Table 6.
THE PROGRAM CLASSIFICATION STRUCTURE

<table>
<thead>
<tr>
<th>THE CODING STRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROGRAM</td>
</tr>
<tr>
<td>SUB-PROGRAM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROGRAM CLASSIFICATION CODES</th>
<th>INSTITUTIONALLY DEFINED CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 INSTRUCTION</td>
<td>5.0 STUDENT SUPPORT</td>
</tr>
<tr>
<td>2.0 ORGANIZED RESEARCH</td>
<td>6.0 INSTITUTIONAL SUPPORT</td>
</tr>
<tr>
<td>3.0 PUBLIC SERVICE</td>
<td>7.0 INDEPENDENT OPERATIONS</td>
</tr>
<tr>
<td>4.0 ACADEMIC SUPPORT</td>
<td></td>
</tr>
</tbody>
</table>

Instructional activities are classified under three program headings: 1.0 Instruction - all credit instruction, 3.0 Public Service - noncredit programs for nonmatriculated students, and 5.0 Student Support - supplemental instructional services for matriculated students. Instructional activities are placed in the following subprograms:

1.0 Instruction (credit): 1.1 General Academic
1.2 Occupational Vocational
1.3 Special Session
1.4 Extension (for credit)

3.0 Public Service: 3.1 Community Education
3.2 Community Service
3.3 Cooperative Extension

5.0 Student Service: 5.2 Supplemental Educational Services for matriculated students

#### PROGRAM CATEGORY AND SUBCATEGORY: ACADEMIC DISCIPLINE OR TYPE OF INSTRUCTION

For the Instruction and Public Service Programs, the program category and subcategory (4 digits) describe academic disciplines. The HEGIS taxonomy is used for this purpose except in the case of the Cooperative Extension Service.

For the Supplemental Educational Services Subprogram, the program category (2 digits) describes academic disciplines by the general classes of the HEGIS taxonomy; detailed classifications by discipline are not used. For this subprogram the first digit of the program subcategory describes type of instruction (e.g., tutorial, short course); the second digit of the program subcategory is not assigned. Note that this is the only program type for which the PCS provides for a description of type of instruction.
**TABLE 6, CONTINUED.**

**PROGRAM SECTOR: LEVEL OF INSTRUCTION OR TYPE OF AUDIENCE**

For the Instruction Program and (optionally) for the Student Support Program, the program sector describes the course level (e.g., preparatory, lower division, graduate).

For the Public Service Program, the first digit of the program sector describes audience type as follows: 6 - individuals, 7 - community groups (e.g., professional groups), 8 - community sectors (e.g., socioeconomic groups), 9 - other groups.

1 excludes conventional educational programs, but includes such activities as television.

2 e.g., noncredit, remedial programs.
serve as a tool for planning and budgeting. It can also be used as the basis for record systems for accounting, registration, and other administrative activities. The disadvantages of the PCS for systems that serve part-time students stem from the fact that the structure is based on conventional assumptions about college and university students and about types of instruction. In addition to its limitations for describing shared responsibilities, the PCS does not anticipate the need to classify programs by both level (e.g., lower division, graduate) and type of client served (e.g., low income persons, dairy farmers). Nor does it anticipate the need for classification by both type of instruction (e.g., lecture, tutorial, correspondence) and subject matter, (see Table 6).

Although these characteristics of the PCS make its use for descriptions of part-time programs somewhat awkward, other than the problem of describing shared responsibilities, the difficulties can be solved by using the unassigned elements in the code to provide any additional information that may be required. Alternatively, the code can be extended, or a compatible, but slightly different code can be used to describe part-time programs.

The Extension Management Information System (EMIS)

The Extension Management Information System (EMIS) is a federally mandated system for the collection and reporting
of information about Cooperative Extension programs. The Cooperative Extension Service of each state develops its own computerized information system (SEMIS) using the general framework of EMIS but developing its own taxonomy of goals, subjects, and other categories. A few state universities have developed variants of SEMIS that can be used for their general extension as well as cooperative extension programs (Michigan State University, 1974). The system provides for reporting the amount of time and type of activity required to support the program goals of the agency. The basic framework provides for reporting:

-- goals and objectives as defined in an annual plan of work,

-- characteristics of the learning experiences (subject matter, level of instruction, and format (i.e., credit or noncredit),

-- characteristics of the delivery system (instructional technique and location),

-- characteristics of the audience (type of group, whether or not the program is intended for low income persons, size, and racial composition). ¹

EMIS was not designed as a tool for planning and budgeting.

¹ The example here is based on the Missouri Extension Information System. Details vary considerably among systems.
### Table 1: Missouri Extension Management Information System

<table>
<thead>
<tr>
<th>FEDERAL ID</th>
<th>PROGRAM PLANNING UNIT</th>
<th>S</th>
<th>I</th>
<th>SUBGOAL</th>
<th>I</th>
<th>OBJECTIVE</th>
<th>PRIMARY</th>
<th>EST NUMBER OF STUDENTS</th>
<th>MAN DAYS PLANNED TO REACH THIS OBJECTIVE</th>
<th>PHYSICAL IDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>14</td>
<td>26</td>
<td>27</td>
<td>30</td>
<td>31</td>
<td>34</td>
<td>38</td>
<td>40</td>
<td>44</td>
<td>54 78 80</td>
</tr>
</tbody>
</table>

### Descriptions and Examples of Categories for EMIS

**Program Planning Units**
- Extension offices

**Goal and Subgoals (examples)**
- Goal: economic development
- Subgoal: to help improve marketing, merchandising, ...

**Annual Objectives (examples)**
- Affirmative action
- Occupational health
- Rural development

**Program Categories (examples)**
- Business, industry & labor
- Food and fiber
- Quality of living

**Subjects (examples)**
- Beef & beef products
- Consumerism, housing

**Levels (examples)**
- Undergraduate, graduate

**Formats**
- Credit, noncredit

**Techniques (examples)**
- Individual instruction, classes, newspapers

**Mass Media**
- Audience estimates are available for all media in the state

**Student's Locations (examples)**
- County or campus where course held, statewide

**Audience Type (examples)**
- Professional association
- Senior citizens
- Citizen committees

**Income Characteristics of Audience (ICC)**
- Low income
- Not low income

(Young, 1974)
It is intended for planning and reporting the expenditure of time, rather than money. It is possible, however, to develop budgeting and accounting systems that parallel the EMIS system (Michigan State University, 1974). (See Table 7 for an outline of one particular SEMIS.)

Because the EMIS framework permits a detailed description of activities by purpose, audience, learning experience, and delivery system, it is well suited for the classification of part-time programs. Other than the problem of describing shared responsibility, the only difficulty with the existing SEMIS classifications is that they do not use the HEGIS taxonomy for course descriptions. Where the framework is extended to programs for which the HEGIS taxonomy is appropriate, however, there should be no serious problem in substituting HEGIS for other taxonomies.

**Taxonomies that Provide for Descriptions of Levels of Service**

For evaluating and comparing the costs of programs that are operated jointly by two or more sponsors and those in which students must depend on outside resources, it is necessary to know what services are the responsibility of each agency or individual. Neither of the nationally-used
TABLE 8. SOME CESIS DESCRIPTORS, MICHIGAN STATE UNIVERSITY

MSU or non-MSU facility.

# of instructional personnel from MSU, other institutions, elsewhere.

Instructional hours by personnel from MSU, other institutions, elsewhere.

MSU or non-MSU sponsoring unit.

TABLE 9. CONFERENCE CLASSIFICATIONS, DIVISION OF CONTINUING EDUCATION UNIVERSITY OF MASSACHUSETTS, AMHERST

Type of Conference: (conference, short course, institute, seminar, workshop, or clinic)\(^1\)

Sponsorship: (University of Massachusetts, civic groups, students, other approved groups, religious or service agencies, unclassified)\(^2\)

Service Level. (1. booking services, 2. facilitation of programs and physical arrangements, 3. specific extra services, (e.g., registration), with fees-for-services).

---

1 Services for each type are described in a handbook (University of Massachusetts, Division of Continuing Education, 1973).

2 According to the handbook, different prices and some different services are associated with different categories of sponsors.
systems just described provides for such descriptions. Two systems that make some provision for data about sponsorship and scope of service are CESIS (Continuing Education Service Information System) of Michigan State University (1974) and a system developed for the University of Massachusetts Division of Conference Services (University of Massachusetts Division of Continuing Education, 1973). The systems represent two different approaches to solving the problem. As they are now designed, both have serious limitations. On the one hand, the CESIS classification is part of a computerized reporting system, but it provides for a very limited amount of quantifiable information about sponsorship and scope of service. On the other hand, the University of Massachusetts system provides for greater detail but has not been incorporated into a general information and reporting system; it is an informal guide for pricing conference programs. (See Tables 8 and 9).

---

1 Since 1973 the Conference Services office has undergone a complete administrative and financial reorganization and is no longer a part of the Division of Continuing Education. This description refers to the system in effect from 1973 to 1975.
Limitations and Difficulties in the Development of Data Bases

Ideally, uniform and reliable reporting systems should provide the information needed for planning, budgeting, operations, and control by decision makers within institutions and by those at the state and federal levels. There are, however, major obstacles to designing information systems that meet all these needs. In the words of Frederick E. Balderston (1974):

"An ideal data system for a university would contain, in accessible form, all the raw facts necessary to supply the pertinent information - no more and no less - to a decision-maker having a valid need for it. The system would draw these facts from all the scattered sources and combine them in just the right way. It would translate the information into terms convenient to the decision-maker. It would deliver the information instantly, and it would operate at zero cost! Such a system in not of this world."

(Balderston, 1974).

The major obstacles to the development of a complete data base for an institution are the following:

1) As a practical matter, subordinate agencies comply only perfunctorily with demands for information unless they perceive the benefits to themselves as at least equal to their own costs. For example, versions of EMIS that require weekly time sheets for each employee produce data that are
considered suspect by many. 1

2) Large amounts of data, even if accurate, are
difficult to interpret and therefore are not useful to most

3) Cost is always a major constraint on collecting,
storing, and retrieving information.

4) In designing a taxonomy for any one part of the
system, the needs and demands of other agencies must be
considered.

5) Systems of organizing and aggregating data must be
adaptable to changes in clientele, programs, services, and
finances.

The consequences of these difficulties and limitations
is that information systems are usually shaped by external
reporting requirements and by operational needs. Data that
are valuable only for planning are omitted unless they can
be incorporated into the system with little cost and
disruption. Planners, then, must usually rely upon
information that is available in an institutional data base
designed for other purposes supplemented by special reports,
investigations, and surveys (McIntosh, 1973). This last

1 Employees of the Cooperative Extension Service frequently
express skepticism about the value of EMIS and the quality
of the weekly reports.
aspect of gathering and analyzing data is discussed in Appendix A.

**Taxonomies and the Institutional Data Base: Conclusion**

It has been seen that there are two widely used systems for classifying data about postsecondary education. The Program Classification Structure is designed for traditional systems while the Extension Management Information System provides a framework for taxonomies describing state cooperative extension services. Although both of these systems can provide for most of the information needs of educational programs for part-time students, neither provides for the description of programs in which responsibilities are shared. The CESIS system of the University of Michigan and the system developed for the University of Massachusetts Conference Services represent two alternatives for filling this gap.

The CESIS system provides for the inclusion of a very limited amount of easily quantified information in an existing computerized data base.

The University of Massachusetts system provides for detailed information about sponsors and scope of service, but the information is based on a printed manual describing and categorizing the offerings of the system. Although the classifications have been used for determining fees, there is no provision for recording permanently the classification
assigned to the individual conferences.

In short, neither CESIS nor the University of
Massachusetts system in its present form can provide data
about sponsorship and scope of service that are adequate for
evaluating and comparing programs. Nor is it known whether
or not either of the approaches they represent or some
combination of the two could form the basis of a practical,
inexpensive taxonomy for data to be stored on permanent
records. As will be seen in the discussion of LEARN, the
possibility of developing such a taxonomy may be worth
investigating.
PART III. LEARN: LIFELONG LEARNING FOR ADULTS.

RESOURCES AND NEEDS
CHAPTER VIII
AN OVERVIEW OF PART III:
THE PROJECT TO DEVELOP AND TEST A BUDGET MODEL
FOR ADULT AND PART-TIME EDUCATION

Part III and the appendices describe the development, testing, and demonstration of LEARN and the conclusions resulting from the study.

Description of the Model

LEARN is a planning tool for part-time adult education. The model was designed to meet the needs of the Division of Continuing Education of the University of Massachusetts at Amherst. Although it is intended to represent one specific system, many of its components are completely general. LEARN can serve as the base for new models designed for other systems of part-time adult education.

LEARN is a variable budget model; it permits analysis of the relationship between cost, price, enrollment, and net income. The model organizes and displays information in two ways, computing both direct and program budgets. Programs may be defined in terms of students' educational goals or of such personal characteristics as age and sex. Among the key features of the model are two induced load matrices, or tables giving the ratios of service use to program enrollments. There is one matrix for instructional services.
and one for support services.

LEARN is a small, interactive model that is intended for use with highly aggregated data. Data requirements are minimal and output is concise. Each run of the model represents a single time period.

The data requirements, components, and output of the model are described in chapter IX. Table 10 shows a simplified flow chart. Tables 11 and 12 show the variables and equations of the model. Program listings and demonstration runs are shown in Appendices B and C.

Testing the Model and Demonstrating Its Use

LEARN was subjected to a number of tests including verification of the mathematics and programming, testing for accuracy in representing an existing system, and evaluation as a planning tool. Two sets of data were used, dummy data representing an imaginary system called Mini-Extension and actual data representing the on-campus credit programs of the University of Massachusetts Division of Continuing Education. Gathering and preparing the data to represent the University of Massachusetts programs constituted a major test of LEARN as a planning tool.

Chapter X is devoted to a discussion of the testing of LEARN. Included are descriptions of the on-campus credit programs of the University of Massachusetts Division of Continuing Education and of the preparation of the data to
The primary resources report is actually part of an extended enrollment report.
represent this system. Appendix A describes the preparation of the enrollment data and the induced load matrices in greater detail. Demonstration runs are shown in Chapter X and in Appendix C.

Discussion of Results

LEARN was found to be accurate and easy to use. The variable budget proved to be a simple, flexible mechanism for representing income and cost. The induced load matrices promise to be helpful in analyzing the relationships between student characteristics, on the one hand, and income, cost and the use of services, on the other.

It was found that data can be prepared for the model quickly and at low cost, provided that all institutional records are in machine readable form. Where some or all of the records are available only in hard copy, the time required to prepare the data depends both on the records system and on the purpose of the study. In some cases the effort is too great to be justified by any results from an analysis with LEARN.

Several problems were identified in the course of testing LEARN. The most serious ones stem from a basic difference between the planning approach implicit in the model and that actually used by the Division of Continuing Education.
LEARN is demand driven; it represents an idealized situation where instructional enrollment and the use of support services depend only on the composition of the student body and students' needs for services as portrayed by the induced load matrices. The Division of Continuing Education and systems like it, however, respond not only to the students' needs, but also to those of potential instructors and of the institution itself. The avoidance of financial risk is an important consideration. Among the consequences of the Division's policies are that enrollments are sometimes limited by capacity and that instructional salaries may depend on class size.

To increase the model's value as a planning tool for the Division of Continuing Education it should be modified to permit the representation of capacity limits and the interrelationship between enrollments and instructional salaries. A module permitting direct specification of instructional enrollments would solve the first problem, while one that calculated instructional salaries from enrollments would solve the second. It appears that these changes will increase the flexibility of the model without adding significantly to its complexity. Other minor changes could facilitate the use of the model, but none is essential.
In addition to the changes already mentioned, possibilities for further study include:

1) developing enrollment projection and student flow modules for use with LEARN,

2) developing a taxonomy that is suitable for describing jointly sponsored and independent study programs, and

3) using the individual modules of LEARN as elements of models for other systems of adult and part-time education.

Chapter XI is devoted to a discussion of the results of the study. Some of the issues related to the enrollment data and the induced load matrices are discussed in greater detail in Appendix A.
CHAPTER IX
DESCRIPTION OF THE MODEL

General Features of the Model

LEARN is a simple, variable budget\(^1\) model that organizes and displays budget information in two different ways, computing both direct and program budgets. In the direct, or delivery system, budget, all activities — and the enrollments, income and costs associated with them — are grouped into services (e.g., classroom instruction, counseling, and general administration); in the program budget, the income and costs of the services are allocated among the programs, each of which serves a particular group of students classified either by personal characteristics or by educational goals (e.g., by age or degree sought). The model computes costs, income, unit costs, and surpluses or deficits for both the direct and program budgets. Any single run represents one time period.

The model is intended for use with highly aggregated data, that is, for use with broad classifications of client

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1 Variable budget or cost-price-volume-income analysis is the study of the relationship of costs, prices, and volume to net income. Costs and income are divided into fixed and variable components. The term variable budget is also applied to the analysis of the differences between ideal and actual performance. This latter type of study is a device of management control and is not of interest here.
groups and services. Data requirements are minimal and output is concise. All data are entered at the computer terminal and results are returned directly to the terminal. The small size and interactive nature of the model permit the user to experiment with many alternatives and to assess in very general terms the major effects of the changes in plans or circumstances. LEARN does not produce detailed budgets, but merely helps the user decide which alternatives merit more detailed study.

The mathematics of the model are similar to those of other algebraic budget models. There are some differences to allow for the special attributes of part-time education. It should be emphasized that the enrollment estimates are independent (i.e., input) variables in LEARN. Enrollment policies and estimates of enrollment must be derived from trend analyses, market studies, and other sources outside the model. Appendix A describes enrollment studies for one project that used LEARN.

**LEARN, a Model for Continuing Education**

LEARN is a planning tool for part-time education. The model is designed to meet the needs of a particular organization at a particular level of decision making. It is intended to represent the Division of Continuing Education of the University of Massachusetts at Amherst and the decisions made by the head of the agency and those made
at higher levels of the institutional and state educational hierarchies. These include decisions to request or to distribute funds and to set fees, as well as decisions to initiate, modify, or terminate various programs and services.

LEARN permits the user to examine the financial implications of:

-- alternative goals for serving new and existing client groups,

-- alternative means of achieving the goals, and

-- changes in the external environment (e.g., market conditions and levels of subsidy).

For example, it may help the user answer such questions as:

-- What will be the cost of increasing the enrollments in a special bachelor's degree program by 10%? Will the change affect the level of fees required to support the service?

-- What will be the changes in cost of the program if certain changes are made in the instructional and student services offered? Should fees be changed?

-- If changes in the age composition of the client pool cause a shift in enrollments, what changes in services or fees may be desirable?

Like many such agencies, the Division of Continuing Education at the University of Massachusetts emphasizes the
development of programs to serve the ever-changing needs of adult learners. In order to meet the needs and demands of a broad segment of the population, the Division has a wide range of programs and offers learning experiences of several kinds and in several formats. It is heavily dependent on fees.

LEARN was developed with these characteristics in mind. It is designed 1) to facilitate the classification of students by characteristics other than educational goals, 2) to permit the representation of a variety of instructional services, and 3) to permit the use of variable costs and income for support services. It is intended to facilitate the rapid examination of a large number of alternatives.

LEARN can be used to represent the decisions of any educational system, but its usefulness will undoubtedly be greatest for those with clientele and missions similar to those of the University of Massachusetts Division of Continuing Education.

In the remainder of this chapter, the data requirements of the model, its major components, its output, and the computer programs will be discussed. Tables 10 and 11 show a simplified flow chart and a mathematical description of the model. The computer programs, including documentation and instructions for use, are listed in Appendix B. Sample input and output are shown in Appendix C.
TABLE 11. LEARN -------------- VARIABLE AND EQUATIONS

SEE ALSO TABLE 12 FOR A FOLD-OUT SHEET GIVING AN ALPHABETICAL LIST OF VARIABLES

DIMENSIONS: P programs (student groups) - index: i
            C instructional services - index: j
            S support services - index: k
            CC relevant budget categories - index: l
            (e.g., CC for program receipts)
            U relevant budget units - index: m
            (e.g., per credit, per student)

I. INPUT VARIABLES

<table>
<thead>
<tr>
<th>symbol</th>
<th>dimension</th>
<th>description</th>
<th>equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>(P)</td>
<td>total enrollment.</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>(P)</td>
<td>fractional enrollment in each program.</td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>(P)</td>
<td>program enrollment. (user specifies either N &amp; F or PE).</td>
<td>PE = NxF</td>
</tr>
<tr>
<td>FLM</td>
<td>(PxC)</td>
<td>fractional course load matrix: for each program or student group, the percent load in each instructional service.</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>(P)</td>
<td>instructional load vector for a typical student in each group.</td>
<td></td>
</tr>
<tr>
<td>ICLM</td>
<td>(PxC)</td>
<td>induced course load matrix: for a typical student in each group, the load in each instructional service (user specifies either L &amp; FLM or ICLM).</td>
<td>ICLM = LIxFLM, where I is the identity matrix</td>
</tr>
<tr>
<td>DM</td>
<td>(PxS)</td>
<td>induced service load matrix: the use of each support service by a typical student in each group.</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: there is a basic difference in the way the model treats the ICLM and DM: the ICLM is based on a single measure of use (e.g., the credit hour), while the DM may use a different measure for each service (e.g., visits for counseling, credit hours for registration).
TABLE 11 CONTINUED

I. **INPUT VARIABLES** continued

<table>
<thead>
<tr>
<th>symbol</th>
<th>dimension</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDB</td>
<td>(P)</td>
<td>constant base program resource, if any.</td>
</tr>
<tr>
<td>PDR</td>
<td>(P)</td>
<td>base ratio of program resources to program enrollment.</td>
</tr>
<tr>
<td>PDI</td>
<td>(P)</td>
<td>increment ratio of program resource to program enrollment.</td>
</tr>
<tr>
<td>CDB</td>
<td>(C)</td>
<td>ratio variables for instructional services (similar to program variables above).</td>
</tr>
<tr>
<td>CDR</td>
<td>(C)</td>
<td>ratio variables for instructional services (similar to program variables above).</td>
</tr>
<tr>
<td>CDI</td>
<td>(C)</td>
<td></td>
</tr>
<tr>
<td>SDB</td>
<td>(S)</td>
<td></td>
</tr>
<tr>
<td>SDR</td>
<td>(S)</td>
<td></td>
</tr>
<tr>
<td>SDI</td>
<td>(S)</td>
<td></td>
</tr>
</tbody>
</table>

**RATIO VARIABLES**

**INCOME AND COST DATA**

- DPROGINC (PxCxU) program income.
- DPROGCOST (PxCxU) program cost.
- DCORSINC (CxCxU) instructional service income.
- DCORSCOST (CxCxU) instructional service cost.
- DSERVINC (SxCxU) support service income.
- DSERVCOST (SxCxU) support service cost.

1 In the computer programs, ratio variables are contained in the vectors PRATB, PRATI, CRATB, CRATI, SRATB, and SRATI. These vectors also include instructions for the calculations (see resource variables below).

2 Note that CC and U refer to the categories and units for the particular array, for example, program income categories and units for DPROGINC.
### TABLE 11 CONTINUED

#### II. COMPUTED VARIABLES

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimension</th>
<th>Description</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWLM</td>
<td>(PxC)</td>
<td>instructional workload matrix.</td>
<td>CWLM = PE \times I \times ICLM, where I is the identity matrix.</td>
</tr>
<tr>
<td>CE</td>
<td>(C)</td>
<td>enrollment in each instructional service.</td>
<td>CE = ICLM \times PE</td>
</tr>
<tr>
<td>TCE</td>
<td></td>
<td>total instructional enrollment.</td>
<td>TCE = \sum_{j} CE_j</td>
</tr>
<tr>
<td>CPEM</td>
<td>(PxC)</td>
<td>for each instructional group, percent of total use attributable to each program.</td>
<td>CPEM_{ij} = CWLM_{ij} \times CE_j</td>
</tr>
<tr>
<td>SWLM</td>
<td>(PxS)</td>
<td>support service workload matrix.</td>
<td>SWLM = PE \times I \times DM, where I is the identity matrix.</td>
</tr>
<tr>
<td>SE</td>
<td>(S)</td>
<td>use of each support service.</td>
<td>SE = DM \times PE</td>
</tr>
<tr>
<td>SPEM</td>
<td>(PxS)</td>
<td>for each support service, percent of total use attributable to each program.</td>
<td>SPEM_{ik} = SWLM_{ik} \times SE_k</td>
</tr>
<tr>
<td>TL</td>
<td>(P)</td>
<td>total instructional load for each group of students.</td>
<td>TL_{i} = PE_{i} \times L_{i}</td>
</tr>
</tbody>
</table>

#### PRIMARY RESOURCE VARIABLES

1. For each enrollment or use variable (e.g., credits taken, counseling visits), there may be one primary resource variable (e.g., courses given, counselors).
Primary Resource Equations

The equations for computing primary resources from enrollments may be either (a) linear or (b) step functions.

Program Equations - Type (a)

\[ PR_i = PDB_i + (PDR_i \times PEB_i) + PDI_i(PE_i - PEB_i), \]

where PEB is the value of PE in the base case; all other variables are shown elsewhere in these tables.

- Type (b)

\[ PR_i = PDB_i + \text{integer part of } ((PDR_i \times PEB_i) + .5) \]
\[ + \text{integer part of } ((PDI_i(PE_i - PEB_i)) + .5). \]

The equations for CR and SR have the same form.

Any of the variables may equal zero.

DIRECT BUDGET VARIABLES

The variable names used internally in the budget calculations are shown here. See equations below.

<table>
<thead>
<tr>
<th>group</th>
<th>dimension</th>
<th>INCOME</th>
<th>COST</th>
<th>NET</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs</td>
<td>by category (PxCC)</td>
<td>DPIC</td>
<td>DPCC</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>by program (P)</td>
<td>PI</td>
<td>PC</td>
<td>NDP</td>
<td>DPUC</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>TPI</td>
<td>TPC</td>
<td>TNDP</td>
<td>TDPUC</td>
</tr>
<tr>
<td>Inst. services</td>
<td>by category (CxCC)</td>
<td>DCIC</td>
<td>DCCC</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>by inst. service (C)</td>
<td>CI</td>
<td>CC</td>
<td>NDC</td>
<td>DCUC</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>TCI</td>
<td>TCC</td>
<td>TNDC</td>
<td>TDCUC</td>
</tr>
<tr>
<td>supt. services</td>
<td>by category (SxCC)</td>
<td>DSIC</td>
<td>DSCC</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>by supt. service (S)</td>
<td>SI</td>
<td>SC</td>
<td>NDS</td>
<td>DSUC</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>TSI</td>
<td>TSC</td>
<td>TNSD</td>
<td>---</td>
</tr>
<tr>
<td>Grand totals</td>
<td></td>
<td>TOTINC</td>
<td>TOTCOST</td>
<td>GRANDNET</td>
<td>GRANDUNIT</td>
</tr>
</tbody>
</table>
TABLE 11 CONTINUED

II. COMPUTED VARIABLES, continued

PROGRAM BUDGET VARIABLES

The variable names used internally in the budget calculations are shown here. All variables are vectors of length P. See equations below.

<table>
<thead>
<tr>
<th>group</th>
<th>INCOME</th>
<th>COSTS</th>
<th>NET</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Program^1</td>
<td>PI</td>
<td>PC</td>
<td>NDP</td>
<td>DPUC</td>
</tr>
<tr>
<td>Attributable to instructional services</td>
<td>PCI</td>
<td>PCC</td>
<td>NPCB</td>
<td>PCUC</td>
</tr>
<tr>
<td>Attributable to support services</td>
<td>PSI</td>
<td>PSC</td>
<td>NPSB</td>
<td>PSUC</td>
</tr>
<tr>
<td>Total</td>
<td>TPBI</td>
<td>TPBC</td>
<td>NETPB</td>
<td>TPRUB</td>
</tr>
</tbody>
</table>

Budget Equations

Category Budgets

Equation for program income category budget:  
\[ DPIC_i = DPROG\text{INC}_i \times \text{VECTOR} \]

where VECTOR is the vector of enrollments, resources, and constants corresponding to program income units (e.g., number of students for per student income)^2

Equations for the remaining category budgets have the same form.

General Direct Budget

Equations for direct program budget:

\[ PI = \sum_1 \text{DPIC}_i \]
\[ PC = \sum_1 \text{DPCC}_i \]
\[ \text{NPI}_i = \text{PI}_i - \text{PC}_i \]
\[ \text{DPUC}_i = \text{PC}_i / \text{PE}_i \]

Equations for the remaining general direct budget have the same form. Unit costs for instructional services and support services are based on instructional enrollment (CE) and support service use (SE).

---

1 same as for the direct budget.

2 In the LEARN computer programs, VECTOR is constructed using the subroutine \text{RATID} of the program DIRBD. \text{RATID} uses the unit index numbers specified in subroutine \text{TISUBU} to identify the enrollment or resource variable that corresponds to each income or cost unit in the financial input (see program \text{CODELIST} for the code). The value of VECTOR for each calculation is stored in \text{VARL}, a local variable of program DIRBD.
TABLE 11 CONTINUED

II. **COMPUTED VARIABLES**, continued

**Budget Equations**, continued

**Total Direct Budget**

**Equations for programs:**

$$TPI = \sum_{i} PI_i$$

$$TPC = \sum_{i} PC_i$$

$$TNDP = TPI - TPC$$

$$TDPUC = TPC/N$$

**Equations for instructional services and support services are of the same form.**

$$TDUC = TCC/TCE;$$ there is no variable representing total unit costs of services.

**Grand Totals**

$$TOTINC = TPI + TCI + TSI$$

$$TOTCOST = TPC + TCC + TSC$$

$$GRANDNET = TOTINC - TOTCOST$$

$$GRANDUNIT = TOTCOST/N$$

**Program Budget**

**Direct program budget:** same as direct budget for programs.

**Equations for instructional services:**

$$PCI = CPEM \times CI$$

$$PCC = CPEM \times CC$$

$$NPCBi = PCI_i - PCC_i$$

$$PCUCi = PCC_i/PE_i$$

**Equations for support services are of the same form.**

**Total Program Budget**

$$TPBI = PI_i + PCI_i + PSI_i$$

$$TPBC_i = PC_i + PCC_i + PSI_i$$

$$NETPB_i = TPBI_i - TPBC_i$$

$$TPRUB_i = TPBC_i/PE_i$$
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC</td>
<td>Course Cost Vector</td>
</tr>
<tr>
<td>CBD</td>
<td>Base Course Resource</td>
</tr>
<tr>
<td>CDI</td>
<td>Course Resource Increment Vector</td>
</tr>
<tr>
<td>CDR</td>
<td>Course Resource Base Vector</td>
</tr>
<tr>
<td>CE</td>
<td>Course Enrollment</td>
</tr>
<tr>
<td>CPEM</td>
<td>Percent of Course Enrollment from Each Program</td>
</tr>
<tr>
<td>CR</td>
<td>Course Resources</td>
</tr>
<tr>
<td>CRATB</td>
<td>Course Resource Base Equation</td>
</tr>
<tr>
<td>CRATI</td>
<td>Course Resource Increment Equation</td>
</tr>
<tr>
<td>CWLM</td>
<td>Course Workload Matrix</td>
</tr>
<tr>
<td>DCC</td>
<td>Course Costs by Category</td>
</tr>
<tr>
<td>DCIC</td>
<td>Course Income by Category</td>
</tr>
<tr>
<td>DCSCCOST</td>
<td>Course Cost Data</td>
</tr>
<tr>
<td>DCSINC</td>
<td>Course Income Data</td>
</tr>
<tr>
<td>DCUC</td>
<td>Course Unit Cost Vector</td>
</tr>
<tr>
<td>DM</td>
<td>Induced Service Load Matrix</td>
</tr>
<tr>
<td>DPCC</td>
<td>Direct Program Cost by Category</td>
</tr>
<tr>
<td>DPIC</td>
<td>Direct Program Income by Category</td>
</tr>
<tr>
<td>DPROCCOST</td>
<td>Program Cost Data</td>
</tr>
<tr>
<td>DPROCINC</td>
<td>Program Income Data</td>
</tr>
<tr>
<td>DPUC</td>
<td>Direct Program Unit Cost Vector</td>
</tr>
<tr>
<td>DSCC</td>
<td>Service Cost by Category</td>
</tr>
<tr>
<td>DSRVCOST</td>
<td>Service Cost Data</td>
</tr>
<tr>
<td>DSRVIC</td>
<td>Service Income Data</td>
</tr>
<tr>
<td>DSIC</td>
<td>Service Income by Category</td>
</tr>
<tr>
<td>DSUC</td>
<td>Service Unit Cost Vector</td>
</tr>
<tr>
<td>F</td>
<td>Fractional Enrollment in Each Program</td>
</tr>
<tr>
<td>FLM</td>
<td>Fractional Course Load Matrix</td>
</tr>
<tr>
<td>ICLM</td>
<td>Induced Course Load Matrix</td>
</tr>
<tr>
<td>L</td>
<td>Course Load Vector</td>
</tr>
<tr>
<td>N</td>
<td>Total Number of Students</td>
</tr>
<tr>
<td>NDC</td>
<td>Net Course Cost Vector</td>
</tr>
<tr>
<td>NDP</td>
<td>Net Direct Program Income Vector</td>
</tr>
<tr>
<td>NDS</td>
<td>Net Service Income Vector</td>
</tr>
<tr>
<td>NETPB</td>
<td>Net Program Income</td>
</tr>
<tr>
<td>NPCB</td>
<td>Net Course Income by Program</td>
</tr>
<tr>
<td>NPSB</td>
<td>Net Service Income by Program</td>
</tr>
<tr>
<td>PC</td>
<td>Direct Program Cost Vector</td>
</tr>
<tr>
<td>PCC</td>
<td>Course Cost by Program</td>
</tr>
<tr>
<td>PCI</td>
<td>Course Income by Program</td>
</tr>
<tr>
<td>PCUC</td>
<td>Course Unit Cost by Program</td>
</tr>
<tr>
<td>PDB</td>
<td>Base Program Resource</td>
</tr>
<tr>
<td>PDI</td>
<td>Program Resource Increment Ratio</td>
</tr>
<tr>
<td>PDR</td>
<td>Program Resource Base Ratio</td>
</tr>
<tr>
<td>PE</td>
<td>Program Enrollment Vector</td>
</tr>
<tr>
<td>PI</td>
<td>Direct Program Income Vector</td>
</tr>
<tr>
<td>PR</td>
<td>Program Resources</td>
</tr>
<tr>
<td>PRATB</td>
<td>Program Resource Base Equation</td>
</tr>
<tr>
<td>PRATI</td>
<td>Program Resource Increment Equation</td>
</tr>
<tr>
<td>PSC</td>
<td>Service Cost by Program</td>
</tr>
<tr>
<td>PSI</td>
<td>Service Income by Program</td>
</tr>
<tr>
<td>PSUC</td>
<td>Service Unit Cost by Program</td>
</tr>
<tr>
<td>SC</td>
<td>Service Cost Vector</td>
</tr>
<tr>
<td>SDB</td>
<td>Base Service Resource</td>
</tr>
<tr>
<td>SDI</td>
<td>Service Resource Increment Ratio</td>
</tr>
<tr>
<td>SDR</td>
<td>Service Resource Base Ratio</td>
</tr>
<tr>
<td>SE</td>
<td>Service Enrollment Vector</td>
</tr>
<tr>
<td>SI</td>
<td>Service Income Vector</td>
</tr>
<tr>
<td>SPEM</td>
<td>Percent of Service Use from Each Program</td>
</tr>
<tr>
<td>SWLM</td>
<td>Service Workload Matrix</td>
</tr>
<tr>
<td>TCC</td>
<td>Total Course Cost</td>
</tr>
<tr>
<td>TCE</td>
<td>Total Course Enrollment</td>
</tr>
<tr>
<td>TCI</td>
<td>Total Course Income</td>
</tr>
<tr>
<td>TCR</td>
<td>Total Course Resources</td>
</tr>
<tr>
<td>TDCUC</td>
<td>Total Course Unit Cost</td>
</tr>
<tr>
<td>TDPUC</td>
<td>Total Direct Program Unit Cost</td>
</tr>
<tr>
<td>TL</td>
<td>Total Instructional Load Vector</td>
</tr>
<tr>
<td>TNDP</td>
<td>Total Net Direct Program Income</td>
</tr>
<tr>
<td>TND5</td>
<td>Total Net Service Income</td>
</tr>
<tr>
<td>TPBC</td>
<td>Total Program Cost</td>
</tr>
<tr>
<td>TPBI</td>
<td>Total Program Income</td>
</tr>
<tr>
<td>TPC</td>
<td>Total Direct Program Cost</td>
</tr>
<tr>
<td>TPI</td>
<td>Total Direct Program Income</td>
</tr>
<tr>
<td>TPR</td>
<td>Total Program Resources</td>
</tr>
<tr>
<td>TPRUB</td>
<td>Total Program Unit Costs</td>
</tr>
<tr>
<td>TSC</td>
<td>Total Service Cost</td>
</tr>
<tr>
<td>TSI</td>
<td>Total Service Income</td>
</tr>
</tbody>
</table>
Data Requirements

The following data are required for the model:

-- program enrollments,

-- instructional and service load matrices (i.e.,
utilization rates of instructional and other services by the
students in the various programs),

-- formulas and ratios for computing primary resource
requirements (e.g., number of courses taught, counseling
hours used),

-- fixed and variable income by category and program or
service (e.g., flat grant for evening courses, course fees
per credit),

-- fixed and variable costs by category or service
(e.g., registration mailing costs per student, instructional
salaries per course).

The input variables are listed in Table 11. Appendix C
shows a terminal session with simplified data.

Although data on income, costs, and program enrollment
need no explanation beyond that provided in the variable
list and examples, the induced load matrices and resource
formulas require some additional comment.
Induced Load Matrices

An induced load matrix is simply a table giving the impact in a typical student in each category upon each service. The elements of the matrix can be expressed either in terms of the actual use or in fractional terms. For example, one element of the induced course load matrix of a traditional university might be the number of credit hours per semester taken in physics by a typical upper division electrical engineering major; the same information might be expressed as the fraction of the student's total load taken in physics.

LEARN uses induced load matrices of two types:

-- an induced instructional load matrix, the ICLM
-- an induced support service load matrix, the DM.

The first of these matrices is similar to the induced load matrix in the example above. However, the matrix is not limited to descriptions of programs of study and course enrollments, but may be used to describe students and instruction in any way that suits the purpose of the analysis (for example, the preference of men versus those of women for different types of hobby courses, measured in student class hours). In LEARN, all elements of the instructional load matrix must use the same unit of measure (e.g., student credit hours, continuing education units, or number of classes). For this reason, a series of runs is
required to represent a system whose instructional services must be measured using more than one kind of unit.

The induced service load matrix shows the impact of a typical student of each type upon each support service (the probability of using the counseling service, for example). The matrix is used in the computation of the budgets of those services whose income or costs vary with program enrollment. A different unit of measure may be used for each service (e.g., credit hours for registration and students for administration).

It is not always necessary to use the load matrices to describe systems of adult and continuing education. Where this feature of the model is not needed, the user may group all students into a single category; the matrices are then reduced to vectors that give a typical student's use of each service. Examples of induced load matrices are shown in the tables at the end of Chapter X and in Appendix C, Section 2.

Formulas for Computing Primary Resource Requirements

Primary resource requirements are usually defined in terms related to staff requirements (for example, number of courses taught or number of counseling hours). LEARN provides a limited choice of formulas for computing these requirements from enrollments and service use. The equations may be either linear or step functions and may include a fixed base amount, a base ratio, and an increment
ratio.

The model provides for the definition of one primary resource for programs, one for instructional services, and one for each support service. It is not necessary to define all the possible primary resources. Where the resources are defined, a separate formula is specified for each individual service. The formulas are shown in Table 11.

Where a service requires more than one resource, secondary resources must be defined in the financial module with the cost data. Secondary resources are measured directly in dollars and may be constant or may vary with program enrollments, instructional enrollments, service use, or primary resource requirements.

The Major Components of the Model: Output of the Model

LEARN is a modular model with four major parts. These compute 1) enrollments, 2) primary resource requirements, 3) the direct budget, and 4) the program budget. The modules are used in succession, so that it is possible to conduct a partial study without undertaking a complete budget analysis. The modules will now be described briefly.

1 This simply means that, for example, class sizes may vary.

2 Alternatively, dummy services may be defined.
The best way to understand them is to follow through the equations in Table 11 and the examples in Appendix C. These tables also show the output of the model.

**Enrollments** In the first segment of the model, instructional enrollments and the use of other services (e.g., the number of visits to counselors) are computed directly from the program enrollments and induced load matrices. If program categories are not used, the calculations are based on total enrollment and the load vectors.

**Primary Resource Requirements**

The resource module computes the primary resource requirement associated with each program and service from the formulas specified by the user (Table 11). The computations are, of course, omitted in all cases where primary resources have not been defined.

**The Budget Modules**

The calculations of both the direct and program budgets are simple and direct. The direct budget module is made up of a series of linear equations. The computation of the budget for each income and cost category is of the form: $a_0 + a_1 u_1 + a_2 u_2 + \ldots$, where $a_i$ is a unit of income or cost and $u_i$ is an enrollment, service use, or primary resource requirement. The total budget for each service and the grand total budget are computed from the category budgets. The category and direct budgets include any direct income or cost associated with programs; for this purpose only, each
program is treated like a service.

In the program budget, income and costs are allocated to each program on the basis of the fractional use of each service by each group of students. The result is a table giving the income, cost, net income, and unit cost for each program and for each program's share of each service.

Using the Model.

The normal method of using LEARN is first, to construct a base case that represents the system as a whole or part of it and that approximates current conditions or a particular plan for the future, and then, to represent modifications of the system using repeated runs of the model. Repeated runs of LEARN may be used directly to analyze the effects of various changes in plans or circumstances; values of any variable can be changed, and programs may be added or dropped. Repeated runs may also be used for sensitivity analysis. This last topic requires further discussion.

Sensitivity analysis is the testing of the importance of individual variables. Such analysis can be used to help: 1) determine the suitability of the model for a particular analysis, 2) uncover feasible solutions, and 3) choose among feasible solutions.

1 The term is sometimes applied more narrowly to the study of errors of estimation.
The model can be tested for its suitability in representing a given situation by running a series of tests and varying the values of the variables within the range of uncertainty. If the results are overly sensitive to small changes in estimates and better data cannot be obtained, the model may not be useful for the particular application.

If the model appears to be suitable, but repeated trials do not uncover solutions to the problems at hand, a systematic study of the effects of the individual variables may help uncover improved solutions.

Sensitivity analysis may help the decision maker to choose among alternatives that appear to be acceptable. By learning which variables are important and which are relatively unimportant the decision maker may be able to reduce risks and to choose alternatives that satisfy goals not represented in the model. For example, if net income is extremely sensitive to enrollment changes, it may be necessary to raise fees to guard against losses, and if net income is not sensitive to the type of instruction, the type thought to be best suited to the students' needs can be chosen.

The use of the model is discussed at length in Chapters X and XI.
The Computer Programs

LEARN has been programmed for the computer using the APL programming language. APL was chosen because of the convenience to the programmer, especially in designing small, interactive models. While LEARN is intended for use by persons who do not know APL, a knowledge of the language gives the user additional flexibility in entering and modifying data.

The programs have been designed for ease in entering and modifying data. Many prompts and error messages are provided. Modifying data is especially easy. Subroutines provide for adding and dropping items (e.g., programs, services, cost units), changing the name of any item, modifying the primary resource equations, and changing the value of any variable. Percent changes can be specified for income and cost variables and for total enrollment. Once a change is specified, LEARN adjusts dimensions and values internally, except that, for two types of change, adjustments must be made by the user: the user must enter the appropriate new data if new items (such as programs or types of cost units) have been added, and the user must correct the fractional load matrix and fractional enrollment vector if either has been affected by the deletion of a program or service.
User documentation and program listings are to be found in Appendix B.

The Model LEARN: A Summary

The major characteristics of the model can be summarized by saying that LEARN is a small variable budget model that computes both direct and program budgets. The model represents one period of time in each run, it is interactive, it is modular, and it is designed for use by systems that depend on variable income and that offer a wide and changing variety of educational programs for adults.
CHAPTER X

TESTING THE MODEL AND DEMONSTRATING ITS USE

The testing of LEARN will be described in this chapter as will the preparation of data for the model and two sets of demonstration runs. Conclusions drawn from the tests will be reported in the next chapter.

The Tests Required

LEARN was tested at three levels by:

1) verifying the model, i.e., checking the correctness of the mathematics and computer programming;

2) checking the accuracy of the model's representation of an actual system and the plausibility of its estimates of the effects of changes in the input variables;

3) studying the practicality of the model by examining its behavior when provided with the kind of data that is likely to be available for institutional research.

The following tests were conducted:

1) simulated data were used to verify the model as it was being built;

2) actual data representing the on-campus programs of the Division of Continuing Education, University of Massachusetts were used to test the accuracy of the model;

3) the same actual data were used to assess the strengths and weaknesses of the model as a planning tool.
In addition to their use in testing the model, the simulated and actual data were used to demonstrate the types of analysis that can be undertaken with LEARN. Tables 13 through 22 illustrate possible applications of the model.

**Verifying the Model and Testing Its Accuracy**

Verifying the model and testing its accuracy were essentially trivial tasks. Constructing a model that computes budgets from estimates of enrollments and fixed and variable income and costs is straightforward and presents little possibility of error, except for mistakes in algebra and programming. Once such errors have been eliminated, a model like LEARN can be expected to compute budgets correctly as long as correct data are provided.

To verify the model, runs with the dummy data were checked by hand to test the algebra and programming the model. The final test runs were correct. A complete demonstration run is shown in Appendix C.

The accuracy of the model and its sensitivity to changes in the individual variables were tested using runs representing the on-campus programs of the University of Massachusetts Division of Continuing Education. The results are shown in detail later in the chapter (Tables 19 through 22). Briefly, it was not possible to check the model against an actual budget of the Division because some of the necessary information was unavailable. Nonetheless, there
is every indication that the model represents the system reasonably well and that the output could be brought into conformity with actual budgets with very little additional information about non-salary expenditures and the allocation of costs. The differences between the model budget and actual budgets should not affect the application of the model.¹

Evaluating the Model as a Planning Tool

The assessment of the model's strengths and weaknesses as a planning tool is the most important test of LEARN. It will be recalled that the fundamental thesis behind the development of LEARN was that a small, simple, variable budget model that uses highly aggregated data and that produces both direct and program budgets could help decision makers answer questions about possible alternative plans and circumstances. It was postulated that such a model would have the following advantages over a larger and more complex one.

1) The highly aggregated representations of enrollment would be stable over time.

2) The data could be gathered relatively easily.

¹ This is because the missing data represent relatively fixed costs; although the absolute values of the budget estimates may be in error, the relationship between the various alternatives should be represented correctly.
3) The model would be easy to understand and easy to use. Since the model has not been used by decision makers, it is not possible to reach definite conclusions about its usefulness. However, the processes of assembling the data and making the demonstration runs did yield indications of the strengths and weaknesses of LEARN.

**Demonstration Runs of the Model**

The remainder of the chapter will be devoted to the two sets of demonstration runs of LEARN. Tables 13 through 18 summarize the input and output of the runs that used dummy data, and Tables 19 through 22 summarize the input and output of the runs representing programs of the Division of Continuing Education. The tables show the results of the tests and also illustrate possible uses of the model. The final section of the chapter describes the gathering and preparation of the data to represent the on-campus Division programs. The results of the tests will be discussed in Chapter XI.

**Mini-extension: A Demonstration of the Model LEARN**

**Using Dummy Data**

The testing and demonstration of LEARN with dummy data are based on an imaginary case study of a fictional institution called Mini-Extension. Mini-Extension is
described in this section, and the input and output of the
model for a base case and several alternatives are
summarized. Complete tables of input and output for the
base case are shown in Appendix C, Section II. Sample
terminal sessions for the base case and two alternatives are
shown in Appendix C, Sections I and III.

Description of Mini-Extension

Mini-Extension is a division of Small University. Its
credit division serves four groups of students:
1) nurses seeking professional bachelors’ degrees,
2) policemen and firemen seeking professional
bachelors’ degrees;
3) other students seeking a variety of bachelors’
degrees, and
4) general students not currently enrolled in degree
programs.
The credit division offers three kinds of instruction:
regular university courses, correspondence classes, and
evening classes. Any student who registers through the
division may enroll in regular classes at Small University
on a space available basis. The correspondence courses and
evening classes are organized and operated by the extension

1 NOTE: THE "DATA" AND ANALYSES SHOWN HERE FOR
MINI-EXTENSION ARE ENTIRELY IMAGINARY AND ARE NOT INTENDED
TO ILLUSTRATE REALISTIC ENROLLMENTS, INCOME, OR COSTS FOR
ANY ADULT, PART-TIME EDUCATIONAL PROGRAM.
division.

The credit program receives income from a number of sources. There are program fees, registration fees, and credit fees, program grants from outside agencies, and in-kind grants from Small University. The credit fee is the same for all instruction, but the division keeps only a portion of the regular class fee; the remainder is passed through to the university.

The division is expected to break even each semester. As a matter of policy, both surpluses and deficits are frowned upon; surpluses are considered inappropriate for public agencies, and deficits are prohibited by state statute.

In planning for the coming year, the director of the credit division must consider the effects of several possible changes, including increases or decreases in enrollment caused by variations in demand, a reduction in class size, the addition of classes in a nearby city, and the elimination of the nursing program. Using LEARN, the following cases are considered:

1) a base case assuming no changes in policy or conditions;
2 and 3) an overall enrollment increase and decrease of 10%;
4) a decrease in class size of 5%;
5) the addition of off-campus extension classes causing
### TABLE 13. MINI-EXTENSION, THE BASE CASE

For computer printout showing sample terminal sessions and input tables, see Appendix C.

#### Summary of Input

Number of students: \( N = 200 \)

<table>
<thead>
<tr>
<th>Program enrollment, PE</th>
<th>nursing</th>
<th>police-fire</th>
<th>other deg</th>
<th>general</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ext.</td>
<td>corres.</td>
<td>reg.</td>
<td></td>
</tr>
<tr>
<td>Induced course load matrix</td>
<td>Nursing</td>
<td>2.4</td>
<td>---</td>
<td>.6</td>
</tr>
<tr>
<td>enrollment (student-credit hours) in each instruct</td>
<td>Police-fire</td>
<td>4.2</td>
<td>.6</td>
<td>1.2</td>
</tr>
<tr>
<td>group by a typical student of each kind</td>
<td>Other degree</td>
<td>1.8</td>
<td>.9</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>1.5</td>
<td>1.2</td>
<td>3.1</td>
</tr>
</tbody>
</table>

#### DM

<table>
<thead>
<tr>
<th>Induced service load matrix</th>
<th>Nursing</th>
<th>(visits) .5</th>
<th>(cr. taken) 3</th>
<th>gen admin. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>relative use of services by typical students of each kind</td>
<td>Police-fire</td>
<td>.6</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Other degree</td>
<td>.7</td>
<td>9</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>.1</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

See Appendix C for ratio formulas and financial input.

#### Summary of Output

### Enrollments and Resources

#### Instructional Services

<table>
<thead>
<tr>
<th>enrollment (cr. taken)</th>
<th>resources (cr. taught)</th>
</tr>
</thead>
<tbody>
<tr>
<td>extension</td>
<td>414</td>
</tr>
<tr>
<td>corresp.</td>
<td>183</td>
</tr>
<tr>
<td>reg. class.</td>
<td>393</td>
</tr>
</tbody>
</table>

#### Support Services

<table>
<thead>
<tr>
<th>enrollment</th>
<th>resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>couns.</td>
<td>73 visits</td>
</tr>
<tr>
<td>regis.</td>
<td>990 cr. tk.</td>
</tr>
<tr>
<td>gen. adm.</td>
<td>200 students</td>
</tr>
</tbody>
</table>

### BUDGETS

<table>
<thead>
<tr>
<th>INCOME</th>
<th>COST</th>
<th>NET</th>
<th>COST PER STUDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursing</td>
<td>5674</td>
<td>3835</td>
<td>1839</td>
</tr>
<tr>
<td>Police-Fire</td>
<td>10947</td>
<td>10982</td>
<td>-35</td>
</tr>
<tr>
<td>Other Degree</td>
<td>10131</td>
<td>9689</td>
<td>441</td>
</tr>
<tr>
<td>General</td>
<td>13060</td>
<td>15160</td>
<td>-2100</td>
</tr>
<tr>
<td>TOTAL</td>
<td>39811</td>
<td>39666</td>
<td>145</td>
</tr>
</tbody>
</table>

### Comment

If policies and enrollment are constant, the division will continue to break even.
**TABLE 14**  
MINI-EXTENSION, 10% ENROLLMENT INCREASE

Summary of Input

N = 220

<table>
<thead>
<tr>
<th></th>
<th>nursing</th>
<th>police-fire</th>
<th>other</th>
<th>degree</th>
<th>general</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>22</td>
<td>33</td>
<td>55</td>
<td>110</td>
<td></td>
</tr>
</tbody>
</table>

ICLM, DM, ratio formulas, income and cost data — same as base case.

Summary of Output

Enrollments and Resources

<table>
<thead>
<tr>
<th>Instructional Services</th>
<th>Support Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>enrollment (cr. taken)</td>
<td>resources (cr. taught)</td>
</tr>
<tr>
<td>extension</td>
<td>455</td>
</tr>
<tr>
<td>corresp.</td>
<td>201</td>
</tr>
<tr>
<td>reg. classes</td>
<td>432</td>
</tr>
</tbody>
</table>

Total Budget

<table>
<thead>
<tr>
<th>Total Budget</th>
<th>INCOME</th>
<th>COST</th>
<th>NET</th>
<th>COST PER STUDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>42842</td>
<td>40988</td>
<td>1853</td>
<td>186</td>
</tr>
</tbody>
</table>

For Comment and Footnote, see Table 15.
TABLE 15. MINI-EXTENSION, 10% ENROLLMENT DECREASE

Summary of Input

N = 180

<table>
<thead>
<tr>
<th>nursing</th>
<th>police-fire</th>
<th>other</th>
<th>degree</th>
<th>general</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>18</td>
<td>27</td>
<td>45</td>
<td>90</td>
</tr>
</tbody>
</table>

ICLM, DM, ratio formulas, income and cost data -- same as base case.

Summary of Output

Enrollments and Resources

<table>
<thead>
<tr>
<th>Instructional Services</th>
<th>Support Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>enrollment</td>
<td>enrollment</td>
</tr>
<tr>
<td>(cr. taken)</td>
<td>(cr. taught)</td>
</tr>
<tr>
<td>extension</td>
<td>extension</td>
</tr>
<tr>
<td>corresp.</td>
<td>corresp.</td>
</tr>
<tr>
<td>reg. classes</td>
<td>reg. classes</td>
</tr>
<tr>
<td>373</td>
<td>165</td>
</tr>
<tr>
<td>24</td>
<td>165</td>
</tr>
<tr>
<td>354</td>
<td>354</td>
</tr>
<tr>
<td>couns.</td>
<td>regis.</td>
</tr>
<tr>
<td>65 visits</td>
<td>891 cr. taken</td>
</tr>
<tr>
<td>1 counselor</td>
<td>29 man-hrs.</td>
</tr>
<tr>
<td>gen. adm.</td>
<td>180 students</td>
</tr>
</tbody>
</table>

Total Budget

<table>
<thead>
<tr>
<th>INCOME</th>
<th>COST</th>
<th>NET</th>
<th>COST PER STUDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>36780</td>
<td>38344</td>
<td>-1564</td>
<td>213</td>
</tr>
</tbody>
</table>

Comment

A 10% increase in enrollment will cause a substantial surplus, and a 10% decrease will cause the opposite. This result is to be expected, since the ratio formulas have been set to reflect the historical fact that changes in the number of extension classes lag behind changes in enrollments. (See the base and increment rates in the ratio formulas, Appendix C.)

1 User may specify the percent change in enrollment; LEARN will compute the new N and PE.
TABLE 16. MINI-EXTENSION, 5% DECREASE IN THE SIZE OF EXTENSION CLASSES

Note: The 5% change affects only the base ratio.

Summary of Input

Enrollment, income, and cost data — same as base case.

Ratio Formulas for Computing Number of Extension Credits

Type of formula — step
base number of classes = 0
base ratio = .063
increment ratio = .03

Other Ratio Formulas — same as base case.

Summary of Output

<table>
<thead>
<tr>
<th>Instructional Resources (compared to base case)</th>
<th>Number of extension credits taught</th>
<th>cost of extension classes</th>
<th>Net from extension classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>base case</td>
<td>25</td>
<td>13236</td>
<td>1254</td>
</tr>
<tr>
<td>5% decrease in class size</td>
<td>26</td>
<td>13671</td>
<td>819</td>
</tr>
</tbody>
</table>

Total Budget

<table>
<thead>
<tr>
<th>INCOME</th>
<th>COST</th>
<th>NET</th>
<th>COST PER STUDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Budget</td>
<td>39811</td>
<td>40101</td>
<td>-290</td>
</tr>
</tbody>
</table>

COMMENT

Reducing class size by 5% causes a small deficit, but the extension classes continue to break even.
### Summary of Input

N = 220

<table>
<thead>
<tr>
<th></th>
<th>nursing</th>
<th>pol-fire</th>
<th>oth deg</th>
<th>general</th>
<th>off-campus general</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PE</strong></td>
<td>20</td>
<td>35</td>
<td>50</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td><strong>ICLM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nursing</td>
<td>2.4</td>
<td>---</td>
<td>.6</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>pol-fire</td>
<td>3.6</td>
<td>.6</td>
<td>.9</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>oth deg</td>
<td>1.8</td>
<td>.9</td>
<td>5.85</td>
<td>.45</td>
<td></td>
</tr>
<tr>
<td>general</td>
<td>1.5</td>
<td>1.2</td>
<td>.3</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>off c gen</td>
<td>---</td>
<td>---</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nursing</td>
<td>.5</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pol-fire</td>
<td>.6</td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oth deg</td>
<td>.7</td>
<td>9</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>general</td>
<td>.1</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>off c gen</td>
<td>.01</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Income and Cost Input** (in addition to base case input)
- off-campus income: $35/credit
- off-campus cost: $360/credit taught for instructional salaries
- 500 for administration, 100 for mailing, 50 for advertising.

**Ratio formulas for off-campus classes**
- Type of Formula: step
- base number of classes: 0
- base ratio: 0.08
- increment ratio: 0.04

**Other Ratio Formulas** — same as base case

Table 17 continued next page
TABLE 17 CONTINUED

Summary of Output

<table>
<thead>
<tr>
<th>Instructional Services</th>
<th>Support Services</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>enrollment (cr. taken)</td>
</tr>
<tr>
<td>extension</td>
<td>414</td>
</tr>
<tr>
<td>corres.</td>
<td>186</td>
</tr>
<tr>
<td>reg. classes</td>
<td>366</td>
</tr>
<tr>
<td>off-campus</td>
<td>99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
</tr>
<tr>
<td>Nursing</td>
</tr>
<tr>
<td>Police-Fire</td>
</tr>
<tr>
<td>Other degree</td>
</tr>
<tr>
<td>General</td>
</tr>
<tr>
<td>Off-campus general</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Comment

The $400 deficit attributable to the new off-campus general students is more than offset by the gains attributable to changes in the police and fire enrollments.
TABLE 18. MINI-EXTENSION, DROPPING THE NURSING PROGRAM

Summary of Input

N = 180

PE, ICLM, DM, ratio formulas, financial data - same as base case, except that nursing is eliminated and all nursing students dropped.

Summary of Output

<table>
<thead>
<tr>
<th>Instructional Services</th>
<th>Support Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>enrollment (cr. taken)</td>
<td>resources (cr. taught)</td>
</tr>
<tr>
<td>extension</td>
<td>366</td>
</tr>
<tr>
<td>corres.</td>
<td>183</td>
</tr>
<tr>
<td>reg. classes</td>
<td>381</td>
</tr>
</tbody>
</table>

Budget

<table>
<thead>
<tr>
<th></th>
<th>INCOME</th>
<th>COST</th>
<th>NET</th>
<th>COST PER STUDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>police-fire</td>
<td>11055</td>
<td>11290</td>
<td>-235</td>
<td>376</td>
</tr>
<tr>
<td>other degree</td>
<td>10311</td>
<td>10109</td>
<td>201</td>
<td>202</td>
</tr>
<tr>
<td>general</td>
<td>13421</td>
<td>15835</td>
<td>-2414</td>
<td>158</td>
</tr>
<tr>
<td>Total</td>
<td>34787</td>
<td>37234</td>
<td>-2447</td>
<td>207</td>
</tr>
</tbody>
</table>

Comment

The combined effect of decreasing enrollment by 10% and dropping a program that has a substantial income would be a substantial deficit. Such a change would not be made unless a major shift in demand were anticipated or the action were mandated by a superior agency.

---

1 The user instructs LEARN to delete the nursing program; the new ICLM (or FLM) and new PE (or F) must be entered by the user. All other adjustments are made automatically.
twenty additional students to enroll in Mini-Extension. The
fifteen students who do not enter one of the degree programs
are grouped into a new program since they represent a new
population group.

6) the elimination of the nursing program and dropping
of all students enrolled.
Each case is analyzed separately. The results are
summarized in Tables 13 through 18.

As a result of the preliminary studies, the
administrator decides to explore the following possibility:
increasing fees to offset an expected 5% enrollment decline
while adding the off-campus classes. It is likely that
several additional runs of LEARN will be necessary before
the administrator will be ready to prepare a budget proposal
for the Dean of Continuing Education.

On-Campus Credit Programs of the
Division of Continuing Education: A Test and
Demonstration of the Model LEARN Using Actual Data

The second set of tests for the model was based on a study of
the on-campus credit programs of the University of
Massachusetts Division of Continuing Education. These
programs will now be described and the input and output of
the model for a base case and several alternatives
summarized.
Description of the University of Massachusetts Division of Continuing Education

The Division of Continuing Education, University of Massachusetts at Amherst offers a variety of credit and noncredit learning experiences. Its largest and oldest division, the Evening College, now provides students with the opportunity to earn credit at Amherst in the fall and spring semesters. The Evening College also offers off-campus courses and operates summer and winter sessions; the composition of the student body and the mix of courses in the off-campus programs and in the summer and winter sessions are quite different from those of the regular term, on-campus sessions. Only the latter group is represented in the test and demonstration of LEARN.

The Students. The composition of the Evening College student body has been about the same for a number of years. The majority of the students are under twenty-five, are seeking bachelors' degrees, and register


1 See Appendix A for more detailed information about the students, instructional services, and support services and for references to the sources of data.

2 From this point on, all statistics refer to the on-campus, regular semester offerings. The term Evening College is used to refer to this group. Within the Division, the term sometimes refers to the on-campus, Division-sponsored courses only.
with the Division for a single semester.

- 80% of the students are under thirty years of age;
55% are under twenty-five;
- 50% or more are seeking a bachelor's degree;
- 60% register for only one semester.

As might be expected, the students' behavior is strongly correlated with their age. Younger students are more likely than older students to take lower-division courses, to take day classes, and to take courses in mathematics and science. They are less likely to take professional courses or to use the counseling service. The students' choice of courses and use of counseling services are also correlated with their educational goals and enrollment history. The behavior of the various age groups has been relatively stable over time. Statistics by age, degree intentions, and enrollment history are shown in Appendix A.

The Division offers three kinds of opportunity for on-campus instruction: 1) registration in regular day classes of the University on a space-available basis, 2) independent study, and 3) evening courses sponsored by the Division. Most of the Continuing Education courses are lower-division. By far the largest portion is in Social Sciences and Humanities and Fine Arts. The Business School and The School of Natural Science and Mathematics are the only other schools represented by more than a handful of
The distribution of on-campus courses has been relatively stable for a number of years. There have been some changes, most notably shifts away from education and to business. On occasion, the Division has offered a block of upper-division courses in a particular discipline in an effort to provide better opportunities for students who wish to obtain a degree through part-time study; interest has not been sufficient to sustain the programs past one or two semesters. Statistics on course enrollments are shown in Appendix A.

**Enrollments and Class Size.** The enrollment in the Division’s evening classes is subject to several kinds of variation. There have been: 1) somewhat higher enrollments in the fall than in the spring, 2) a long-term decline as students have shifted to day classes, and 3) occasional sharp drops or rises between one term and the next. Only the sudden shifts have affected class size, and the effects have been transitory: In the short run, the change in the number of classes has been proportionally less than that in registrations. However, the number of classes has usually been adjusted the semester following the enrollment change, so that class size has remained relatively constant over the long term.
Support Services. The support services of the Division of Continuing Education include registration, counseling, evening college administration, other program administration, program development, public relations, publications (including preparation of the evening college catalog), a secretarial pool, a business office, and general administration. Much of the work of the support services is directly or indirectly attributable to the Evening College, if only because the Evening College is by far the largest program of the Division.

The offices of evening college administration, registration, and counseling serve the credit programs almost exclusively. They work with the off-campus, summer, and winter programs as well as those on campus in the regular sessions. The staffing of the registrar's office varies somewhat with enrollment; the office makes heavy use of temporary help because its work load varies over the course of the semester. The staffing of the other two offices has not varied with enrollment in recent semesters.

Income of the Division. The income of the Evening College comes primarily from student fees. The Division of

1 The organization of the Division, the services it provides, and the importance of the various activities have all changed over time. However, the basic core of activities serving the on-campus credit programs has been relatively constant.
Continuing Education has received a number of grants, but these have been for special purposes rather than for regular on-campus programs. The University provides a number of in-kind services to the Division. These include rent-free classroom and office space, the director's salary, and other, lesser items. The in-kind services are not included in the Division's budgeting and accounting systems.

The major source of income is the $35 credit fee. There are also a $10 registration fee, such special charges as late fees and change-of-course fees, and a number of optional fees passed through to the University for items ranging from an identification card to health care.

**Instructional Salaries.** The Division has a salary schedule that depends on type of instructor (a lower rate for graduate students than for others) and enrollment (proportional to enrollment up to a class size of seventeen and fixed above that number). If enrollment falls below the cut-off point, the instructor has the option of accepting the lower pay or declining to teach the course, in which case it is cancelled.

**Supply and Demand for Courses.** Although the Division solicits offers to teach courses where demand is high and discourages them where demand is low, it can provide students with the opportunity to enroll in a course or an independent study program only if it can be made available, a factor that lies largely outside the control of the
Division: enrollment in day classes is on a space-available basis, an independent study program can be arranged only if the student can find an instructor willing to participate, and an evening class is offered only if a qualified instructor is willing to teach an approved course¹ and if enrollment is sufficient.

Course offerings are a function of outside factors in another way. The Division lists courses in the catalog at the request of instructors if the University's standards are met, regardless of whether demand warrants the offering. As a result, in areas of low demand there is often an excess of courses, the number of cancelled courses is high, and the enrollment in those actually taught is low.

Relationship of Costs to Supply and Demand. The combined effect of the Division's instructional salary schedule and its dependence on others for course offerings is that both enrollments and costs are functions of both the supply and demand for courses. The following two examples illustrate the situation.

At present, the demand for business courses is high. The Business School is operating at capacity and can offer very limited help to the Division of Continuing Education. There are almost no opportunities for part-time students to

¹ In general, all credit courses and instructors must be approved by the appropriate faculty.
enroll in day classes. Although the Business School does make an effort to provide a range of business courses through the Evening College, most are taught by graduate students since the faculty have little time for this activity. The result is that 1) enrollment in business courses is limited by capacity, and 2) unit costs are low because classes are large and instructional salaries low.

In contrast to the case of the Business School, the demand for humanities courses is quite low, both in the day and the evening. Part-time students have the opportunity to take a wide variety of humanities courses during the day and, since many faculty members are eager to teach evening classes, more evening classes are offered than are needed. As a result: 1) enrollment in humanities classes is determined by demand and 2) unit costs are high because classes are small and salaries high.

Studying the On-Campus Credit Programs Using LEARN

LEARN has been used to model a base case and several alternatives representing the Division’s on-campus credit offerings for the Fall 1979 semester. The following cases were examined:

1 NOTE: THESE EXAMPLES ARE MERELY EXERCISES TO TEST AND DEMONSTRATE THE BEHAVIOR OF THE MODEL. THEY DO NOT REPRESENT PRACTICAL APPLICATIONS OF LEARN IN TERMS OF THE ACTUAL POLICIES THAT WERE IN EFFECT AT THE TIME OR IN TERMS OF THE KIND OF DETAILED EXPLORATION OF INDIVIDUAL ALTERNATIVES THAT WOULD BE NECESSARY FOR DECISION MAKING.
TABLE 19. UNIVERSITY OF MASSACHUSETTS EVENING COLLEGE  
FALL 1979  
THE BASE CASE INPUT

<table>
<thead>
<tr>
<th>FINANCIAL INPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instructional Services Income</strong> per student credit-hour</td>
</tr>
<tr>
<td>university day classes</td>
</tr>
<tr>
<td>all other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Instructional Services Cost</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evening Classes</strong></td>
</tr>
<tr>
<td><strong>Lower Division</strong></td>
</tr>
<tr>
<td>Liberal arts</td>
</tr>
<tr>
<td>per cr. taught</td>
</tr>
<tr>
<td>salaries:</td>
</tr>
<tr>
<td>other:</td>
</tr>
<tr>
<td>fixed:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Independent study</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>All upper division</td>
</tr>
<tr>
<td>300</td>
</tr>
<tr>
<td>23</td>
</tr>
<tr>
<td>2.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Support Services Income</strong> - registration fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>evening college administration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Support Service Cost</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Counseling</strong></td>
</tr>
<tr>
<td>salaries</td>
</tr>
<tr>
<td>other</td>
</tr>
<tr>
<td><strong>Registration</strong></td>
</tr>
<tr>
<td>salaries</td>
</tr>
<tr>
<td>other</td>
</tr>
<tr>
<td><strong>Evening College Admin.</strong></td>
</tr>
<tr>
<td>salaries</td>
</tr>
<tr>
<td>other</td>
</tr>
<tr>
<td><strong>Registration</strong></td>
</tr>
<tr>
<td>salaries</td>
</tr>
<tr>
<td>other</td>
</tr>
</tbody>
</table>

1 Approximates actual conditions in 1977-78 and 1978-79.

2 Liberal Arts = humanities, fine arts, social sciences, and rhetoric; Science = science and mathematics; professional = all other.

3 Computed on the basis of the 1979-80 salary schedule, typical class sizes, and number of graduate student instructors; pay varies with class size and is lower for graduate students.

4 No data available; set at 10% of average instructional salary.

5 An arbitrary estimate of the base cost of maintaining the option.

6 Based on published salaries and on number of employees and estimated share of total for fall semester on-campus activities. Total staff is 2 FTE counselors, 2 FTE regular registration employees (shown as fixed cost), 2 FTE part-time registration employees (shown as variable cost), and 3 FTE evening college administration employees.

7 No data available. Counseling and registration set at 5% of variable salary costs. The amount for Evening College administration includes an arbitrary estimate of the cost of such items as the catalog, advertising, and mailing.
**TABLE 19 CONTINUED**

**BASE CASE FOR THE EVENING COLLEGE**

**ENROLLMENTS**

<table>
<thead>
<tr>
<th>Total enrollment, N = 1300</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enrollment by age</strong>, PE</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>

**ICLM (credit-hours taken by a typical student in each age group)**

<table>
<thead>
<tr>
<th>AGE</th>
<th>CELD-LART</th>
<th>CELD-SCI</th>
<th>CELD-PROF</th>
<th>CEUD-ALL</th>
<th>INDEP</th>
<th>REG UM DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>under 26</td>
<td>.65</td>
<td>.55</td>
<td>.48</td>
<td>.41</td>
<td>.40</td>
<td>.62</td>
</tr>
<tr>
<td>26-30</td>
<td>.19</td>
<td>.32</td>
<td>.33</td>
<td>.36</td>
<td>.37</td>
<td>.24</td>
</tr>
<tr>
<td>over 30</td>
<td>.16</td>
<td>.12</td>
<td>.19</td>
<td>.23</td>
<td>.23</td>
<td>.15</td>
</tr>
</tbody>
</table>

**DM (relative use of services by typical students in each age group)**

<table>
<thead>
<tr>
<th>counseling (visits)</th>
<th>registration</th>
<th>eve. admin. (students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>student credit hrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>under 26</td>
<td>.17</td>
<td>6.1</td>
</tr>
<tr>
<td>26-30</td>
<td>.33</td>
<td>6.0</td>
</tr>
<tr>
<td>over 30</td>
<td>1.00</td>
<td>3.2</td>
</tr>
</tbody>
</table>

**RATIO FORMULAS FOR PRIMARY RESOURCE REQUIREMENTS**

**Instruction** - credits taught from student credit-hours

<table>
<thead>
<tr>
<th>base amt.</th>
<th>base ratio</th>
<th>increment ratio</th>
<th>step (s) or linear (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELD-LART</td>
<td>0</td>
<td>.07</td>
<td>.035</td>
</tr>
<tr>
<td>CELD-SCI</td>
<td>0</td>
<td>.06</td>
<td>.030</td>
</tr>
<tr>
<td>CELD-PROF</td>
<td>0</td>
<td>.056</td>
<td>.028</td>
</tr>
<tr>
<td>CE-UD</td>
<td>0</td>
<td>.067</td>
<td>.067</td>
</tr>
<tr>
<td>INDEP</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>REG UM</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Support Services**

- Counseling - 1/4 counselors from visits
  
  | 0 | .016 | .016 | s |

- Registration - part time registration hours from student credit hours
  
  | 0 | .25  | .25  | 1 |

**1 KEY TO ABBREVIATIONS:**

- **LD** lower division
- **UD** upper division
- **LART** liberal arts (humanities)
- **SCI** science and mathematics
- **PROF** professional (all other schools)
- **CE** continuing education
- **REG UM DAY** regular university day
- **INDEP** independent study, practica, and other special arrangements

2 See Table 11 for the general form of these equations.
TABLE 20. UNIVERSITY OF MASSACHUSETTS EVENING COLLEGE
COMPARISON OF ALTERNATIVES I
THREE SHORT-TERM ALTERNATIVES

BASE CASE
ALTERNATIVE A: 5% enrollment increase.
ALTERNATIVE B: 5% enrollment decrease.
ALTERNATIVE C: Dropping independent study and redistributing students' loads proportionally among the remaining instructional options.

Except as noted, the input for the alternatives is the same as that for the base case.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>PRIMARY RESOURCES</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STUDENTS (by age)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>under 26</td>
</tr>
<tr>
<td>1300</td>
<td>715</td>
<td>338</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>indiv. creds</td>
<td>INDEP</td>
<td>220</td>
</tr>
</tbody>
</table>

A. 5% ENROLLMENT INCREASE

<table>
<thead>
<tr>
<th>INPUT</th>
<th>PRIMARY RESOURCES</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STUDENTS (by age)</td>
<td></td>
</tr>
<tr>
<td>1365</td>
<td>751</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>indiv. creds</td>
<td>INDEP</td>
<td>231</td>
</tr>
</tbody>
</table>
### Table 20 Continued

<table>
<thead>
<tr>
<th>Students (by age)</th>
<th>Primary Resources</th>
<th>Budgets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>instruction</td>
<td>support</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. 5% Enrollment Decrease</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total under 26 26-30 Over 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1235 679 321 235</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CELD-LART 59</td>
<td>counselors 2</td>
<td>income 201.300</td>
</tr>
<tr>
<td>SCI 19</td>
<td>reg. hrs. 1823</td>
<td>cost 114.900</td>
</tr>
<tr>
<td>PROF 47</td>
<td></td>
<td>net 86.400</td>
</tr>
<tr>
<td>CEUD-A11 64</td>
<td></td>
<td>unit 93.0</td>
</tr>
<tr>
<td>indiv. creds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDEPENDENT STUDY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1300 715 338 247</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CELD-LART 66</td>
<td>counselors 2</td>
<td>income 211.900</td>
</tr>
<tr>
<td>SCI 19</td>
<td>reg. hrs. 1918</td>
<td>cost 117.900</td>
</tr>
<tr>
<td>PROF 52</td>
<td></td>
<td>net 94.000</td>
</tr>
<tr>
<td>CEUD-A11 74</td>
<td></td>
<td>unit 90.7</td>
</tr>
<tr>
<td>indiv. creds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REG. UM 4174</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Additional Input for Alternative C

IGLM (credit hours taken by a typical student in each age group)

<table>
<thead>
<tr>
<th>Age</th>
<th>CELD-LART</th>
<th>CELD-SCI</th>
<th>CELD-PROF</th>
<th>CEUD-ALL</th>
<th>REG. UM DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>under 26</td>
<td>.85</td>
<td>.24</td>
<td>.61</td>
<td>.61</td>
<td>3.78</td>
</tr>
<tr>
<td>26-30</td>
<td>.54</td>
<td>.30</td>
<td>.90</td>
<td>1.20</td>
<td>3.06</td>
</tr>
<tr>
<td>over 30</td>
<td>.62</td>
<td>.16</td>
<td>.73</td>
<td>1.04</td>
<td>2.65</td>
</tr>
</tbody>
</table>
TABLE 20 CONTINUED

COMMENTS

ENROLLMENT FLUCTUATIONS: The net contribution to overhead is quite sensitive to changes in enrollment. This is to be expected, because of the delay in adjusting the number of classes to changes in enrollment. In actuality, the sensitivity to enrollment change is lessened somewhat by the policy of adjusting instructional salaries for class size. In runs A and B, instructional salaries were not adjusted for this factor. (See Chapter XI for a discussion of the problems of estimating instructional salaries.)

DROPPING INDEPENDENT STUDY: The model indicates that dropping independent study might result in considerable cost savings and, if the students remained with the system and enrolled in other courses, in an increase in the net contribution to overhead. Considerable additional information is required before any definite conclusions are reached:

1) The values in the ICLM for independent study should be reviewed, probably by conducting additional SPSS runs (see Appendix A).

2) Another alternative, i.e., assuming a partial loss of registrations, should be tested; there is substantial evidence that students often turn to independent study in situations where they are unable to enroll in a course that is particularly important to their studies (see Appendix A).

1 Note that the primary resource for instruction is credits taught, which is directly proportional to number of classes for evening classes, but equals credits taken for regular university classes and independent study. The labels are intended to make this distinction clear.

2 See Table 19 for key to abbreviations.

3 hours of employment for part-time help in the registrar's office.

4 Net contribution to overhead (e.g., share of costs of business office).

5 per student.
TABLE 21. UNIVERSITY OF MASSACHUSETTS EVENING COLLEGE
COMPARISON OF ALTERNATIVES II
TWO MORE SHORT-TERM ALTERNATIVES

BASE CASE
ALTERNATIVE D: 2% INCREASE IN INSTRUCTOR'S SALARIES (fewer graduate student teachers)
ALTERNATIVE E: 2% DECREASE IN INSTRUCTOR'S SALARIES (more graduate student teachers)

Except for the difference in salaries, the input for the alternatives is the same as that for the base case.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>SALARIES</th>
<th>OUTPUT</th>
<th>BUDGETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELD</td>
<td>CELD</td>
<td>CELD</td>
<td>CEUD</td>
</tr>
<tr>
<td>LART</td>
<td>SCI</td>
<td>PROF</td>
<td>ALL</td>
</tr>
<tr>
<td>BASE</td>
<td>290</td>
<td>315</td>
<td>320</td>
</tr>
<tr>
<td>D. 2% pay increase</td>
<td>296</td>
<td>321</td>
<td>326</td>
</tr>
<tr>
<td>E. 2% pay decrease</td>
<td>284</td>
<td>309</td>
<td>314</td>
</tr>
</tbody>
</table>

COMMENTS

It would appear that small fluctuations in the proportion of graduate student teachers do not greatly affect net income (see Chapter XI for a discussion of the problems of estimating instructional salaries).

---

1 See Table 19 for key to abbreviations.


<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Budgets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STUDENTS (by age)</strong></td>
<td><strong>PRIMARY RESOURCES</strong></td>
<td><strong>INCOME &amp; COST</strong></td>
</tr>
<tr>
<td>Total</td>
<td>under 26</td>
<td>26-30</td>
</tr>
<tr>
<td>1300</td>
<td>715</td>
<td>338</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A. 5% ENROLLMENT DECREASE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1235</td>
<td>650</td>
<td>338</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>indiv. creds:</strong></td>
<td>INDEP 220</td>
<td>REG. UM 4393</td>
</tr>
</tbody>
</table>

1 See Table 19 for key to abbreviations.
TABLE 22 CONTINUED

B. 5% ENROLLMENT SHIFT

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1300</td>
<td>650</td>
<td>376</td>
<td>274</td>
</tr>
</tbody>
</table>

cred taught

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CELD-LART</td>
<td>60</td>
<td>counselors 2</td>
</tr>
<tr>
<td>SCI</td>
<td>19</td>
<td>reg. hrs. 1911</td>
</tr>
<tr>
<td>PROF</td>
<td>49</td>
<td>net 91,500</td>
</tr>
<tr>
<td>CEUD-A11</td>
<td>70</td>
<td>unit 91.4</td>
</tr>
</tbody>
</table>

indiv. creds

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEP</td>
<td>227</td>
</tr>
<tr>
<td>REQ. UM</td>
<td>4336</td>
</tr>
</tbody>
</table>

C. ENROLLMENT INCREASE

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1365</td>
<td>650</td>
<td>376</td>
<td>339</td>
</tr>
</tbody>
</table>

cred taught

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CELD-LART</td>
<td>62</td>
<td>counselors 2.25</td>
</tr>
<tr>
<td>SCI</td>
<td>19</td>
<td>reg. hrs. 1966</td>
</tr>
<tr>
<td>PROF</td>
<td>52</td>
<td>net 96,000</td>
</tr>
<tr>
<td>CEUD-A11</td>
<td>74</td>
<td>unit 97.7</td>
</tr>
</tbody>
</table>

indiv. creds

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEP</td>
<td>240</td>
</tr>
<tr>
<td>REQ. UM</td>
<td>4508</td>
</tr>
</tbody>
</table>

COMMENTS

A. ENROLLMENT DECREASE: A decline of only 5% - with the entire decrease among younger students - would cause substantial decreases in the net amount available for overhead expenses and in the ratio of net income to total income. This is not surprising, because the younger students use the least expensive services, but pay the same credit and registration fees as older students.

B. ENROLLMENT SHIFT: The drop in income is only moderate if the loss of younger students is offset by an increase in the number of older students.

C. ENROLLMENT INCREASE: With a decrease in the number of younger students, but an increase in the number of older students sufficient to cause a net increase in enrollment of 5%, net income is actually higher than in the base case; however, the ratio of net income to total income is not as high. As in cases A and B, decreasing the proportion of younger students causes a less favorable income ratio.

1 See Table 19 for key to abbreviations.
1) a base case, representing the Division as it would have operated if the policies and circumstances existing in 1977-78 and 1978-79 had continued.

2) short-term changes:

A. B) a 5% increase and decrease in enrollment.

C) dropping independent study and redistributing the students proportionally among the other instructional options.

D), E) a 2% increase and 2% decrease in average instructional pay, representing a decrease and increase in the proportion of graduate student teachers.

3) long-term changes:

A) a 5% enrollment decrease caused by the loss of 65 students under twenty-six.

B) a shift in enrollment with a loss of 65 students under twenty-six and a gain of 65 students distributed proportionally between the older two groups.

C) a 5% enrollment increase with enrollment distributed as in case 2B, except for an additional increase of 65 students over thirty years of age.

The results of the analyses are summarized in Tables 19 through 22.

Assembling and Preparing Data for the Model LEARN:

A Pilot Study with Data Representing Programs of the Division of Continuing Education

It has been seen that LEARN requires data about

1) enrollments and use of services, 2) use of primary resources, and 3) rates of income and expenditure. The gathering of these data — especially the enrollment data — constituted a major part of the task of testing LEARN.
Enrollment Data and the Induced Load Matrices

Three sources of information can be used in estimating program enrollments and induced load matrices. These are transcripts, registration records, and surveys. All three were used in the pilot study. The methods of preparing data for the study of the Division of Continuing Education - and alternatives to them - are discussed at length in Appendix A. The discussion will be summarized here.

Fractional Program Enrollments and the ICLM. The primary source of information about fractional program enrollments and the ICLM was a random sample of student transcripts. Data from the transcripts were used to estimate fractional program enrollments (F), total course loads (L), and fractional course load matrices (FLM). Instructional services were divided into six groups: registration in university day classes, independent study, and four categories of evening courses. The students were classified in three ways: 1) by age, 2) by number of semesters enrolled, and 3) by matriculation status. Several sets of statistics were developed for the model, using

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1 It will be recalled from the discussions in the last chapter that there are two alternatives for specifying each of these variables. One can specify either the program enrollment (PE) or both total enrollment (N) and fractional enrollment (F), and one can specify either the instructional load matrix (ICLM) or the total load of a typical student of each type (L) and the fractional load matrix (FLM).
different groupings of the above categories. The results of the transcript studies are shown in Table 27. The particular set of statistics used in the trial runs is shown in Table 19.

Registration data provided a check of the estimates of F, L, and FLM that were derived from the transcripts and a means of adjusting them for time trends. Adjusted results are shown in Table 33.

**Total Enrollment.** Total enrollment (N) was estimated from registration statistics. This information could not, of course, be obtained from a sample of the transcripts. The analysis of total enrollment included adjustments for time trends and for enrollment in off-campus classes.

**The Induced Service Load Matrix.** To develop an induced service load matrix (DM), it is necessary to decide which services should be included and then to choose a variable to represent the use of each one. For the study of Continuing Education, discussions with the staff and a review of published financial reports led to a decision to include the three services whose activities are primarily devoted to credit programming. These are counseling, registration, and evening college administration. The following variables were chosen: for counseling - number of students visiting the counselors; for registration - student credit hours;
for evening college administration - enrollment. Since program enrollments and student credit hours can be derived from the enrollment data, only the number of students using the counseling service remained to be estimated. The estimates were derived from responses to questions on a student survey (see Table 30, Appendix A).

Formulas for Computing Primary Resource Requirements

The first step in developing formulas for the primary resource requirements is to decide on the resource variables and types of equations. Once this has been done, the base amount and ratios for each service can be estimated from historical data describing the use of the service and resource. The total use of each service is normally computed when the induced service load matrix is constructed. In any event, it can be computed from this matrix and the enrollment data. The initial primary resource requirement (number of staff, for example) is easily obtained from institutional records.

LEARN can compute one primary resource for programs,

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1 Note that it is not necessary to use these variables to compute resource requirements or costs. For example, in the model of the Evening College, the cost of evening college administration is assumed to be constant. The enrollments were used, however, to compute income from the registration fee.

2 See Table 11 for general descriptions of the primary resource variables and equations.
one for instructional services, and one for each support service. The user need not define all possible primary resources, however.

Three resources were named in the model of the Division of Continuing Education. They are:

for instructional services — credits taught,

for counseling — number of 1/4 counselors,

for registration — number of hours expended above a base of two full-time equivalent employees.

No primary resources were defined for programs or for evening college administration. There are no costs or income associated directly with the programs, and the cost of evening college administration was assumed to be constant over the range of this particular analysis.

**Instructional Services.** Two types of formula were used to compute credits taught from student credit hours, one for evening college courses and another for day classes and independent study.

The equations for the four groups of evening classes are all of the form: 

$$
\text{CREDITS TAUGHT} = \\
\text{integer part of } ((\text{base enrollment } \times \text{ base ratio}) + 0.5) + \\
\text{integer part of } ((\text{enrollment incr } \times \text{ incr ratio}) + 0.5).
$$

---

1 The number of credit hours taught is directly proportional to the number of courses offered: credits taught = (number of classes) x (average credits per class).
The base number of classes was assumed to be zero in every case.

Evening college class sizes were estimated from registration statistics, which include the number of students enrolled in each individual class. The base ratio was computed directly from average class size:

\[ \text{base ratio} = \frac{1}{\text{average class size}}. \]

The increment ratio was set equal to the base ratio, except that for short-term analyses (i.e., one future semester), the increment ratio for lower division courses was set at one-half the base ratio. This factor is a very crude average representing the lag between changes in enrollments and changes in the number of lower division classes given. The actual variation was very wide.

The formula used for number of credits taught in independent study and day classes was simply:

\[ \text{CREDITS TAUGHT} = \text{STUDENT CREDIT HOURS}. \]

The formula is reasonable for independent study, since there is one teacher for each registration. Although the formula is artificial for day classes, it is used because the individual enrollment in a day class is the only item of interest to the Division; the Division provides no instruction, so class size is irrelevant.
Support Services - counseling and registration staff.
The formula used for counseling staff was:

\[
\frac{1}{4} \text{COUNSELORS} = \text{integer part of} \left( \left( \frac{\text{number of students using the services}}{\text{base ratio}} \right) + 0.5 \right).
\]

The formula for registration staff was:

\[
\text{VARIABLE HOURS OF REGISTRATION STAFF TIME} = (\text{student credit hours}) \times (\text{base ratio}).
\]

Although the choices are somewhat arbitrary, there was little difficulty in the case of either service in deciding upon reasonable formulas. The base ratios were computed from available statistics about staffing and the use of services.

Financial Data

To develop estimates of fixed and variable income and costs for LEARN, it is necessary to decide how to represent the variations. For example, the director's salary is usually a fixed cost, credit fees vary with credits, but certain clerical costs may be treated as fixed or may be allowed to vary with enrollments, number of instructors, or some other quantity. Once the units have been determined, the rates can be estimated if financial records by cost center are available - as they would be in any actual application of the model. However, even with access to these data, certain problems can occur. These will be discussed in the next chapter.
Because internal financial records were not available for this study, some problems occurred that would not be expected in the normal use of the model. These will be mentioned briefly in the course of this discussion.

For this study, financial data were obtained almost entirely from public records; some information was obtained through discussions with the Continuing Education staff. Data not available from these two sources were estimated using various rules of thumb. (See Table 19 for the estimates used in the Continuing Education runs.)

Income. Fee schedules are published in the catalog of the Division. Staff members provided information about the portion of the fees forwarded to the University or the State. Only the portions of the credit fee and the regular registration fee that are kept by the Division are included in the model; the parts of these fees that go to the University or the State and all incidental charges are considered to be wash items and are ignored. It is assumed that the credit and registration fees are paid by all students; the source of the funds (i.e., whether from financial aid, the students themselves, or other payers) is not taken into account.

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1 i.e., money collected for other agencies that has no effect on the Division’s finances.
Cost. The basic cost data required for representing the Division of Continuing Education were:

1) instructional salaries
2) direct salary costs of the three support services
3) other direct costs of instructional and support services
4) indirect costs allocated to evening college operations.

The instructional salaries per class were computed from published pay rates, estimates of class size, and estimates of the proportion of graduate students teaching each type of class. The pay rates, which vary with class size and type of instructor, were obtained from a schedule published by the Division. As explained earlier, class size was estimated from the registration data. The proportion of graduate students teaching each type of class was estimated from rather sketchy information published in the Division's annual reports.

All of the data required to estimate instructional salaries for each type of class should be readily available to anyone with access to internal documents. However, even in this case, estimating instructional salaries for alternative plans and circumstances is often cumbersome. Since each salary depends on class enrollment and on type of instructor, salaries for the alternative cases must be estimated outside the model. This difficulty will be
discussed in the next chapter.

The direct salary costs for each support service can be computed from personnel costs and the appropriate enrollments, service demand, or resource requirements:

$$\text{cost per unit} = \frac{1}{\text{ER}} \times (\sum i \text{base salary}_i),$$

where ER is the appropriate enrollment, service use, or resource requirement.

For this study, the costs were computed from public information on salaries, job descriptions provided by the staff, and the enrollments, service demand, and resource requirements that had already been estimated.

Direct non-salary costs can be derived from the budgets of the individual cost centers. Since the information was not available for this study, the data were estimated using rules of thumb for the relationship between salary and non-salary costs.

The indirect costs of each service depend on rules for allocating the expenditures of other cost centers. The Division of Continuing Education allocates part of the costs of such services as typing, mailing, public relations, and publications to the Evening College and other producing units on the basis of actual use. The remainder of the costs of these services and the costs of such services as business administration and the director's office are considered to be general overhead and are not allocated. Since the internal budgets were not available for this
study, an arbitrary, fixed amount was specified to represent the allocated costs. Possible difficulties related to cost allocation will be discussed in the next chapter.

Data for the Model – Conclusion

The preparation of data for LEARN has been described in detail. It is now possible to discuss the results of the tests of the model, including several issues related to the data. The availability of data and the question of stability versus detail are among the major topics considered in the next chapter.
CHAPTER XI
DISCUSSION OF RESULTS

Three general questions formed the basis of the evaluation of LEARN as a tool for the analysis of resources and budgets for part-time adult education:

- Is the model accurate?
- Are the questions that can be answered using the model relevant to the decision making process of the University of Massachusetts Evening College and systems like it?
- Can the model provide information that could not be obtained more easily by some other means?

To study these issues, it was necessary to examine the major features of the model and its data requirements. Several characteristics of the model required particular scrutiny. These were the induced instructional load matrix, the induced service load matrix, the ratio formulas, the static (single term) character of the model, and the way in which the model treats income and cost. Two aspects of the problem of gathering and preparing data also required particular attention. These were 1) the problem of collecting the necessary information at reasonable cost and 2) that of finding groupings and approximations that fit the model and suited the user's needs for information.

The remainder of this chapter will be devoted to discussions of the strengths and weaknesses of the model.
possible improvements, and directions for further study. The last of these topics involves another question about the model: Is LEARN – or any part of it – likely to be useful to systems other than the University of Massachusetts Evening College? The question of transferability will be addressed at several points in the course of the chapter.

**Strengths of the Model**

In general, the expectations for LEARN have proved correct. The model is accurate, it is easy to use, the variable budget has proved to be a simple, flexible mechanism for representing income and costs, and the induced load matrices have proved useful for representing the relationship between program enrollments and the use of services.

**Accuracy**

The model was accurate in representing the on-campus programs of the Division of Continuing Education as it operated in 1977-78 and 1978-79; the representation of alternatives was also realistic. As with any variable budget model, accuracy depends on the relevant range of the approximations used (for example, the range in which fixed costs remain fixed). There was no evidence that the relevant range was exceeded in the pilot test of the model. The question of relevant range will be discussed later in the chapter.
Ease of Use

Operating the model was simple and took relatively little time. The most time-consuming operation was the entering and checking of the base data. Once this was done, each additional run of the model, whether for calculations, displays, or modifications of the input, took only a few minutes.

Representing Budgets and Resources

To prepare financial data for the model, the user must decide on the income and cost categories and units and then compute estimates of fixed and per unit income and costs. The process was described in detail in the last chapter. No serious difficulties were encountered in preparing financial data for LEARN. A true test of the variable budget would require that others try to use the model. However, because the approach used in the model is completely conventional, it is hard to imagine that difficulties would be encountered.

Similarly, the primary resource module, which can be regarded as an intermediate step in the variable budget computation, appears to provide for realistic representations of conditions encountered in part-time education. Tests by other users might lead to some modifications of the ratio formulas and to the provision of more alternatives for representing the relationship between enrollments and resource requirements.
Finally, the static character of the model seems to be consistent with its purpose. It would not be difficult to construct an additional module that permitted the model to perform calculations for several terms, but there is no apparent advantage in doing so.

The ICLM

Several issues related to the induced instructional load matrix require discussion. These are: 1) the use of fixed ratios to represent the relationship of program enrollments to instructional enrollments, 2) the use of highly aggregated data, and 3) the use of fractional load matrices.

In many situations, the fixed ratios of the ICLM give a realistic portrayal of the relationship between program enrollments and budgets. It appears, for example, that the number of humanities and social science courses given by the Division of Continuing Education varies quite closely with demand. In fact, this kind of relationship is probably more common in part-time and adult programs than it is in traditional colleges and universities, where the size of the faculty is relatively fixed.

It is important to note that the ICLM cannot represent situations where the capacity of some instructional services is fixed but the expenditure of resources in other areas fluctuates with demand. This problem will be discussed later in the chapter.
The use of a small number of highly aggregated classifications of students and instructional services has proved to have several benefits: 1) the matrices are stable over time, 2) little computer time is required to run the model, and 3) the computer terminal can be used for all input and output. There are, however, potential problems caused by the loss of detail; these will be discussed in the next section.

Fractional load matrices proved helpful in the study of Evening College because they facilitated the analysis of course load distribution. In order to allow for the option of specifying the ICLM in fractional terms, LEARN requires the user to specify all course loads in the same units (for example, student credit hours). The theoretical disadvantage of this restriction is that highly diverse educational systems cannot be represented in their entirety at one time. For example, subsystems that offer conferences and those that offer credit courses cannot be analyzed together. Experience with the model indicates, however, that this is not a real disadvantage because subsystems serving different client groups are best studied separately. If the need should develop, it would be easy to modify LEARN so that each instructional service could have its own unit of measure; the ICLM would then have the same properties as the induced service load matrix.
The Model's Strengths - Conclusions

In summary, it appears that LEARN is easy to use and that it can represent accurately a wide variety of situations commonly experienced in adult and part-time education.

Some Problems and Some Possible Solutions

Four major potential and actual sources of difficulty were identified in the course of testing LEARN. All involve enrollments and three are directly or indirectly related to enrollment data. The problems are:

1) the inability of the model to represent limitations in capacity,

2) problems in estimating average instructional salary and the values of other variables that are treated as independent, but are sometimes dependent variables,

3) difficulties in grouping instructional services in ways that produce results that are stable over time and that also provide the detail needed for policy analysis,

4) difficulties in gathering data at reasonable cost and in a reasonable length of time.

These difficulties are serious ones. Any of them can prevent the representation of situations commonly encountered in adult and part-time educational systems. Furthermore, there is a fundamental incompatibility between the planning approach implicit in the model and that of the
Division of Continuing Education and systems like it. The model is demand driven; it represents an idealized system that responds directly to student's needs without regard to cost. Such an ideal system does not, of course, have capacity limits or minimum class size. In contrast, as was pointed out in the last chapter, the Division of Continuing Education responds to the needs of providers of instruction and of the University as well as to those of the students. The Evening College offers only those courses that someone wishes to teach and minimizes financial risk by reducing instructional salaries or cancelling courses if enrollments drop below a cut-off point. Thus, neither program enrollment nor average instructional salary is really an independent variable.

Fortunately, solutions can be found to the capacity and salary problems and to the difficulties in gathering and grouping the data as well. It seems likely that the solutions will increase the model's flexibility without adding unduly to its complexity.

The Capacity Problem

Capacity limits are common in postsecondary education. They were encountered in the Evening College where the number of business courses given, rather than demand, determines enrollment. Because LEARN calculates course enrollments from program enrollments and fixed ratios between program and instructional enrollment, the latter
cannot be held constant while the former varies. The model
does permit the resource requirements (for example, number
of courses and total cost) to be fixed, but this is not
equivalent to limiting capacity.

There are several possible solutions to the problem of
representing limited capacities. All involve modifying the
model.

1) It is possible to build a second enrollment module
in which instructional enrollments are specified directly
rather than as a function of program enrollments; student
characteristics would be ignored in this module and, when it
was used, the model would not compute program budgets. The
user could choose between the two modules and could even
start with the present, program enrollment module and switch
over to the capacity module when necessary.

2) The existing enrollment and resource modules could
be modified to provide error messages when enrollments
exceeded specified amounts. The user could then try other
configurations and could switch to the capacity module if it
had been added to the model. The advantage of adding both
the error messages and the capacity module is that the
combination facilitates analysis in situations where the
user does not know it advance whether demand or capacity
controls enrollment.

3) One might construct a more elaborate enrollment
module that allows users to provide instructions for
treating excess demand. The user would be required to specify rules for adjusting the number of students, the distribution of their loads, and their total loads.

A capacity module must be added to the model if LEARN is to have more than the narrowest application. Providing warnings of over-enrollments is also desirable, but is less important than adding a capacity module because users can detect overloads without the aid of error messages. The last option, a program to adjust for over-enrollments, would appear to complicate the model without providing any substantial improvement. Users can probably make more realistic adjustments to enrollments after seeing preliminary results than they could by setting decision rules in advance.

Interdependence Among Variables Treated as Independent

LEARN is basically a series of linear equations that are solved sequentially. The independent variables are enrollment and a sequence of ratios that relate the enrollments to resource requirements and budgets. Setting the initial conditions for the model is straightforward. Problems can occur, however, when alternatives are represented because, when the value of one variable is modified, the change may affect the values of other, supposedly independent, variables. For example, an enrollment change may be great enough to alter the values of costs treated as fixed, or the rules adopted for allocating
overhead costs in one situation may be inappropriate in another. It may be necessary to regroup the information if, for example, the change affects different services within a group differently. These problems of approximation, allocation, and aggregation are common to all models. Although they may be minimal in a model that is well designed for the system it represents, only the user's understanding of both the system and the model can insure that the model will not be misused.

As indicated earlier, no problems of range or allocation of overhead were encountered in the limited trial of LEARN, but one problem of interrelationship between two input variables did occur.

As explained earlier, The Division of Continuing Education has a salary schedule that depends on the type of instructor and on enrollment in the course; there is a lower rate of pay for graduate students than for others, and salaries are fixed above a cut-off point but proportional to student credit hours below that point. Therefore, because enrollment changes may affect both the composition of the teaching staff and the distribution of class sizes, average instructional pay varies in a rather complex way with enrollment. LEARN makes no provision for this situation.

The solution to the problem appears to be the construction of a special module that uses enrollment data and other information provided by the user to compute 1) the
number of classes above the cut-off point, 2) the number and average size of classes below that point, 3) the proportion of graduate student instructors, and finally 4) the average instructional salary for each instructional group. A program to display the input and output of the module would also be added to the model.

The relationship between enrollments and salaries described here is peculiar to the Division of Continuing Education; the special module is intended to represent this system only. The situation illustrates the dictum that, because policies and processes differ substantially even among systems with similar goals, models are rarely transferable.

Stability versus Detail

The third problem - that of describing the system in a way that yields results that are stable over time and that also provides the detail required for analysis - is one that plagues most efforts to model complex systems. The ICLM's developed for the Division of Continuing Education do reflect statistically significant relationships. However, the instructional categories are broader than one would wish. It will be recalled that four categories were used, one for upper division courses and three for lower division

1 See Appendix A.
courses. The three groups of lower division courses were liberal arts, science, and all other. Since the problems encountered in the analysis of each of the four groups of division courses were somewhat different, the categories will be discussed separately.

The liberal arts group includes rhetoric and all courses in the social sciences, humanities, and fine arts. In general, the clientele served by these courses is similar, and capacity is not a significant limitation on enrollments. Because of these similarities, placing the courses in a single group did not cause difficulties in analysis.

The second category, which includes all courses in mathematics and the natural sciences, is also relatively homogeneous. There would be some advantage to dividing the category into two smaller groups, one that included review courses in mathematics and the basic courses in computer programming and the other that included all other science and mathematics courses. Although the two groups of courses serve similar clienteles, the average enrollment in the mathematics review and computer programming courses is much higher than that in the remaining courses. As a result, net costs are much lower in the first group.

More serious problems were encountered with the group classified as "professional and other". This category is diverse in terms of the clients served, class sizes, the
capacities of the courses, and enrollment trends with time. The only reason for grouping the courses together is that statistically significant results were difficult to obtain at lower levels of aggregation. Included in the category are business courses whose enrollments are limited by capacity, courses in agriculture and home economics that meet distribution requirements for a bachelor's degree and whose students are often young and seeking a college degree, and a mixture of other courses, some of which serve special client groups.

There is also considerable diversity in the clientele and class size of upper division courses. The differences in this group are not as great as those in the one just discussed. In particular, enrollments are rarely limited by capacity.

There are no general solutions to the problem of aggregation. Each situation must be examined individually. In some cases, there may be no satisfactory solution, and the model will not prove useful. In the case of the Division of Continuing Education, separate, more detailed studies of some of the larger groups might prove helpful. For example, the category of professional and other courses could be divided into two or three subgroups. Because enrollment in business courses is limited by capacity, it would be necessary to use the capacity enrollment module to analyze that part of the system. It should be noted that,
because of the limitations of the historical data, any
detailed study would be more speculative than was the more
general one done in the pilot study.

Problems in Gathering and Preparing Data

It will be recalled that LEARN requires three kinds of
data—enrollments, resource ratios, and per unit income and
costs. It was seen in the last chapter that gathering data
about income, cost, and the use of resources presents no
serious problems, but that one of the major factors
determining the usefulness of the model is the ability to
collect the necessary enrollment data in a reasonable length
of time and at a reasonable cost. Whether or not this can
be done depends on a number of factors.

The process of gathering and preparing enrollment data
for the pilot study of the Division of Continuing Education
was outlined in the last chapter and is discussed at greater
length in Appendix A. In brief, data were collected from a
random sample of active transcripts for Fall 1977 through
Spring 1979, from registration records for Fall 1976 through
Fall 1978, from three separate surveys, and from interviews
with the staff. With the exception of the results of one
survey, none of the information was originally available in
machine-readable form. The transcript data were coded for
computer analysis for the pilot study. The remaining data
were analyzed by hand.

Even subtracting the time required to plan the project,
preparing data for LEARN was extremely time-consuming. It is doubtful that any results for the model could justify such an expenditure of effort. However, as is pointed out in Appendix A, studies using LEARN may be worthwhile if the time required to collect the data can be reduced substantially or if the data collected prove valuable for other purposes. The preparation of data for LEARN will now be considered with these possibilities in mind.

**Registration Records.** Estimates of enrollment by course type and of total enrollment can be derived from records of class size. Much of this information, which is essential for LEARN, can be obtained only from this source. Statistics from registration records are actually sufficient for conducting limited studies with LEARN; such studies cannot include the analysis of student characteristics.

Regardless of whether registration statistics are in machine-readable form, their use for analyzing enrollments is straightforward. Because the amount of data is small, the task of preparing machine-readable files is not burdensome.

**Transcripts.** Information from transcripts is usually necessary for the development of the induced instructional load matrices. The information about student characteristics and course loads obtained from the transcripts should be useful to decision makers regardless of whether it is used for budget analysis.
If the transcripts are in machine-readable form, the cost of analyzing them is very low once the necessary statistical programs are developed. Even the initial cost of developing the required procedures is not high if statistical packages such as SPSS are used (Nie, et al, 1975). (Appendix A includes an outline of the basic SPSS procedures for such analysis.)

If transcripts are not machine-readable, but other registration and student records are, it may be possible to analyze some aspects of the relationship between student characteristics and course loads at a relatively low cost. It appears that this may be the case for many systems, including the University of Massachusetts Division of Continuing Education.

Questionnaires. Questionnaires can provide information about students' goals and their use of support services that cannot be obtained from institutional records. The pilot test of LEARN used survey results to develop estimates of the use of counseling services.

Had the survey results used in LEARN been unavailable, the estimates could have been developed from information supplied by the counselors, or been based on the number of students or their course loads. Alternatively, counseling could have been treated as a fixed cost. Since the cost of the service is a small part of the total budget and the number of counselors has been constant for some time, the
differences between the various approaches is not likely to be significant.

It can be concluded that although surveys may be useful in providing data for LEARN, they are essential only for certain kinds of studies of students' goals.

Data for the Pilot Study - Conclusion. In summary, whether or not historical data can be gathered in a reasonable length of time and at reasonable cost depends on the record system of the institution. In a system with machine-readable transcripts and registration records, the basic enrollment and course load data can be gathered and processed quickly and at low cost. Where transcripts are not machine-readable, but other student and registration records are, it may be possible to develop a useful data base for LEARN at reasonable cost. Where no student records are machine-readable, or where the researcher does not have access to such records, it is doubtful that the cost of preparing instructional load matrices can be justified; however, in some such cases, it may be worthwhile to use LEARN for more limited studies that require only registration data. In any event, the projects are more likely to be cost-effective if the data can also be used for other purposes.

The development of a survey solely for a budget study rarely, if ever, can be justified. However, a survey that meets a variety of needs for information might well be
Data to Represent New Programs or New Systems.

LEARN has been tested only for situations where historical data are used to represent existing programs and services. Developing data to represent new programs, new services, or entirely new systems is a very different problem. LEARN has not been tested for this kind of use. The issue is discussed in Chapter V.

Problems and Solutions - Summary

The pilot test revealed the need for two additional components of the model: 1) an enrollment module that could represent fixed capacity and 2) a specialized module for the Evening College that would compute instructional salaries as a function of enrollment. It seems reasonable to assume that with these two additions, LEARN could represent the Division as it now operates and as it might operate under alternatives that are likely to be of interest to decision makers.

Of the three questions raised at the beginning of the chapter, one remains to be considered: assuming that data can be obtained and that the model can represent accurately the alternatives of interest to planners, will LEARN provide information that could not be obtained more easily and less expensively by some other means?

The pilot test revealed no new insights about the Division of Continuing Education. It is not possible to say
whether it would have been helpful if decision makers within the Division had provided questions of interest to them. The evidence tends to point to the conclusion that, for decision makers who find the model's approach compatible with their own way of thinking, LEARN could be useful as a tool for working through alternative plans, that is, it could help the decision makers to think about the effects of various actions under different assumptions about the many forces that affect students' decisions and affect the system in other ways. To discover whether there are decision makers who would find the model attractive and whether they would actually find it helpful, it would be necessary to find institutions willing to test the model.

Minor Modifications and Technical Improvements

During the testing of LEARN, it became apparent that two additional statistics would be useful for comparing alternatives. These are 1) the ratio of net income to total income - for the direct, program, and total budgets, and 2) the cost per instructional unit (e.g., per student credit hour) - for the program and total budgets.

Calculations of the ratio of net income to total income should be added to both the direct and program budget modules. The cost per instructional unit should be provided as an alternative to the cost per student, the statistic now provided in the program, and total budgets; this option
should be available only for these budgets. The unit costs of direct services should continue to be computed on the basis of the units used to measure each service (e.g., counseling visits for counseling).

Although LEARN in its present form is easy and inexpensive to use, there are many possibilities for improving its convenience to the user and for reducing costs. These include simplifying the dialog and displays, editing the programs for greater efficiency, improving the file system for storing and retrieving the base data, protecting the basic copy of LEARN, and providing additional options for modifying the financial data. Most of these changes would require substantial programming time; only the last would improve the convenience of the model to the user significantly. The program for modifying financial data now requires the user to reenter substantial blocks of data in order to make minor changes in the input. The model should provide the option of changing individual elements of the financial arrays.

Conclusions - Directions for Further Study

It has been seen that a number of changes could be made to LEARN that would improve its ability to analyze enrollments and budgets of the Division of Continuing Education. In addition to the pursuit of these possibilities, three directions for further study merit
Consideration:

1) Developing one or more enrollment forecasting modules for LEARN,
2) Developing a taxonomy that describes the scope of each service,
3) Using the basic modules of LEARN as elements of individual models for other systems.

**Enrollment Forecasting Modules**

A statistical enrollment projection module could be used to develop estimates of enrollments and course load distributions from transcripts and registration records. The results would provide input for the existing programs. A statistical package such as SPSS would no doubt be used to perform the basic computations for an enrollment projection module. The enrollment study described in Appendix A represents a starting point for the development of such a model.

Consideration might also be given to developing a student flow module to estimate enrollments in certain programs or instructional services from information about the population pool. For example, one question of special interest to the Division of Continuing Education is the flow of students back and forth between part-time (Continuing Education) and full-time (regular University) status. Either a Markov or structural flow model could be used to represent this situation.
Enrollment projection and student flow models are discussed at length in Chapter V.

A Taxonomy for LEARN

One possible difficulty in interpreting the output of LEARN is that the scope of the services provided under different alternatives may be different. In the case of the Evening College, the unit costs of regular university courses cannot be compared to those of Evening College classes because the services provided by the Division are not comparable. Such situations are common in educational systems that serve part-time students. A formal taxonomy might help decision makers—particularly those remote from the immediate scene—to interpret the results of the model. This issue was discussed in Chapters II and VII.

LEARN as a General Model

It has been stated repeatedly that planning models must almost always be designed specifically for the systems they represent. Certainly, the experience with LEARN, especially the difficulties encountered in representing capacity and in estimating instructional salaries, tend to support this assertion. Nonetheless, while it is true that complete models are rarely transferable, certain modules of LEARN are quite general and may well be applicable to other adult, part-time educational systems.

First, the variable budget is a device used by many organizations that depend on sales for income. A model that
represents budgets as a combination of fixed and variable costs and incomes should be widely applicable. The proposed instructional enrollment module, which would allow the direct specification of instructional and service use, together with the existing financial input and direct budget modules, represents a conventional approach to variable budgeting. It should be possible to design a variety of planning and budgeting models starting with this base.

Second, the induced instructional load matrix and the related program budget module have sufficiently broad application in part-time and adult education that they too should be transferable. Their value is, of course, that they add to the basic variable budget model the ability to analyze the relationships between student characteristics and budgets.

The potential value to other systems of the two other basic features of LEARN is less clear. Because costs and income can be estimated directly from the variables associated with programs and instructional services, the induced service load matrix and the resource ratios are not absolutely essential to the analysis of programs and

---

1 The direct service module must be rewritten if the model is to be used without the primary resource module. This is not a major task.
The service load matrix is useful if the resource requirements of at least one support service are a function of program enrollment. LEARN was designed with this possibility in mind; it was assumed, for example, that the need for counselors might vary with the composition of the student body. In the case of the Division of Continuing Education, although there was a significant correlation between student characteristics and the use of some support services, the resource requirements of the services were relatively fixed. If this pattern is a common one, the need for induced service load matrices may not be as great as was believed when LEARN was designed.

The primary resource module provides for the computation of physical, as opposed to dollar, resources. While it is never necessary to use this intermediate step to develop budget estimates, it seems quite likely that decision makers would prefer a model that provides estimates of such quantities as the number of classes to one that provided only the estimated costs of the services.

Discussion of Results - Summary

To summarize, LEARN provides realistic analyses of enrollments and budgets in many situations encountered in part-time postsecondary education. The model is easy and
inexpensive to use, but the preparation of the necessary data may be burdensome if institutional records are not machine-readable. Two rather serious limitations of the model, its inability to represent limits in capacity and to compute instructional salaries as a function of enrollment, can almost certainly be corrected without unduly complicating the model. A variety of other, relatively minor changes could facilitate the use of the model. In addition, the value of the model might be enhanced if an enrollment projection or student flow module were added or if a taxonomy describing the scope of individual services were developed.

Finally, although LEARN has been designed for use by a specific educational system, its basic features could provide the core for similar models of other systems of adult and part-time education.
Acknowledgments...

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APPENDIX A

ESTIMATING COURSE ENROLLMENTS AND USE OF STUDENT SERVICES

1. INTRODUCTION

The model, LEARN, requires estimates of students' course loads and use of institutional services. Values of the following variables must be specified: ¹

- N = total number of students enrolled during the semester,
- F = percent of the student population represented by each category of student,
- L = total course load of typical students in each category,
- FLM = percent of course load in each type of course taken by a typical student in each group (the fractional load matrix),
- DM = for typical students in each group, the relative use of each noninstructional service (the induced service load matrix).

Appendix A describes methods of estimating values of these variables using data from transcripts, class lists, surveys, [...

¹ Alternatively, the program enrollments, PE, and the induced course load matrix, ICLM, could have been estimated. PE = N x F, ICLM = L x I x FLM, where I is the identity matrix.
and interviews. Emphasis is on the procedures used in the pilot study of the Evening College at the University of Massachusetts, Amherst; alternative approaches are considered only briefly. The appendix includes the results of the pilot study, i.e., the estimates of N, F, L, FLM, and DM used in the initial runs of LEARN (Tables 30 and 33).

2. THE USE OF STUDENT TRANSCRIPTS TO DEVELOP ICLM'S

Obtaining the Sample

Like most adult education programs, the Division of Continuing Education of the University of Massachusetts at Amherst is small enough that the entire population of the past few years could have been studied had the transcripts been available in machine-readable form. Alternatively, a random sample could have been selected by the computer. Unfortunately, because the Continuing Education transcripts are kept on typed cards only, these options were not available.

The sampling procedure used in this study is described in Table 23. The procedure was chosen in preference to random sampling because of its lower cost in clerical time. The chances of statistical bias appear to be slight (see Table 23 for further discussion).
### TABLE 23. SAMPLE SELECTION

**GROUP I. MATRICULATED STUDENTS** (SPSS file MATSTU)

**Population** - a) all students who had received bachelor's degrees through the Division in the period from Fall 1977 through Spring 1979 (about 60 students).

b) all students who had taken at least one course through the Division in the period Fall 1977 through Spring 1979 and who had matriculated, but NOT graduated (about 30 students).

**Sample** - ALL students in (a) plus any students in (b) selected in the course of choosing Group II (see below).

**Sample size** - 66 students

352 semester records

68 semester records to compute ICLM's (only those of students living within fifteen miles of campus and only semesters Fall 1975 through Spring 1979.

**NOTE** - The file MATSTU included all the semester records of each student selected, but of course, none of the semester records of students who matriculated after July 1979, the date the sample was selected.

**GROUP II. OTHER STUDENTS** (SPSS file OTHSTU)

**Population** - All students who had taken at least one course through the Division in the period from Fall 1977 through Spring 1979 and had neither matriculated nor graduated (about 4000 students).

**Sample** - about 1000 transcripts were chosen from the "active student file", the file of all students who had taken at least one course in the past four semesters, but had not graduated. The records were selected in the following manner: a sequence of 250 consecutive alphabetized records was chosen from each of four sections of the alphabet; the first record in each sequence was chosen randomly with the restriction that it be at least 250 records from the end of the section. Records of matriculated students were removed from the file and placed in the MATSTU file.

**Sample size** - 973 student records

1586 semester records

698 semester records to compute the final ICLM's (only those students living within fifteen miles of campus and semesters Fall 1977 - Spring 1979).

**NOTE** - The method of sampling may have introduced biases of two kinds - 1) several members of single family might have been chosen and 2) certain ethnic groups might be either over- or under-represented.

---

1 SPSS is a statistical programming package (Nie, et al., 1975).
Organizing the Data

An induced course Load Matrix, or ICLM, shows the average percent of course load in each type of course taken by each kind of student. Before an ICLM can be constructed from transcript data, the raw data must be manipulated and aggregated. (For example, ages must be computed from birth dates and then grouped). An important preliminary step is the calculation of the percent of course load in each type of course for each semester record.

Tables 24 - 26 outline the approach used to organize the data for the study of the University of Massachusetts Evening College. Table 24 shows a typical transcript. Table 25 shows the initial variables coded from the transcripts. Table 26 gives a general SPSS$^2$ program for computing percents of course loads from the individual semester records.

---

1 See Tables 24 through 26.

### Table 24. A Typical Transcript

<table>
<thead>
<tr>
<th>NAME</th>
<th>ID: 234</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOME ADDRESS</td>
<td>MA 01007 N</td>
</tr>
<tr>
<td>PARENT/GI</td>
<td></td>
</tr>
<tr>
<td>ADMITTED FROM</td>
<td></td>
</tr>
<tr>
<td>BIRTHDATE</td>
<td>8/26/47</td>
</tr>
<tr>
<td>FIRST ENROLLMENT</td>
<td>9/2/75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPT.</th>
<th>NO.</th>
<th>DESCRIPTIVE TITLE</th>
<th>CREDIT</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM</td>
<td>111</td>
<td>GEN CHM (SCI)</td>
<td>3</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>310</td>
<td>SPECIAL PROBLEMS</td>
<td>3</td>
<td>P</td>
</tr>
<tr>
<td>PSYCH</td>
<td>200</td>
<td>PHYSIOLOGICAL PSYCH</td>
<td>3</td>
<td>BC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPT.</th>
<th>NO.</th>
<th>DESCRIPTIVE TITLE</th>
<th>CREDIT</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEXNO</td>
<td>CER</td>
<td>SCHOL OF EDUCATION LEARNING EXPERIENCES - FALL 1975</td>
<td>LVL MOD CRED</td>
<td>3.00</td>
</tr>
<tr>
<td>LEX5810</td>
<td>J</td>
<td>FUNDAMENTAL APPLIED NUTRITION</td>
<td>GP</td>
<td>A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPT.</th>
<th>NO.</th>
<th>DESCRIPTIVE TITLE</th>
<th>CREDIT</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>JS</td>
<td>396</td>
<td>LOCAL REPORTING</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>JS</td>
<td>396</td>
<td>LOCAL REPORTING</td>
<td>6</td>
<td>A</td>
</tr>
</tbody>
</table>

UNIVERSITY OF MASSACHUSETTS - DIVISION OF CONTINUING EDUCATION
Amherst, Massachusetts

DEGREE AWARDED

DATE

MAJOR

406
TABLE 25. STATISTICAL ANALYSIS FOR TRANSCRIPTS - VARIABLES

A. INPUT VARIABLES CODED FROM STUDENT' TRANSCRIPTS

NOTE: Each record coded for SPSS\(^1\) represented a single semester for an individual student; the student data listed below appeared in identical form in all records of each individual.

1. STUDENT DATA - FOR ALL SEMESTERS ENROLLED

a. INFORMATION APPLICABLE TO ALL STUDENTS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDID</td>
<td>student ID for the project (not University ID)</td>
</tr>
<tr>
<td>ZIPCODE</td>
<td>grade point average for entire period recorded on transcript</td>
</tr>
<tr>
<td>BIRTHYR</td>
<td>number of semesters attended in entire period recorded on transcript</td>
</tr>
<tr>
<td>GPA</td>
<td>number of semesters skipped between first and last semester recorded on transcript</td>
</tr>
<tr>
<td>TOTALSEM</td>
<td>semester and year matriculated</td>
</tr>
<tr>
<td>SEMSKIP</td>
<td>semester and year graduated</td>
</tr>
</tbody>
</table>

b. INFORMATION APPLICABLE TO MATRICULATED STUDENTS ONLY (i.e., to students who were matriculated \textit{at any time} during the period recorded on the transcript).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATRDATE</td>
<td>semester and year matriculated</td>
</tr>
<tr>
<td>GRADATE</td>
<td>semester and year graduated</td>
</tr>
<tr>
<td>MAJOR</td>
<td>total number of non-evening credits recorded on transcript</td>
</tr>
<tr>
<td>NONCECR</td>
<td>were credits earned</td>
</tr>
<tr>
<td>UMREG</td>
<td>a four year college</td>
</tr>
<tr>
<td>UMSUMWTR</td>
<td>from sources at</td>
</tr>
<tr>
<td>JUNIORCL</td>
<td>for each source</td>
</tr>
<tr>
<td>OTHERCOL</td>
<td>military of other experience</td>
</tr>
<tr>
<td>EXPER</td>
<td>credit by examination</td>
</tr>
<tr>
<td>EXAM</td>
<td>did student seek a second bachelor's degree? (yes or no)</td>
</tr>
<tr>
<td>SECONDBA</td>
<td>sequence of attendance as a regular and evening student</td>
</tr>
<tr>
<td>TIMEUM</td>
<td>at the University (never attended regular session, attended</td>
</tr>
</tbody>
</table>

\(1\) Nie, et al. (1975).

\(2\) University of Massachusetts
### TABLE 25 CONTINUED

**SEMIER AND COURSE DATA - FOR EACH SEMESTER ENROLLED**

<table>
<thead>
<tr>
<th>SEMNUM</th>
<th>number of semesters attended to date, including current semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOFCRED</td>
<td>number of credits for each course</td>
</tr>
<tr>
<td>LEVEL1 - LEVEL6</td>
<td>level of each course (i.e., 100, 200, 300, ...)</td>
</tr>
<tr>
<td>TYPE1 - TYPE6</td>
<td>type of course (i.e., regular UMass course, Evening College course, practicum, independent study)</td>
</tr>
<tr>
<td>DEPT1 - DEPT6</td>
<td>department category (i.e., school, except that Arts and Sciences courses were initially categorized by department and Rhetoric and Bachelor of General Studies courses were coded separately from other special programs)</td>
</tr>
<tr>
<td>LEVTY1 - LEVTY6</td>
<td>combined categories indicating level and type of course</td>
</tr>
<tr>
<td>SORT1 - SORT6</td>
<td>combined categories indicating department, level, and type</td>
</tr>
</tbody>
</table>

**B. FINAL VARIABLES USED FOR THE ICLM'S**

<table>
<thead>
<tr>
<th>AGEGROUP</th>
<th>students' ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Groups: 25 and under, 26-30, over 30¹</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMNO</th>
<th>number of semesters attended to date, including current semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Groups: 1, 2, 3-4, 5 or more semesters¹</td>
</tr>
</tbody>
</table>

| TOTCRED | total number of credits earned by the student for the semester |

| PCCR² | percent of student's credit load in category i; eight categories were used: |

- **Upper Division, Lower Division** (course level)
- **Evening, Regular, Special** (course type)
- **Humanities - Social - Sciences - Rhetoric, Natural - Science - Mathematics, Professional and Other** (department category)

---

¹ Higher levels of aggregation were also used.

² See Table 26.
TABLE 26. GENERAL PROGRAM FOR DEVELOPING ICLM'S FROM STUDENTS' TRANSCRIPTS

(SPSS - Statistical Package for the Social Sciences)^1

<table>
<thead>
<tr>
<th>RUN NAME</th>
<th>PERCENT OF INDIVIDUAL CREDIT LOAD IN EACH COURSE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET FILE</td>
<td>PANAL (aggregated data)</td>
</tr>
<tr>
<td>COMPUTE</td>
<td>TOTCRED=NOFCRED1+NOFCRED2+NOFCRED3+NOFCRED4+NOFCRED6</td>
</tr>
<tr>
<td>DO REPEAT</td>
<td>XNC=NC1 TO NC45 (or total number of categories defined)</td>
</tr>
<tr>
<td>COMPUTE</td>
<td>XNC=0</td>
</tr>
<tr>
<td>END REPEAT</td>
<td>XDEPT=DEPT1, DEPT2, DEPT3, DEPT4, DEPT5, DEPT6</td>
</tr>
<tr>
<td>DO REPEAT</td>
<td>XLEVEL=LEVEL1, LEVEL2, LEVEL3, LEVEL4, LEVEL5, LEVEL6</td>
</tr>
<tr>
<td>IF</td>
<td>XTYPE=TYPE1, TYPE2, TYPE3, TYPE4, TYPE5, TYPE6</td>
</tr>
<tr>
<td>IF</td>
<td>XLEVEL=LEVEL1, LEVEL2, LEVEL3, LEVEL4, LEVEL5, LEVEL6</td>
</tr>
<tr>
<td>IF</td>
<td>XSORT=SORT1, SORT2, SORT3, SORT4, SORT5, SORT6</td>
</tr>
<tr>
<td>IF</td>
<td>XNOFCRED=NOFCRED1, NOFCRED2, NOFCRED3, NOFCRED4, NOFCRED5, NOFCRED6</td>
</tr>
<tr>
<td>IF</td>
<td>(XDEPT EQ 1) NC1 = NC1 + XNOFCRED</td>
</tr>
<tr>
<td>IF</td>
<td>(XLEVEL EQ 1) NCB = NC8 + XNOFCRED</td>
</tr>
<tr>
<td>IF</td>
<td>(XTYPE EQ 1) NC10 = NC10 + XNOFCRED</td>
</tr>
<tr>
<td>IF</td>
<td>(XLEVEL EQ 11) NC13 = NC13 + XNOFCRED</td>
</tr>
<tr>
<td>IF</td>
<td>(XSORT EQ 11) NC18 = NC18 + XNOFCRED</td>
</tr>
<tr>
<td>END REPEAT</td>
<td>XPCCR = PCCR1 TO PCCR45</td>
</tr>
<tr>
<td>END REPEAT</td>
<td>XNC = NC1 TO NC45</td>
</tr>
<tr>
<td>COMPUTE</td>
<td>XPCCR = XNC/TOTCRED</td>
</tr>
</tbody>
</table>

NOTE: PCCR1 - PCCR45 are the percentages of total credit load in each type of course for each semester record. The elements of the ICLM's, i.e., the average percentages for each type of student, are computed using the SPSS program breakdown.

1 Nie et al. (1975).
Exploratory Analysis

Choosing Student and Course Characteristics and Levels of Aggregation

The choice of student and course characteristics to be studied in the model depends on the potential value of the resulting ICLM's for decision making. Three factors must be considered:

- the availability of adequate data,
- the existence of significant relationships for the variables chosen, first between student and course characteristics and second between the course characteristics and the budget,
- the likelihood of future changes in the distribution of either the students or their course selections.

The following variables were available from the transcripts:

student variables: age, sex, matriculation status, semester enrolled, grades, goal (degree and major), educational history.

course variables: department, level, relationship to core requirements, whether Evening College or a regular university course, title. (Transcripts do not indicate whether the course was held in Amherst or elsewhere.)

1 not available for this study as confidential data were blocked out.

2 Available for matriculated students only.
Similar data would be found on the transcripts of most college and university extension programs. Depending on the method of research and the characteristics of the institution, any of the statistics may meet the criteria listed above.

In the study of the evening college, the major part of the exploratory analysis consisted of trying out possible ICLM's by selecting variables and testing for significance with various levels of aggregation. Once a set of variables and groupings is chosen, computing the elements of the ICLM is simply a matter of averaging the data from individual semester records. Analysis of variance (ANOVA) can give a rough idea of the significance of the differences between the groups selected.\(^1\) The SPSS program BREAKDOWN provides a convenient means of testing a large number of possible ICLM's in a short time.

As expected, it was found that a high level of aggregation is required to produce results that are statistically significant. The results of the analysis are reported in the next section.

---

\(^1\) The conditions for ANOVA are violated because the sample is not random and more importantly because percentages are not normally distributed. However, since the levels of significance given by the ANOVA for the final groupings are all less than .05, it is safe to assume that these ICLM's represent statistically significant differences in student behavior (Steger, 1971; Boneau, 1960; Cochran, 1947; Glass and Stanley, 1970).
Looking for Trends with Time

Analyses of transcript data might be expected to reveal both secular and seasonal variations in course distributions. Because in this project, only transcripts of students who were enrolled in 1977-78 and 1978-79 were selected, secular trends could not be studied from the transcript data. Seasonal differences were found. Time trends are discussed in Section 3 of this appendix.

Selecting the Sample for the Final Analysis

Before constructing the final ICLM's it is necessary to decide which parts of the sample best represent the population under study. The sample described below was used in the ICLM's for LEARN.

A. ICLM's representing all students enrolled on the Amherst campus.

1) The OTHSTU file (see Table 23) was used, 2) students not living within fifteen miles of Amherst were excluded, and 3) all semesters before Fall 1977 were excluded.

B. ICLM's representing students who matriculated through the Division and their enrollments in courses at Amherst.

1) The MATSTU file (see Table 23) was used, 2) all students not living within fifteen miles of Amherst were excluded, and 3) all semesters before Fall 1975 were excluded.

The reasons for these choices are as follows:
1. The OTHSTU file: Even though this file includes no records for students who matriculated prior to July, 1979, it is reasonably representative of the entire student population. This is because the proportion of matriculated students is very small and because students who matriculated after July, 1979 are represented in the OTHSTU file. (Students who matriculate typically attend several semesters before doing so.)

2. The MATSTU file: Although this file does not contain the records of students who matriculated after July, 1979, it is representative of students who matriculate through the Division.

3. Residence within fifteen miles of Amherst: By eliminating records of students living outside the Amherst area, the number of off-campus courses represented could be expected to be reduced to an insignificant portion of the total.

4. Recent semesters: the population sampled included only those students who took courses during the period Fall 1977 though Spring 1979. Using records of courses from earlier semesters could introduce biases, especially in the analysis of the OTHSTU group; these students typically attend only one semester. Because of the small number of matriculated students and the stability of their behavior, earlier records were used in the analysis of this group.
Results: ICLM's and Other Variables Computed from Transcripts
(See Table 27.)

The ICLM's (Variable FLM)

Several ICLM's were computed. The differences among them lie in the student and course attributes analyzed:

Students are described in terms of age, semesters enrolled, and whether they seek a degree through the Division. 1 Age and semesters enrolled are analyzed separately.

Courses are described in terms of level (upper or lower division), type (Evening College, regular university, or independent-special), and department group (science—mathematics, other arts and sciences, all other). ICLM's were developed for each individual classification. The distribution of the total student enrollment among combined course categories (e.g., level and type) was also computed. In most cases there were not enough data to compute ICLM's for combined course classifications directly from the transcript data. 2

Since each description of the students can be combined with each description of the courses, the total number of ICLM's is large. The final choice for use in LEARN and budget analysis depends upon the problems to be studied (see Chapter X for the samples actually used).

1 It is not possible to isolate the records of students who will not seek a degree through the Division. It is only possible to develop ICLM's that compare course loads of students who have matriculated with those of students who have not done so.

2 They were computed by combining the variables computed directly.
Other Variables

Two other enrollment variables were computed from the transcript data: $F$, the fraction of students of each type, $L$, the total number of credits taken each semester by typical students in each group. The remaining enrollment variables, namely $N$, the total semester enrollment, and $DM$, the induced service load matrix, were computed from other data. These are discussed in Section 2 of this appendix.
**TABLE 27. FRACTIONAL LOAD MATRICES AND STUDENT PROFILES FROM TRANSCRIPT DATA**

**PART A. ALL STUDENTS**

computed from 1977-1978 and 1978-1979 records of students in the Amherst area (15 miles of campus); based on about 700 semester records for students classed as "Other".

I. Fractional Load Matrices for Age Groups

a. DEPARTMENT GROUPS ($FLM_2$)

<table>
<thead>
<tr>
<th></th>
<th>HUM-RHET</th>
<th>SCI-MATH</th>
<th>BGS, EDUC.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOC</td>
<td>SCI</td>
<td>BUS, OTHER</td>
</tr>
<tr>
<td>25 and under</td>
<td>.33</td>
<td>.19</td>
<td>.28</td>
</tr>
<tr>
<td>26-30</td>
<td>.35</td>
<td>.23</td>
<td>.42</td>
</tr>
<tr>
<td>over 26</td>
<td>.47</td>
<td>.13</td>
<td>.40</td>
</tr>
<tr>
<td>ALL AGES</td>
<td>.47</td>
<td>.19</td>
<td>.34</td>
</tr>
</tbody>
</table>

b. LOWER OR UPPER DIVISION ($FLM_1$)

<table>
<thead>
<tr>
<th></th>
<th>LD</th>
<th>UD</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 or under</td>
<td>.74</td>
<td>.26</td>
</tr>
<tr>
<td>over 25</td>
<td>.60</td>
<td>.40</td>
</tr>
<tr>
<td>ALL AGES</td>
<td>.68</td>
<td>.32</td>
</tr>
</tbody>
</table>

c. CE, DAY, OR, SPECIAL ($FLM_3$)

<table>
<thead>
<tr>
<th></th>
<th>CE</th>
<th>DAY</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>REG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 or under</td>
<td>.42</td>
<td>.54</td>
<td>.04</td>
</tr>
<tr>
<td>over 25</td>
<td>.51</td>
<td>.42</td>
<td>.07</td>
</tr>
<tr>
<td>ALL AGES</td>
<td>.46</td>
<td>.49</td>
<td>.05</td>
</tr>
</tbody>
</table>

d. TOTAL CREDITS (L)

<table>
<thead>
<tr>
<th></th>
<th>CE LD</th>
<th>CE UD</th>
<th>DAY LD</th>
<th>DAY UD</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 and under</td>
<td>6.12</td>
<td></td>
<td></td>
<td></td>
<td>.55</td>
</tr>
<tr>
<td>26-30</td>
<td>5.99</td>
<td></td>
<td></td>
<td></td>
<td>.26</td>
</tr>
<tr>
<td>over 30</td>
<td>5.19</td>
<td></td>
<td></td>
<td></td>
<td>.19</td>
</tr>
<tr>
<td>ALL AGES</td>
<td>5.92</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

e. FRACTION OF ALL STUDENTS (F)

<table>
<thead>
<tr>
<th></th>
<th>CE LD</th>
<th>CE UD</th>
<th>DAY LD</th>
<th>DAY UD</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 and under</td>
<td>.35</td>
<td>.11</td>
<td>.32</td>
<td>.16</td>
<td>.06</td>
</tr>
<tr>
<td>26-30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>over 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL AGES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

f. LEVEL AND TYPE COMBINED – PERCENT OF TOTAL COURSE LOAD

<table>
<thead>
<tr>
<th></th>
<th>CE LD</th>
<th>CE UD</th>
<th>DAY LD</th>
<th>DAY UD</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL STUDENTS</td>
<td>0.20</td>
<td>0.25</td>
<td>0.02</td>
<td>0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

g. DEPARTMENT CATEGORY AND TYPE COMBINED – PERCENT OF TOTAL COURSE LOAD

<table>
<thead>
<tr>
<th></th>
<th>hum rht</th>
<th>soc sci</th>
<th>sci math</th>
<th>bus, educ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ce reg</td>
<td>ce reg</td>
<td>ce reg</td>
<td>ce reg</td>
</tr>
<tr>
<td></td>
<td>spec</td>
<td>spec</td>
<td>spec</td>
<td>spec</td>
</tr>
<tr>
<td>ALL STUDENTS</td>
<td>0.20</td>
<td>0.25</td>
<td>0.02</td>
<td>0.06</td>
</tr>
</tbody>
</table>
TABLE 27 CONTINUED

PART A. ALL STUDENTS, continued

II. FLM'S AND OTHER VARIABLES FOR NUMBER OF SEMESTERS ENROLLED TO DATE

a. DEPARTMENT GROUPS (NO VARIATION BY SEMESTER) (FLM<sub>d</sub>)

<table>
<thead>
<tr>
<th></th>
<th>HUM-RHET</th>
<th>SCI-MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL STUDENTS</td>
<td>.48</td>
<td>.19</td>
<td>.33</td>
</tr>
</tbody>
</table>

b. LOWER OR UPPER DIVISION  

c. CE, DAY, OR SPECIAL  
d. TOTAL CREDITS  
e. FRACTION OF ALL STUDENTS

<table>
<thead>
<tr>
<th>SEMESTERS</th>
<th>(FLM&lt;sub&gt;1&lt;/sub&gt;)</th>
<th>(FLM&lt;sub&gt;c&lt;/sub&gt;)</th>
<th>(L)</th>
<th>(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.71 .29</td>
<td>.51 .44</td>
<td>.05</td>
<td>.44</td>
</tr>
<tr>
<td>2</td>
<td>.69 .31</td>
<td>.42 .54</td>
<td>.04</td>
<td>6.51</td>
</tr>
<tr>
<td>3-4</td>
<td>.60 .40</td>
<td>.25 .64</td>
<td>.11</td>
<td>7.00</td>
</tr>
<tr>
<td>5 or more</td>
<td>.47 .53</td>
<td>.49 .44</td>
<td>.07</td>
<td>6.15</td>
</tr>
<tr>
<td>ALL</td>
<td>.68 .32</td>
<td>.46 .49</td>
<td>.05</td>
<td>5.91</td>
</tr>
</tbody>
</table>

See Part A1 of this table for the distribution of the total student enrollment across combined course categories.

1 Variables computed directly from transcripts. See Table 33 for corrections for time trends and other factors.

2 The number of students who will eventually matriculate through the Division in the "other" student sample is approximately the same as that expected from a random sample of the entire population. This is because a typical student who receives a degree through the Division attends for more than five semesters, but does not matriculate until the final semester. The error introduced by the approximation is very small because the total number of matriculated students is very small.

3 KEY TO ABBREVIATIONS:

LD = lower division  
UD = upper division

CE = division of continuing education  
DAY = regular university day

SPECIAL = all learning experiences other than regular courses, whether given by the Division or directly by the departments; almost all fall in the latter category. Included are independent study, practice teaching, other practica, and other less common kinds of learning experience.

HUM-RHET SOC SCI = humanities, rhetoric, and social sciences  
SCI-MATH = natural sciences and mathematics

BUS, EDUC, BGS, OTHER = business, education, bachelor of general studies and other

4 Including current semester.
TABLE 27 CONTINUED

PART B. MATRICULATED STUDENTS

Computed from records of students in the Amherst area (15 miles of campus) using data from fall 1975 through Spring 1979, based on about 90 semester records for students categorized as "matriculated," i.e., those who had matriculated before the end of the Spring 1979 semester.

I. FLM'S FOR AGE GROUPS

a. DEPARTMENT GROUPS (FLM_d)

<table>
<thead>
<tr>
<th></th>
<th>HUM-RHET</th>
<th>SCI-MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 and under</td>
<td>.53</td>
<td>.16</td>
<td>.31</td>
</tr>
<tr>
<td>over 30</td>
<td>.51</td>
<td>.05</td>
<td>.44</td>
</tr>
<tr>
<td>ALL</td>
<td>.52</td>
<td>.10</td>
<td>.38</td>
</tr>
</tbody>
</table>

b. LOWER OF UPPER DIVISION (FLM_t)

c. CE, DAY, OR SPECIAL (FLM_s)
d. TOTAL CREDITS OF ALL STUDENTS (L)
e. FRACTION (F)

<table>
<thead>
<tr>
<th></th>
<th>LD</th>
<th>UD</th>
<th>CE</th>
<th>DAY</th>
<th>SPEC</th>
<th>(L)</th>
<th>(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 and under significant</td>
<td>.48</td>
<td>.38</td>
<td>.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>over 30 difference</td>
<td>.76</td>
<td>.13</td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td>.67</td>
<td>.33</td>
<td>.63</td>
<td>.25</td>
<td>.12</td>
<td>8.79</td>
<td>1.00</td>
</tr>
</tbody>
</table>

f. LEVEL AND TYPE COMBINED - PERCENT OF TOTAL COURSE LOAD

<table>
<thead>
<tr>
<th></th>
<th>CE LD</th>
<th>CE UD</th>
<th>DAY LD</th>
<th>DAY UD</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL students</td>
<td>.49</td>
<td>.14</td>
<td>.18</td>
<td>.07</td>
<td>.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CE reg</th>
<th>spec</th>
<th>CE reg</th>
<th>spec</th>
<th>CE reg</th>
<th>spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL students</td>
<td>.35</td>
<td>.11</td>
<td>.06</td>
<td>.05</td>
<td>.05</td>
<td>.23</td>
</tr>
</tbody>
</table>
TABLE 27 CONTINUED

PART B. MATRICULATED STUDENTS, continued

II. FLM’S FOR NUMBER OF SEMSTERS ENROLLED TO DATE

a. DEPARTMENT GROUPS (FLM_d)

<table>
<thead>
<tr>
<th>SEMESTERS</th>
<th>HUM-RHET</th>
<th>SCI-MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOC</td>
<td>SCI</td>
<td></td>
</tr>
<tr>
<td>under 5</td>
<td>.58</td>
<td>.14</td>
<td>.28</td>
</tr>
<tr>
<td>5 or more</td>
<td>.44</td>
<td>.06</td>
<td>.50</td>
</tr>
<tr>
<td>ALL</td>
<td>.52</td>
<td>.10</td>
<td>.38</td>
</tr>
</tbody>
</table>

b. LOWER c. CE, DAY, OR SPECIAL DIVISION (FLM_c)

<table>
<thead>
<tr>
<th>SEMESTERS</th>
<th>LD</th>
<th>UD</th>
<th>CE</th>
<th>DAY</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>.78</td>
<td>.22</td>
<td>.49</td>
<td>.39</td>
<td>.12</td>
</tr>
<tr>
<td>3-4</td>
<td>.52</td>
<td>.48</td>
<td>.64</td>
<td>.31</td>
<td>.05</td>
</tr>
<tr>
<td>5 or more</td>
<td>.52</td>
<td>.48</td>
<td>.64</td>
<td>.31</td>
<td>.05</td>
</tr>
<tr>
<td>ALL</td>
<td>.67</td>
<td>.33</td>
<td>.63</td>
<td>.25</td>
<td>.12</td>
</tr>
</tbody>
</table>

c. TOTAL CREDITS (L)

d. FRACTION OF ALL STUDENTS (F)

<table>
<thead>
<tr>
<th>SEMESTERS</th>
<th>L</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>8.79</td>
<td>.66</td>
</tr>
<tr>
<td>3-4</td>
<td>10.44</td>
<td>.21</td>
</tr>
<tr>
<td>5 or more</td>
<td>7.64</td>
<td>.13</td>
</tr>
<tr>
<td>ALL</td>
<td>8.79</td>
<td>1.00</td>
</tr>
</tbody>
</table>

See Part B1 for the distribution of the total matriculated student enrollment across combined course categories.
### TABLE 27 CONTINUED

#### PART C. DIFFERENCES BETWEEN MATRICULATED STUDENTS AND ALL STUDENTS

summarized from Parts A and B.

#### a. DEPARTMENT GROUPS (FLM₄)

<table>
<thead>
<tr>
<th></th>
<th>HUM-RHET</th>
<th>SCI MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculated</td>
<td>.52</td>
<td>.10</td>
<td>.38</td>
</tr>
<tr>
<td>all students</td>
<td>.47</td>
<td>.19</td>
<td>.34</td>
</tr>
</tbody>
</table>

#### b. LOWER AND UPPER DIVISION (FLM₂)

<table>
<thead>
<tr>
<th></th>
<th>LD</th>
<th>UD</th>
<th>CE</th>
<th>DAY</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>mat. stdnts</td>
<td>.68</td>
<td>.32</td>
<td>.63</td>
<td>.25</td>
<td>.12</td>
</tr>
<tr>
<td>all students</td>
<td>no difference</td>
<td>.46</td>
<td>.49</td>
<td>.05</td>
<td></td>
</tr>
</tbody>
</table>

#### c. CE, DAY, OR SPEC (FLM₄)

<table>
<thead>
<tr>
<th></th>
<th>CE</th>
<th>DAY</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculated</td>
<td>8.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>all students</td>
<td>5.91</td>
<td>approx.</td>
<td>.15</td>
</tr>
</tbody>
</table>

#### d. TOTAL CREDITS OF ALL STUDENTS (L)

<table>
<thead>
<tr>
<th></th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculated</td>
<td>.25</td>
</tr>
<tr>
<td>all students</td>
<td>.29</td>
</tr>
</tbody>
</table>

#### e. FRACTION (FLM₄) (F)

<table>
<thead>
<tr>
<th></th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculated</td>
<td>.12</td>
</tr>
<tr>
<td>all students</td>
<td>.06</td>
</tr>
</tbody>
</table>

#### f. LEVEL AND TYPE (FLM₄)

<table>
<thead>
<tr>
<th></th>
<th>CE</th>
<th>LD</th>
<th>CE</th>
<th>UD</th>
<th>DAY</th>
<th>UD</th>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculated</td>
<td>.49</td>
<td>.14</td>
<td>.18</td>
<td>.07</td>
<td>.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>all students</td>
<td>.36</td>
<td>.11</td>
<td>.31</td>
<td>.16</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### g. DEPARTMENT CATEGORY AND TYPE COMBINED (FLM₄)

<table>
<thead>
<tr>
<th></th>
<th>hum rhet &amp; soc sci</th>
<th>sci math</th>
<th>bus. educ BGS, other</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculated</td>
<td>.35</td>
<td>.11</td>
<td>.06</td>
</tr>
<tr>
<td>all students</td>
<td>.19</td>
<td>.26</td>
<td>.03</td>
</tr>
</tbody>
</table>
3. USING DATA FROM OTHER SOURCES FOR ESTIMATING COURSE ENROLLMENTS AND USE OF STUDENT SERVICES

In addition to transcripts, there are two important sources of information about an institution's students and courses:

- registration data (i.e., data about courses and classes),
- surveys and interviews of students and staff members.

**Registration Data**

Course registrations and information derived from these data can be used to estimate the values of certain variables used in budget analysis, to help decide what variables and aggregations to study, and to help check results derived from the analysis of transcripts and surveys. The following information about enrollments can be derived from class lists: registrations by type of course, total registrations

---

1 Only institutional data are considered here. For discussions of other sources of information (e.g., census data), see Chapter 5.

2 Student and class files both originate with the student's course registration, but are maintained separately in most records systems.
and number of students, trends with time, and preferences by sex.

In this project, registration data for the period, Fall 1976 through Fall 1978 were used for four purposes: 1) to estimate the value of \( N \) (total number of students), 2) to help determine what variables and aggregations would be most useful for describing courses, 3) to check the results of the transcript analysis, and 4) to analyze changes over time. The results of these studies are shown in the tables and graphs that follow:

Table 28 summarizes the registration and enrollment statistics.

Figures 1-6 represent the preliminary study of variables and aggregations as well as the preliminary analysis of time trends; the same set of graphs served both purposes.

Table 29 shows comparisons of the results for the transcript analysis and those of the registration study. The comparisons are discussed on page 430.

Time trends will be discussed in Section 3 of this appendix.

**Surveys and Interviews**

Surveys and interviews must be used to obtain information about students’ goals, their past education, and their use of support services, such as counseling. Methods
TABLE 28. TOTAL ENROLLMENT AND COURSE ENROLLMENTS FROM REGISTRATION DATA.

<table>
<thead>
<tr>
<th></th>
<th>FALL 76</th>
<th>SPRING 77</th>
<th>FALL 77</th>
<th>SPRING 78</th>
<th>FALL 78</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF STUDENTS (N)</td>
<td>1275</td>
<td>1190</td>
<td>1350</td>
<td>1135</td>
<td>1300</td>
</tr>
<tr>
<td>TOTAL LOAD PER STUDENT (L)</td>
<td>6.04</td>
<td>5.82</td>
<td>5.96</td>
<td>6.07</td>
<td>5.80</td>
</tr>
<tr>
<td>% OF TOTAL LOAD (^2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>day total</td>
<td>.45</td>
<td>.53</td>
<td>.56</td>
<td>.63</td>
<td>.59</td>
</tr>
<tr>
<td>ce total</td>
<td>.55</td>
<td>.47</td>
<td>.44</td>
<td>.37</td>
<td>.41</td>
</tr>
<tr>
<td>CE: hum-rhet, soc sci</td>
<td>.25</td>
<td>.22</td>
<td>.19</td>
<td>.15</td>
<td>.16</td>
</tr>
<tr>
<td>sci-math</td>
<td>.09</td>
<td>.05</td>
<td>.07</td>
<td>.05</td>
<td>.07</td>
</tr>
<tr>
<td>other</td>
<td>.21</td>
<td>.20</td>
<td>.18</td>
<td>.17</td>
<td>.18</td>
</tr>
<tr>
<td>% of CE LOAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower division</td>
<td>.93</td>
<td>.91</td>
<td>.76</td>
<td>.76</td>
<td>.75</td>
</tr>
<tr>
<td>upper division</td>
<td>.07</td>
<td>.09</td>
<td>.24</td>
<td>.24</td>
<td>.25</td>
</tr>
</tbody>
</table>

---

1 This table and Table 27 have been adjusted for special library science courses that were included in the original analysis of registration data (Figures 1-7), but do not appear on the transcripts.

2 See Table 27 for key to abbreviations.
Fig. 1 University of Massachusetts, Division of Continuing Education - Amherst campus
1976-1978 Registration Data
Undergraduate Enrollment - Day and Evening

FALL ONLY

SPRING ONLY

SPRING AND FALL
Fig. 2  1976-1978 Registration Data
Undergraduate Credits per Student
Day and Evening

- day credits/day student
- total credits/all students
- eve. credits/eve. student
- lower div. eve. credits/eve. student
- upper div. eve. credits/eve. student

 credits/student

Fall 76  Spring 77  Fall 77  Spring 78  Fall 78

- total credits/all students
- day credits/all students
- eve. credits/all students

Fall 76  Spring 77  Fall 78  Spring 78  Fall 78
Fig. 3  1976-1978 Registration Data
Undergraduate Credits by School - Day and Evening

LOWER DIVISION

<table>
<thead>
<tr>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

KEY:
- hum, fine arts, rhet
- social sciences
- basic math, progr.
- other sci. 2 math
- business adm.
- all other

UPPER DIVISION

<table>
<thead>
<tr>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

KEY:
- business adm.
- bachelor of general studies 2
- cont. ed.
- all other

Dates:
- Fall 76
- Spring 77
- Fall 78
- Spring 77
- Fall 78
- Spring 78
- Fall 78
Fig. 4 1976-1978 Registration Data Undergraduate Credits by School - Day and Evening Classes

GROUP I
- Humanities, Fine Arts, & Rhetoric
- Social and Behavioral Sciences
- Natural Sciences & Mathematics

GROUP II
- School of Business Adminis.
- School of Education
- All other
Fig. 5  Percent of Course Load by Department Types and for Day versus Evening Classes

- total regular day
- total evening

% of course load

- other
- humanities & social sci.
- natural sci. & mathematics

- total regular day
- total evening

- other
- humanities & social sci.
- natural sci. & mathematics

- total regular day
- total evening

- other
- humanities & social sci.
- natural sci. & mathematics

Fall 76  Spring 77  Fall 77  Spring 78  Fall 79

FALL ONLY

SPRING ONLY

SPRING AND FALL
Fig. 6  1976-1978 Registration Data
Percent of Course Load
Lower and Upper Division Evening Classes

lower division evening classes

upper division evening classes

Fall 76  Spring 77  Fall 77  Spring 78  Fall 78
TABLE 29. TRANSCRIPT AND REGISTRATION STUDIES: COMPARISON OF RESULTS  

PERCENT OF COURSE LOAD  
(all students)  
from  
transcripts  
from 77-78  
registration  
data  
from 78  
registration  
data  

DEPARTMENT GROUPS  
CE: hum-rhet, soc sci  .19  .18  .16  
sci math  .08  .06  .06  
other  .18  .18  .17  

CONTINUING EDUCATION VERSUS REGULAR DAY CLASSES  
CE TOTAL  .45  .42  .39  
DAY TOTAL  .55  .58  .61  

LOWER DIVISION VERSUS UPPER DIVISION  
CE: LD  .77  .79  .76  
UD  .23  .21  .24  

TOTAL CREDITS PER STUDENT  5.93  5.94  5.92  

CONCLUSIONS  
1. The two studies yield results that are consistent with each other. The greatest discrepancy is in the continuing education versus regular day percentages of course load. It appears that the bias stems from the difficulty in determining whether certain courses listed on the transcripts are continuing education or regular courses. The solution to the difficulty is to adjust the ICLM's to fit the registration data (see Table 33).  
2. The data may need adjustment for time trends (see part 3 of this appendix).  

1 See Table 27 for key to abbreviations.  
2 On the transcripts, the field for course number contains four spaces. An asterisk in the fourth space designates continuing education sponsored courses. However, if the course number has four symbols, there is no indication of sponsorship. These cases were treated as missing values in the analysis of sponsorship.
include: 1) staff interviews and questionnaires, 2) anonymous student surveys, and 3) student surveys where students are identified and their responses combined with information from their transcripts. These approaches are compared in Table 34.

Both staff interviews and anonymous questionnaires were used to acquire information for LEARN. Although no attempt was made to combine transcript and survey data, the analysis of the anonymous questionnaires suggests that this approach would be productive and economical.

Discussions with the staff provided suggestions for categorizing students and for developing scenarios to be tested using LEARN. In addition, staff interviews provided a qualitative check on information from other sources. Staff estimates of the impact of different groups of students on counseling and other support services were particularly important. No quantitative results were obtained from this source.

Three anonymous surveys of Continuing Education students were studied: a questionnaire distributed at registration in 1974 (University of Massachusetts Division of Continuing Education, 1974), 2) a telephone survey conducted in 1977 (Davis and Weglowski, 1977), and 3) a comprehensive survey designed for use with LEARN and pilot tested in October 1979. Although the two earlier surveys were of value to this project only for background
information, had either included a question about the use of student services (e.g., 5a, Table 32), it would have yielded satisfactory estimates that might have been used in the induced service load matrix, DM.

The survey designed for this project is shown in Table 32. The results of the pilot test of the questionnaire are shown in Tables 30 and 31. Part of the induced service load matrix, DM, was constructed from these data (see Table 30 for estimates of the use of the counseling service and comments on these results).

The pilot test of the questionnaire demonstrated the feasibility of the approach and pointed up certain advantages and disadvantages. On the positive side, the survey provided a straightforward method of estimating certain values for the induced service load matrix (that is, of analyzing the use of the counseling service by various kinds of students classified by age, semesters of study, and goals); a less detailed survey could have achieved this purpose, however. On the negative side, a comprehensive survey is expensive and time consuming. Furthermore, for constructing ICLM's, the use of transcripts alone or in combination with a signed questionnaire is cheaper and yields better results. In short, a comprehensive survey should be conducted only if decision makers have a strong interest in a wide range of results. Since this was not the case in the Division of Continuing Education, the project
### TABLE 30. USE OF COUNSELING SERVICES

#### A. PROBABILITY OF USE DURING SEMESTER

<table>
<thead>
<tr>
<th>AGE</th>
<th>SEMESTERS ENROLLED</th>
<th>DEGREE INTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>under 25 .17</td>
<td>under 25 .17</td>
<td>do not seek degree ---</td>
</tr>
<tr>
<td>26-30 .33</td>
<td>25 or more .50</td>
<td>seek degree .35</td>
</tr>
<tr>
<td>over 30 1.00</td>
<td></td>
<td>all students .29</td>
</tr>
</tbody>
</table>

#### B. RELATIVE USE

<table>
<thead>
<tr>
<th>AGE</th>
<th>SEMESTERS ENROLLED</th>
<th>DEGREE INTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>under 25 1</td>
<td>under 25 1</td>
<td>do not seek degree ---</td>
</tr>
<tr>
<td>26-30 2</td>
<td>25 or more 3</td>
<td>seek degree 1.2</td>
</tr>
<tr>
<td>over 30 6</td>
<td></td>
<td>all students 1.0</td>
</tr>
</tbody>
</table>

#### COMMENTS

Although data from the pilot test provide only very crude estimates of the use of counseling services by various groups of students, using these results appears to be justified because, in all three cases, the estimates are consistent with the impressions of the counseling staff.

Because the survey was conducted early in the semester, the estimates may well be low. This is not necessarily a problem because only the relative use of the services is important in LEARN. It seems reasonable to assume that the relative values remain constant over the semester.

---

1 The classification "degree-seeking" vs. "all students" is used in LEARN because students not seeking a degree could not be identified as a separate group in the analysis of the transcripts.
TABLE 31. SURVEY RESULTS

RESULTS OF A PILOT TEST CONDUCTED IN A MATHEMATICS 104 (REVIEW ALGEBRA) CLASS. THE COURSE IS OFFERED FOR ONE CREDIT AND IS PART OF A THREE CREDIT SEQUENCE. TWENTY-ONE STUDENTS FILLED OUT THE QUESTIONNAIRE SHOWN IN TABLE 32.

1. COURSE LOAD

Math 104: 100%

Average total credits: 5

Department categories: hum-rhet, soc sci\(^2\) .23  
                        sci math .60  
                        prof, other .17

Course type: Evening .68  
              Day .32  
              Special ---

Course level: lower division .90  
              upper division .10

Location: Amherst 1.00

2. 3 DESIRED COURSES (see also page 236)

65% desired other courses in Fall 1979

43% would have taken additional credits in Fall 1979 if they had been able to enroll in the courses of their choice.

average additional load\(^3\)

students who would take more credits  5 credits  
all students  2 credits

department categories of courses desired: hum-rhet, soc sci\(^2\) .36  
                                         sci, math .40  
                                         prof, other\(^4\) .24

4. TIME AND LOCATION PREFERRED

strong preference for day courses  10%  
a preference for locations other than Amherst  30%  
(other responses were scattered)

5. USE OF STUDENT SERVICES

Continuing Education Services: Any use  30%

<table>
<thead>
<tr>
<th>Service</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>transfer matters</td>
<td>15%</td>
</tr>
<tr>
<td>career counseling</td>
<td>10%</td>
</tr>
<tr>
<td>veterans' affairs</td>
<td>5%</td>
</tr>
<tr>
<td>other</td>
<td>5%</td>
</tr>
</tbody>
</table>

\(^1\) In addition to other courses in the mathematics review sequence.

\(^2\) See Table 27 for key to abbreviations.

\(^3\) Assumes an average of one credit for remaining courses in the mathematics review sequence.

\(^4\) Mostly business courses.
TABLE 31 CONTINUED

SURVEY QUESTION 5, continued

addition fees: no additional fees paid — 48%
Identification card (19% paid this only) — 48
at least one health fee — 14
at least one other fee — 19
{ Adds up to more than
100%; some students
paid more than one
type of fee. }

6. (See page 437.)

7. HIGHEST DEGREE: high school 62%
two-year college 24
four-year college 14
other —

8. NUMBER OF SEMESTERS ENROLLED THROUGH DIVISION; 1ST SEMESTER 62%
2-4 28
more than four 10

9. NUMBER OF SEMESTERS FULL-TIME AT THE UNIVERSITY:

<table>
<thead>
<tr>
<th></th>
<th>none</th>
<th>1-3</th>
<th>over 3</th>
<th>——</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75%</td>
<td>25</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

10. REASONS FOR TAKING COURSES — items listed as very important or important:
college degree — 72%
qualify for graduate school (have college degree) — 10
advance in present occupation — 33
change occupations — 50
increase skills and knowledge — 85
other —

11. PLANS FOR A BACHELOR’S DEGREE

<table>
<thead>
<tr>
<th>All students</th>
<th>degree-seeking students</th>
</tr>
</thead>
<tbody>
<tr>
<td>a &amp; b. major:</td>
<td></td>
</tr>
<tr>
<td>hum. soc sci</td>
<td>5%  7%</td>
</tr>
<tr>
<td>science</td>
<td>28  37</td>
</tr>
<tr>
<td>bus. other</td>
<td>42  56</td>
</tr>
<tr>
<td>not seeking degree</td>
<td>25</td>
</tr>
<tr>
<td>c. where:</td>
<td></td>
</tr>
<tr>
<td>through evening college</td>
<td>24%  31</td>
</tr>
<tr>
<td>reg. Univ. of Mass.</td>
<td>38  51</td>
</tr>
<tr>
<td>other</td>
<td>5  7</td>
</tr>
<tr>
<td>undecided</td>
<td>8  11</td>
</tr>
<tr>
<td>not seeking degree</td>
<td>25</td>
</tr>
<tr>
<td>d when:</td>
<td></td>
</tr>
<tr>
<td>within 1 year</td>
<td>——</td>
</tr>
<tr>
<td>1-2 years</td>
<td>15% 20%</td>
</tr>
<tr>
<td>3-5 years</td>
<td>48  64</td>
</tr>
<tr>
<td>over 5 or undecided</td>
<td>12  16</td>
</tr>
<tr>
<td>not seeking degree</td>
<td>25</td>
</tr>
</tbody>
</table>

12. AREA

| Amherst     | 50% | under 26 | 60% | F 38% | self of family | 85% |
| within 15 miles | 25  | 26-30   | 30  | M 62  | other         | 15  |
| outside 15 miles | 25  | over 30 | 10  |       |               |     |
TABLE 31 CONTINUED

SURVEY QUESTION 2. OTHER COURSES DESIRED

(and for which student is qualified; lower division unless indicated otherwise)

<table>
<thead>
<tr>
<th>Science and Mathematics:</th>
<th>1 each - physics, chemistry, computer science; 3 different math courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business:</td>
<td>3 accounting (1 upper division); 1 computers for business; 1 business law (upper division?)</td>
</tr>
<tr>
<td>Languages:</td>
<td>1 each - French, Spanish, Russian</td>
</tr>
<tr>
<td>Social Sciences:</td>
<td>3 economics, 1 sociology</td>
</tr>
</tbody>
</table>

Two reasons were given for not enrolling:

inconvenient time (conflict with work or other courses) 15 students
day courses overenrolled 9
TABLE 31 CONTINUED

SURVEY QUESTION 6. "What do you like most about Continuing Education? What do you like the least?

SUMMARY OF RESPONSES

NO RESPONSE - 3 students

LIKE BEST - 22 COMMENT BY 17 STUDENTS

**Flexibility and Convenience**
- Flexibility (no specifics) ----------- 1 comment
- Ability to go part-time ------------- 5
- Open admissions ------------------ 4
- Evening hours convenient --------- 5
- Location convenient for job ------ 1

**Atmosphere and Quality of Instruction**
- People helpful and interested ------ 1
- Relaxed atmosphere in class ------- 1
- Small size of evening classes ------ 1
- Helpful instructors ----------------
- Quality of Instruction ------------- 2

LIKE LEAST - 16 COMMENTS BY 11 STUDENTS

**Scheduling Problems; Lack of Available Classes**
- DAY COURSES: Difficulty of getting into classes --- 3 comments
- EVENING COURSES: limited choice -------------- 3
- course conflicts ------------------ 2
- inconvenience, prefer weekly meetings ------ 1

**Other Difficulties and Inconveniences**
- Expense --------------------------------- 1
- Inconvenient Bookstore Hours -------------- 1
- Location of registration ---------------- 1
- Inconvenience of getting identification card ---- 1

**Quality of Service; Attitudes**
- Courses not designed for needs of part-time students -- 1
- Teachers consider evening students as second class ---- 1
- Not enough explanation of services available to part-time students ---------------------------------- 1

QUESTIONS 15 AND 16 WERE NOT TABULATED; THE RESULTS WERE SCATTERED.
TABLE 32. PILOT SURVEY: QUESTIONNAIRE

- 1 -

STUDENT SURVEY

The Division of Continuing Education is conducting this survey to help us gain a better understanding of our students' needs.

The survey is STRICTLY CONFIDENTIAL. You are not asked to sign your name. Results will be circulated only in the form of overall impersonal statistics.

Please return the questionnaire to your instructor when you have completed it.

Thank you very much for your help.

Charles E. Heller, Director, Credit Programs

PART I. COURSE REGISTRATIONS AND PREFERENCES; STUDENT SERVICES

1. Please list all courses in which you are now enrolled through the Division of Continuing Education. Check the appropriate boxes to indicate the type and location of your courses.

<table>
<thead>
<tr>
<th>DEPARTMENT</th>
<th>COURSE NUMBER (or description)</th>
<th>COURSE TYPE</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Please describe any courses that you PARTICULARLY WISHED TO TAKE THIS FALL but in which you are NOT enrolled. Include courses desired, whether or not they are currently offered. Check appropriate boxes to indicate why you are not enrolled. Indicate course number and type only if applicable.

<table>
<thead>
<tr>
<th>I had hoped to take THIS FALL but have NOT ENROLLED in the following:</th>
<th>COURSE TYPE if applicable</th>
<th>REASON NOT ENROLLED</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPARTMENT &amp; COURSE NUMBER OR COURSE DESCRIPTION</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fall, 1979

DIVISION OF CONTINUING EDUCATION - CREDIT PROGRAMS
162 E Hastings Laboratory
University of Massachusetts
Amherst, Massachusetts 01003
TABLE 32 CONTINUED

1. Would you have taken a greater course load this semester if all the courses you want to take had been available to you?
   - Yes, I would have taken up to ___ credits in Fall '79.
   - No, I would not have increased my course load.

2. What times and locations are convenient for you for college level courses?
   - For Question 4, please circle numbers using the following code:
     1 = very desirable  
     2 = desirable  
     3 = acceptable  
     4 = undesirable  
     5 = unacceptable

- a. Locations
  - 1 2 3 4 5 Amherst
  - 1 2 3 4 5 (list other cities where you would like courses)
  - 1 2 3 4 5 own home
  - 1 2 3 4 5 at work

- b. Times
  - (Use spaces below to suggest specific times)
  - WEEKDAYS BEFORE 2 PM
    - 1 2 3 4 5 Mon-Fri AM
    - 1 2 3 4 5 Mon-Fri 12-2 PM
  - WEEKDAYS - LATE AFTERNOONS AND EVENINGS
    - 1 2 3 4 5 Mon-Thurs 2-4 PM
    - 1 2 3 4 5 Mon-Thurs even.
    - 1 2 3 4 5 Friday 2-4 PM
  - SATURDAYS
    - 1 2 3 4 5 Saturday AM
    - 1 2 3 4 5 Sat 12-4 PM
  - SPECIAL CONCENTRATED COURSES*
    - 1 2 3 4 5 Special courses

3. Student Services (for Question 5, check all appropriate boxes)
   - a. Number of Semesters as a Continuing Education student last Spring
   - b. Semester first enrolled in credit courses through the Division of Continuing Education
     - FALL, '79
     - SPRING, '79
   - c. Total credits earned prior to Fall '79 as a Continuing Education student:

4. How much did you pay through Continuing Education Fall '79?
   - Fine arts
   - Health services
   - Health insurance
   - General recreation
   - Picture ID
   - Student activities

5. What do you like best about Continuing Education? What do you like the least?

6. What is the highest degree or diploma you have received?
   - High school or equivalent
   - Associate degree (or two years college)
   - Bachelor's degree
   - Master's degree
   - Other:

7. History of Enrollment at UMass/Amherst through the Division of Continuing Education
   - Never a Continuing Education student before Fall '79; I am skipping to Question 9.

- a. Number of Semesters as a Continuing Education Student, Including Fall '79
   - 2 3 4 5 6 7 8 or more

- b. Semester first enrolled in credit courses through the Division of Continuing Education
   - FALL, '79
   - SPRING, '79

- c. Total credits earned prior to Fall '79 as a Continuing Education student:
### Table 32 Continued

#### 9. Enrollments at UMass/Amherst
- **CONTINUING EDUCATION**

#### 9a. FALL 79
- None (Continuing Education only)
- Undergraduate, full-time
- Graduate student (regular or special)

#### 9b-1. PRIOR SEMESTERS
- No prior semesters outside Continuing Education; I am skipping to Question 10.

#### 9b. Total NUMBER of semesters enrolled prior to Fall 79
- **Semesters undergraduate (full time)**
- **Semesters grad student (regular or special)**

#### 9c. Most recent semester prior to Fall 79
- Fall, 79 OR Spring, 79

#### 9d. Any degrees from UMass/Amherst?
- **Degree** | **Year** | **School or Department**

#### 10. Please indicate the importance to you of each reason for taking college level courses.

For Question 10, circle the appropriate numbers using the following code:
- 1 = very important
- 2 = important
- 3 = a factor
- 4 = of minor importance
- 5 = not a factor

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

- **You are seeking a college degree.**
- **You wish to qualify for admission to a graduate school.**
- **You are seeking advancement in your present occupation.**
- **You are seeking to change occupations.**
- **You are seeking to increase your skills and knowledge.**
- **Other:**

#### 11. PLANS TO EARN A BACHELOR'S DEGREE

- **Not seeking a bachelor's degree**
- **Undecided**

#### 11a. WHAT degree do you expect to earn?
- **3A** BS **BBA** DS **other:**
- **undecided**

#### 11b. MAJOR, if decided:

#### 11c. WHERE do you expect to earn your degree?
- **UMass/Amherst through CE**
- **other college or university**
- **undecided**

#### 11d. WHEN do you expect to earn your degree?
- **Within 1 year**
- **1-2 years**
- **3-5 years**
- **over 3 years**
- **don't know**

#### Part III. Personal Data

#### 12. LOCAL RESIDENCE:
- **City or town**
- **Zip**

#### 13. YEAR OF BIRTH:

#### 14. SEX:
- F
- M

#### 15. ANNUAL INCOME of self and spouse to nearest $5,000:

#### 16. OCCUPATIONS (check all appropriate boxes)
- Full time
- 10-35 hours/week
- Under 10 hours/week
- Seeking work
- Paid or Volunteer

#### 17. SOURCES OF FUNDS FOR FALL 79
- **CONTINUING EDUCATION FEES**
  - **Personal earnings (self/spouse)**
  - **Your family**
  - **Contribution from employer**
  - **Veterans' benefits**
  - **Personal bank loan**
  - **Social Security**
  - **Financial aid arranged through Continuing Education**
  - **Other:**

<table>
<thead>
<tr>
<th>Portion of Fee</th>
<th>1/2</th>
<th>1/2</th>
<th>1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal earnings (self/spouse)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Your family</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution from employer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veterans' benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal bank loan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Security</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial aid arranged through Continuing Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
was discontinued at the conclusion of the pilot test.

Surveys in which the students’ identities are known appear to be the best tools for developing comprehensive descriptions of an institution’s clientele. Because the survey information can be combined with transcript data, the questionnaires can be relatively short. A limited survey of this nature for the Division of Continuing Education would seek the following information:

- name, permission to use transcripts
- history as a full-time student at the university
- use of student services (5a)
- educational level (7)
- goals (10)
- plans to obtain a bachelor’s degree (11).

1 The numbers in parentheses refer to questions on the comprehensive survey shown on Table 32.

2 The following can be substituted for question 9:

Have you ever been enrolled at UMass, Amherst as a:
   a) regular full-time undergraduate?
      __yes; dates____
      __no
   b) regular or special grad student?
      __yes; dates____
      __no.

Data from the students’ regular University of Massachusetts transcripts can then be incorporated into the study. Alternatively, Question 9 can be asked.
4. CHANGES IN ENROLLMENT WITH TIME

In the study of changes in Evening College enrollment with time, transcript and registration data were examined for evidence of seasonal variations, secular trends, and sudden shifts. There were indications that all three kinds of change have occurred.

There appeared to be seasonal variations in three variables: the total number of students enrolled, the proportion of science registrations, and the proportion of evening class registrations. All are higher in the Fall than in the Spring.

Registration statistics show that the total number of students enrolled varies markedly between Fall and Spring semesters (see Table 28 and Figure 1). The transcripts provide no information about total enrollment. Separate runs of LEARN for Fall and Spring semesters can be used to take the seasonal variations into account.

The registration statistics indicate that there may be small seasonal variations in the relative enrollment in day and evening classes and in those in science and non-science classes (see Figure 5). The transcript data show the same fluctuations. No adjustments were made for the variations. Adjustments to the ICLM's would be advisable if the differences were larger and if the variation for individual categories of students were statistically significant.
Secular trends and sudden shifts were also evident in the graphs of the registration data. For example, Figures 1–2 indicate a slow growth in registrations for day classes and a decline in lower division evening registrations in the humanities and social sciences, while Figure 6 shows a rather sudden change between the 1976–77 and 1977–78 academic years in the relative number of day and evening registrations. Discussions with the Continuing Education staff led to the conclusion that these trends and shifts are the result of past changes in policies and students' preferences. As a result, it was decided to weight the recent data more heavily, but not to project the trends forward.

The variations representing total enrollment and all those that include relative enrollment in evening and day classes were adjusted for differences between the 1977–79 average and the 1978–79 academic year.

Table 33 summarizes the the basic corrections for changes with time.
TABLE 33. FINAL ESTIMATES

corrections for seasonal variables, shifts over time, and the bias in the transcripts against day courses.

Part A. Basic Corrections

<table>
<thead>
<tr>
<th>Total student enrollment: N</th>
<th>Fall estimate: 1150</th>
<th>Spring estimates: 1300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total credits for each type of student:</td>
<td>L(age), L(semno), L(mat)</td>
<td>(no corrections)</td>
</tr>
<tr>
<td>Fraction of students of each type:</td>
<td>F(age), F(semno), F(mat)</td>
<td>(no corrections)</td>
</tr>
<tr>
<td>Induced course load vectors for all students$^1$</td>
<td>cv(level)</td>
<td>(no corrections)</td>
</tr>
<tr>
<td></td>
<td>cv(deptgroup)</td>
<td>(no corrections)</td>
</tr>
<tr>
<td></td>
<td>cv(type)</td>
<td>evening regular day special</td>
</tr>
<tr>
<td></td>
<td>cv(level-type)</td>
<td>CE LD CE UD REG LD REG UD SPEC</td>
</tr>
<tr>
<td></td>
<td>cv(department-type)</td>
<td>hum. rhet soc sci sci.math other</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CE DAY SPEC CE DAY SPEC CE DAY SPEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.17 .27 .03 .06 .13 --- .17 .14 .03</td>
</tr>
</tbody>
</table>

1 The corrected FLM's are computed from the corrected vectors and the initial FLM's that had been computed directly from the transcript data (see Table 27). It is assumed for the purpose of constructing the corrected FLM's that the difference in each element of the FLM is proportional to the difference in the corresponding element in the appropriate course vector.

\[ FLM_{ij,new} = \frac{x_{ij}}{\sum_i x_{ij}} \times \frac{FLM_{ij,old}}{cv_{i,new}/cv_{i,old}}. \]

The same procedure is used to compute the combined FLM's from separate FLM's for individual course characteristics. In this case, a tentative combined matrix is first computed from the separate FLM's. In the case of level and type, for example:

\[ FLM_{ij,tent} = FLM_{k_j} \times FLM_{i_j} \quad \text{and} \quad x_{ij} = FLM_{i_j,tent} \times (cv_{i,new}/cv_{i,tent}). \]

See Part B of this Table for the corrected ICLM's.

2 See Table 27 for abbreviations.
TABLE 33 CONTINUED

Part B. Final Estimates for All Enrollment Variables

The enrollment analysis yielded several sets of input variables for LEARN. Each set represents a different description of Evening College for the 1978-79 academic year; each represents a possible base case for LEARN.

GROUP I. ALL STUDENTS CLASSIFIED BY AGE

<table>
<thead>
<tr>
<th>number of students, N</th>
<th>N(fall) = 1150</th>
<th>N(spring) = 1300</th>
</tr>
</thead>
</table>

fraction of students in each age group, \( F \)

<table>
<thead>
<tr>
<th>age</th>
<th>under 25</th>
<th>25-30</th>
<th>over 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F(\text{age}) )</td>
<td>.55</td>
<td>.26</td>
<td>.19</td>
</tr>
</tbody>
</table>

total credit load, \( L \)

\[ L(\text{age}) = 6.12 \quad 5.99 \quad 5.19 \quad \text{average load} = 5.92 \text{ credits} \]

CASE 1: department groups

<table>
<thead>
<tr>
<th>( FLM_d )</th>
<th>HUM-RHET</th>
<th>SCI-MATH</th>
<th>BGS, EDUC</th>
<th>BUS, OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>under 25</td>
<td>.53</td>
<td>.19</td>
<td>.28</td>
<td></td>
</tr>
<tr>
<td>25-30</td>
<td>.35</td>
<td>.23</td>
<td>.42</td>
<td></td>
</tr>
<tr>
<td>over 30</td>
<td>.47</td>
<td>.13</td>
<td>.40</td>
<td></td>
</tr>
<tr>
<td>all ages</td>
<td>.47</td>
<td>.19</td>
<td>.34</td>
<td></td>
</tr>
</tbody>
</table>

CASE 2: level

<table>
<thead>
<tr>
<th>( FLM_1 )</th>
<th>LD</th>
<th>UD</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 or less</td>
<td>.74</td>
<td>.26</td>
</tr>
<tr>
<td>over 25</td>
<td>.60</td>
<td>.40</td>
</tr>
<tr>
<td>all ages</td>
<td>.68</td>
<td>.32</td>
</tr>
</tbody>
</table>

CASE 3: type

<table>
<thead>
<tr>
<th>( FLM_t )</th>
<th>EVENING</th>
<th>DAY</th>
<th>SPECIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 or less</td>
<td>.36</td>
<td>.59</td>
<td>.05</td>
</tr>
<tr>
<td>over 25</td>
<td>.45</td>
<td>.47</td>
<td>.08</td>
</tr>
<tr>
<td>all ages</td>
<td>.40</td>
<td>.54</td>
<td>.06</td>
</tr>
</tbody>
</table>
### TABLE 33, PART B  CONTINUED

#### CASE 4: level and type combined  \( FLM_{lt} \)

<table>
<thead>
<tr>
<th></th>
<th>( FLM_{lt} )</th>
<th>( FLM_{lt} )</th>
<th>( FLM_{lt} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( FLM_{lt} )</td>
<td>EVENING</td>
<td>REGULAR</td>
<td>SPECIAL</td>
</tr>
<tr>
<td></td>
<td>CE UD</td>
<td>LD UD</td>
<td></td>
</tr>
<tr>
<td>25 or under</td>
<td>.29 .07</td>
<td>.43 .16</td>
<td>.05</td>
</tr>
<tr>
<td>over 25</td>
<td>.31 .14</td>
<td>.27 .20</td>
<td>.08</td>
</tr>
<tr>
<td>all ages</td>
<td>.30 .10</td>
<td>.36 .18</td>
<td>.06</td>
</tr>
</tbody>
</table>

#### CASE 5: department and type combined  \( FLM_{dt} \)

<table>
<thead>
<tr>
<th></th>
<th>( FLM_{dt} )</th>
<th>( FLM_{dt} )</th>
<th>( FLM_{dt} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( FLM_{dt} )</td>
<td>HUM RHET</td>
<td>SCI MATH</td>
<td>ALL OTHER</td>
</tr>
<tr>
<td></td>
<td>SDC SCI</td>
<td>CE DAY SPEC</td>
<td>CE DAY SPEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 or less</td>
<td>.17 .33</td>
<td>.03 .05</td>
<td>.14 ---</td>
</tr>
<tr>
<td>26-30</td>
<td>.14 .18</td>
<td>.03 .08</td>
<td>.15 ---</td>
</tr>
<tr>
<td>over 30</td>
<td>.19 .24</td>
<td>.04 .05</td>
<td>.08 ---</td>
</tr>
<tr>
<td>all ages</td>
<td>.17 .27</td>
<td>.04 .05</td>
<td>.08 ---</td>
</tr>
</tbody>
</table>
TABLE 33, PART B CONTINUED

GROUP II. ALL STUDENTS CLASSIFIED BY NUMBER OF SEMESTERS ATTENDING

number of students, N

<table>
<thead>
<tr>
<th></th>
<th>N(fall) = 1150</th>
<th>N(spring) = 1300</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>447</td>
<td>60</td>
</tr>
</tbody>
</table>

fraction of students in each group, F

<table>
<thead>
<tr>
<th>semester groups (including current semester)</th>
<th>1</th>
<th>2</th>
<th>3-4</th>
<th>5 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>F(semno) =</td>
<td>.60</td>
<td>.21</td>
<td>.12</td>
<td>.07</td>
</tr>
</tbody>
</table>

total credit load, L

<table>
<thead>
<tr>
<th></th>
<th>L(fall) =</th>
<th>L(spring) =</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.44</td>
<td>6.51</td>
</tr>
</tbody>
</table>

CASE 6: department groups FLM<sub>d</sub>

<table>
<thead>
<tr>
<th></th>
<th>HUM-RHET</th>
<th>SCI, MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCU</td>
<td>.47</td>
<td>.19</td>
<td>.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(no variation with number of semesters)</td>
<td></td>
</tr>
</tbody>
</table>

CASE 7: level FLM<sub>t</sub>

<table>
<thead>
<tr>
<th></th>
<th>LD</th>
<th>UD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASE 8: type FLM&lt;sub&gt;t&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EVENING</td>
<td>DAY</td>
<td>SPECIAL</td>
</tr>
<tr>
<td>1 semester</td>
<td>.45</td>
<td>.49</td>
</tr>
<tr>
<td>2</td>
<td>.36</td>
<td>.60</td>
</tr>
<tr>
<td>3 or more</td>
<td>.29</td>
<td>.63</td>
</tr>
<tr>
<td>all</td>
<td>.40</td>
<td>.54</td>
</tr>
</tbody>
</table>

CASE 9: level and type combined FLM<sub>t</sub>

<table>
<thead>
<tr>
<th></th>
<th>CE</th>
<th>DAY</th>
<th>SPECIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 semester</td>
<td>.35</td>
<td>.10</td>
<td>.34</td>
</tr>
<tr>
<td>2</td>
<td>.27</td>
<td>.09</td>
<td>.41</td>
</tr>
<tr>
<td>3 or more</td>
<td>.19</td>
<td>.10</td>
<td>.33</td>
</tr>
<tr>
<td>all students</td>
<td>.30</td>
<td>.10</td>
<td>.36</td>
</tr>
</tbody>
</table>

CASE 10: department and type combined FLM<sub>d</sub> 

<table>
<thead>
<tr>
<th></th>
<th>HUM, RHET</th>
<th>SCI, MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CE</td>
<td>DAY</td>
<td>SPEC</td>
</tr>
<tr>
<td>1 semester</td>
<td>.19</td>
<td>.25</td>
<td>.03</td>
</tr>
<tr>
<td>2</td>
<td>.15</td>
<td>.30</td>
<td>.02</td>
</tr>
<tr>
<td>3 or more</td>
<td>.12</td>
<td>.31</td>
<td>.04</td>
</tr>
<tr>
<td>all students</td>
<td>.17</td>
<td>.27</td>
<td>.03</td>
</tr>
</tbody>
</table>
TABLE 33, PART B CONTINUED

GROUP III. ALL STUDENTS CLASSIFIED BY MATRICULATION

| number of students, N | N(fall) = 1150 | N(spring) = 1300 |

fraction of students in each group, F

<table>
<thead>
<tr>
<th>students who eventually matriculate</th>
<th>all students</th>
</tr>
</thead>
<tbody>
<tr>
<td>F(mat) = .15</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>total credit load L</th>
</tr>
</thead>
<tbody>
<tr>
<td>L(mat) = 8.79</td>
</tr>
</tbody>
</table>

CASE 11: department groups FLM_d

<table>
<thead>
<tr>
<th>HUM, RHET</th>
<th>SCI, MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOC SCI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>matriculate</td>
<td>.52</td>
<td>.10</td>
</tr>
<tr>
<td>all</td>
<td>.47</td>
<td>.19</td>
</tr>
</tbody>
</table>

CASE 12: level FLM_l

<table>
<thead>
<tr>
<th>LD</th>
<th>UD</th>
<th>CE</th>
<th>DAY</th>
<th>SPECIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculate</td>
<td>.68</td>
<td>.32</td>
<td>.57</td>
<td>.29</td>
</tr>
<tr>
<td>all</td>
<td>(no difference)</td>
<td>.40</td>
<td>.54</td>
<td>.06</td>
</tr>
</tbody>
</table>

CASE 13: type FLM_t

<table>
<thead>
<tr>
<th>LD</th>
<th>UD</th>
<th>CE</th>
<th>DAY</th>
<th>SPECIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>matriculate</td>
<td>.43</td>
<td>.14</td>
<td>.19</td>
<td>.10</td>
</tr>
<tr>
<td>all</td>
<td>.30</td>
<td>.10</td>
<td>.36</td>
<td>.18</td>
</tr>
</tbody>
</table>

CASE 14: level and type combined FLM_lt

<table>
<thead>
<tr>
<th>CE</th>
<th>DAY</th>
<th>SPECIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD</td>
<td>UD</td>
<td>LD</td>
</tr>
<tr>
<td>matriculate</td>
<td>.43</td>
<td>.14</td>
</tr>
<tr>
<td>all</td>
<td>.30</td>
<td>.10</td>
</tr>
</tbody>
</table>

CASE 15: department and type combined FLM_dt

<table>
<thead>
<tr>
<th>HUM, RHET</th>
<th>SOC SCI</th>
<th>SCI, MATH</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CE</td>
<td>DAY</td>
<td>SPEC</td>
</tr>
<tr>
<td>matriculate</td>
<td>.28</td>
<td>.16</td>
<td>.08</td>
</tr>
<tr>
<td>all</td>
<td>.17</td>
<td>.27</td>
<td>.03</td>
</tr>
</tbody>
</table>
Three sources of information about students have been considered: these are transcripts, registration records, and surveys. It has been seen that, for any particular enrollment study, the value of each source depends upon the institution's record system and the resources available for the analysis.

In general, transcripts, surveys, or a combination of the two can be used to analyze the characteristics and behavior of an institution's clientele, to develop the induced course load and service load matrices, and to determine, with the exception of total enrollment and total registrations, the values of all other enrollment variables required for budget studies. Registration statistics provide estimates of total enrollment and registrations. In addition, all three sources provide information that can be used indirectly in budget studies. Registration statistics are especially useful for this purpose.
Transcripts

Transcript studies, when used alone, provide statistics about the relationship between demand for courses and students' ages, majors, abilities, and periods of enrollment. Studies combining transcript and survey data provide additional statistics about students' goals, educational history, and use of services. (The choice among types of survey is discussed below.)

Transcripts may or may not be machine-readable. Institutions with machine-readable transcripts can analyze students' course selections quickly and cheaply. The use of transcripts that are not machine-readable, however, is usually limited by the cost of coding the data. In this case useful results can be obtained at moderate cost by combining the appropriate transcript data with the results of a survey of a small sample of students who are identified.

1 Many adult education programs award no degrees or certificates and keep no transcripts. In studying such programs, registration forms can be substituted for transcripts. However, registration forms have the double disadvantage that they exist only in written form and provide no historical information. A signed questionnaire or a few extra questions on the registration form itself could help overcome these disadvantages.
Registration Statistics

Although in general, registration studies cannot be used to construct ICLM's, they are invaluable for the study of enrollments. Information about course and class registrations is available in many forms. Class rosters, lists of enrollments by course and class, reports of enrollments by type of course, and reports of total enrollments and registrations are assembled by educational institutions, and any of them can prove useful for budget studies. The possibilities can be grouped into three levels of aggregation: general reports of enrollment and registrations, lists of individual course enrollments, and class lists.

---

1 Class lists can be used to construct ICLM's based on sex or surname.
General Reports of Enrollments and Registrations

Although general statistics of the sort compiled for annual reports cannot be used directly to construct ICLM's, they are an inexpensive and easy-to-use source of information about total enrollment, enrollment in major programs, and changes over time. General statistics may be used in LEARN: 1) directly for specifying total enrollment, and 2) indirectly to determine levels of aggregation for course descriptions, to compute adjustments for time trends, and to check results of transcript and survey analyses.

Enrollments by Courses and Classes

Statistics about courses serve the same purposes as general reports, but have the advantage that the data may be grouped to suit the specific needs of the particular study. The disadvantage, of course, is that the additional analysis is time-consuming. Coding the lists of courses for the computer and using the appropriate statistical packages for analysis can save time and increase flexibility in using the information. Registration statistics were used extensively
in the pilot study of LEARN, the data were never coded for computer analysis, however.

**Class Lists**

All of the more general registration statistics can, of course, be derived from class rosters. The lists may prove useful for budget analysis if the statistics for the budget study and those for general reporting can be prepared simultaneously. Otherwise, the additional information obtained may not be worth the work required to code and manipulate these data.

**Surveys**

Surveys are valuable tools for enrollment analysis. Reports of past surveys provide background information and may provide data for analyzing time trends and the use of certain services. Anonymous surveys developed specifically for the purpose can be used to develop all the necessary data for a budget planning model. The cost of such studies is often prohibitive, however. Finally, surveys where the
### TABLE 34. SOURCES OF INFORMATION ABOUT STUDENT CHARACTERISTICS AND BEHAVIOR

<table>
<thead>
<tr>
<th>Transcripts</th>
<th>Registration</th>
<th>Surveys with anonymous</th>
<th>Surveys with registered</th>
<th>Staff Interviews</th>
<th>1. INFORMATION AVAILABLE FROM THIS SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>X A D X X X X X</td>
<td>X X X X X</td>
<td>G</td>
<td>age</td>
<td></td>
<td>sex</td>
</tr>
<tr>
<td>X X X X X X X</td>
<td></td>
<td></td>
<td>course enrollments, current year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X X X X G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X X X X G</td>
<td></td>
<td></td>
<td>course enrollments, prior years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B X X X X X G</td>
<td></td>
<td></td>
<td>educational history</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X X X X G</td>
<td></td>
<td></td>
<td>educational goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X G</td>
<td></td>
<td></td>
<td>vocational, avocational goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>grade average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. VARIABLES AVAILABLE FROM THIS SOURCE

a. FLM, F, L using:
- age
- sex
- enrollment history
- matriculation status
- educational goals
- other goals

b. DM using:
- age, sex, enrollment history, and noneducational goals
- matriculation status and educational goals

c. \( N = \) total number of students
d. Time Trends

3. ADVANTAGES OF USING THIS SOURCE

- low cost, low time demand
- available regardless of "need-to-know"
- accurate
- published or oral reports may be of general value

A only of records are machine readable or researcher has "need to know".
B limited information (e.g., only for some students)
C only if records are machine readable
D directly from class lists only
E available, but significant results difficult to obtain
F qualitative information only
G qualitative information only; valuable for future direction
H only if student signs agreement on survey form
I only if student signs agreement on survey form

1 Students' identities known.
2 Students' identities known. This option is evaluated only for situations where transcripts are not available.
respondants' identities are known and the data are combined with information from the students' transcripts have proved economical and valuable for a wide range of institutional studies (McIntosh, 1971).

Table 34 provides a summary of sources of information for enrollment studies.
APPENDIX B

LEARN - DOCUMENTATION AND LISTINGS OF COMPUTER PROGRAMS

1. DOCUMENTATION FOR LEARN

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEARNHOW</td>
<td>457</td>
</tr>
<tr>
<td>DEMONSTRATION</td>
<td>460</td>
</tr>
<tr>
<td>LEARNVARS</td>
<td>461</td>
</tr>
<tr>
<td>LEARNFNS</td>
<td>565</td>
</tr>
<tr>
<td>DESCINP</td>
<td>467</td>
</tr>
<tr>
<td>FINP</td>
<td>469</td>
</tr>
<tr>
<td>ENRINP</td>
<td>470</td>
</tr>
<tr>
<td>OUPUT</td>
<td>472</td>
</tr>
<tr>
<td>DISP</td>
<td>473</td>
</tr>
<tr>
<td>SERV</td>
<td>575</td>
</tr>
<tr>
<td>TOSTORADATA</td>
<td>476</td>
</tr>
</tbody>
</table>

Note: All programs are written in the APL programming language for the CYBER system at the University of Massachusetts, Amherst.
*** LEARN DOCUMENTATION: PROGRAM LEARNHOW ***

LIFELONG EDUCATION FOR ADULTS: RESOURCES AND NEEDS

A VARIABLE BUDGET MODEL FOR EDUCATIONAL PROGRAMS THAT SERVE PART-TIME ADULT STUDENTS.

SEE PROGRAM, DEMONSTRATION, FOR A DEMONSTRATION RUN.

BASIC FEATURES

LEARN IS A MODULAR PROGRAM THAT PROVIDES FOR THE ANALYSIS OF RELATIONSHIPS BETWEEN ENROLLMENTS, RESOURCES, AND BUDGETS.

INPUT INCLUDES:

1] ENROLLMENTS BY TYPE OF STUDENT (CLASSIFIED BY PERSONAL CHARACTERISTICS OR BY PROGRAM OF STUDY).
   NOTE THAT IF NO ANALYSIS OF THE EFFECTS OF STUDENT CHARACTERISTICS IS DESIRED, STUDENTS MAY BE GROUPED INTO A SINGLE CATEGORY.

2] RATES OF USE OF A) INSTRUCTIONAL AND B) SUPPORT SERVICES BY EACH GROUP OF STUDENTS (THE ICLM AND DM).


4] FEES SCHEDULES, PRICES AND OTHER RATES OF INCOME AND EXPENDITURE.

OUTPUT INCLUDES:

1] ENROLLMENTS - VARIABLES COMPUTED DIRECTLY FROM THE ENROLLMENT DATA.

2] RESOURCE REQUIREMENTS (E.G., NUMBER OF COURSES TAUGHT, NUMBER OF COUNSELORS).

3] THE DIRECT BUDGET, INCLUDING INCOME, COSTS, NET INCOME, AND UNIT COSTS FOR MAJOR BUDGET CATEGORIES.

4] THE PROGRAM BUDGET, INCLUDING INCOME, COSTS, NET INCOME, AND UNIT COSTS FOR EACH PROGRAM OR STUDENT GROUP.

OPTIONS

BECAUSE LEARN IS A MODULAR PROGRAM, IT IS POSSIBLE TO STUDY PARTICULAR RELATIONSHIPS WITHOUT UNDERTAKING A FULL
BUDGET STUDY, THE MODEL CAN BE USED TO STUDY THE RELATIONSHIP OF:
A] PROGRAM ENROLLMENTS TO THE USE OF INSTRUCTIONAL AND OTHER SERVICES,
B] THE USE OF SERVICES TO RESOURCE REQUIREMENTS,
C] ENROLLMENTS AND RESOURCE REQUIREMENTS TO THE DIRECT BUDGET,
D] ALL OF THE ABOVE TO THE PROGRAM BUDGET,
WARNING: IN GENERAL, IT IS UNNECESSARY TO ENTER DATA THAT ARE NOT NEEDED IN A PARTICULAR STUDY (E.G., FINANCIAL DATA FOR A STUDY OF ENROLLMENTS). HOWEVER, ANY REQUEST FOR AN ANALYSIS OR DISPLAY, THAT USES DATA THAT HAVE NOT BEEN ENTERED WILL CAUSE A 'FATAL ERROR', PROCESSING WILL CEASE AND THE USER WILL RECEIVE A MESSAGE THAT MAY SUGGEST A PROGRAMMING ERROR, THE USER SHOULD IMMEDIATELY TYPE A RIGHT ARROW (→) (TO AVOID FILLING THE WORKSPACE WITH INFORMATION FROM INCOMPLETE RUNS), AND THEN BEGIN A NEW RUN, TAKING CARE TO AVOID REQUESTING INAPPROPRIATE CALCULATIONS OR DISPLAYS.

INITIATING A RUN
TO INITIATE A RUN, THE USER TYPES 'LEARN 0' IF THE PROGRAM HAS NEVER BEEN RUN BEFORE AND LEARN 1, OTHERWISE, A USER WHO IS UNFAMILIAR WITH THE PROGRAMS MAY WISH TO UNDERTAKE A TRIAL, 'NULL' RUN, FOR A NULL RUN;
TYPE 'LEARN 0' OR 'LEARN 1' AS APPROPRIATE, INDICATE A DESIRE TO ENTER NEW DATA, BUT ANSWER QUERIES ABOUT THE PARTICULAR INPUT, CALCULATION, OR DISPLAY ROUTINES DESIRED WITH 0'S OR THE CODE SPECIFIED FOR REQUESTING FURTHER INFORMATION.

ENTERING DATA - SEE PROGRAM LEARNVARS AND OTHERS LISTED BELOW FOR INFORMATION.

MODIFYING DATA

REQUESTING DISPLAYS - SEE PROGRAMS LISTED BELOW, NOTE THAT IS USUALLY DESIRABLE TO REQUEST DISPLAYS OF INPUT DATA PRIOR TO REQUESTING CALCULATIONS,
SUMMARY OF ADDITIONAL INSTRUCTIONS
DEMONSTRATION - INSTRUCTIONS FOR A DEMONSTRATION RUN
LEARNVARS - DESCRIPTION OF INPUT AND OUTPUT VARIABLES
LEARNFNS - LIST OF PROGRAMS WITH REFERENCES TO ADDITIONAL INFORMATION
  DESCINF - NAME AND LABEL PROGRAMS
  ENRINP - ENROLLMENT INPUT PROGRAMS
  FINP - INCOME AND COST INPUT
  OUPUT - CALCULATION AND DISPLAY ROUTINES
  DISP - DISPLAY ROUTINES
  SERV - SERVICE ROUTINES
TOSTOREDATA - INSTRUCTIONS FOR STORING AND RETRIEVING BASE DATA FOR THE MODEL

TO RUN THE LEARN PROGRAMS TYPE )CLEAR, THEN TYPE )LOAD A98M000 LRNPROG, PROGRAMS WILL BE READY TO GO.
***************
*** LEARN DOCUMENTATION: PROGRAM DEMONSTRATION ***

FOR A DEMONSTRATION OF LEARN WITH DATA STORED IN THIS WORKSPACE, TYPE THE FOLLOWING COMMANDS:

1) CLEAR
2) COPY A98M000 LRMProg
3) COPY A98M000 LRNDoc ,GRPENRV ,GRPVNAV ,GRPVRY
4) R+1
5) ENCALC (NORMALLY ENCALC IS RUN AS A SUBROUTINE OF LEARN)

YOU ARE NOW READY TO RUN LEARN WITH THE DEMONSTRATION DATA,

1) TYPE LEARN 0.
2) RESPOND TO EACH QUERY AS FOLLOWS:
   Q-1] 3 (TO RUN THE PROGRAMS),
   Q-2] 1 (TO COMPUTE BASES FOR INCREMENT FORMULAS),
   Q-3] 1 (TO REQUEST DISPLAYS),
   Q-4] 1 1 1 1 1 (TO REQUEST ALL DISPLAYS),
   ALL OTHER QUERIES] 1 (FOR GREATEST POSSIBLE DETAIL).
3) TYPE CV TO SEE VALUE OF THAT VARIABLE,

AFTER SEEING THE DATA AND RESULTS, YOU MAY EXPERIMENT WITH MODEL BY RUNNING LEARN (TYPE LEARN 1) AND MODIFYING THE DATA OR CHANGING THE DESCRIPTION OF THE SYSTEM, THEN REQUESTING CALCULATIONS AND DISPLAYS.

************
**INPUT AND OUTPUT VARIABLES FOR BUDGET MODEL LEARN**

I. **INPUT VARIABLES**

A. NAMES (FOR PROGRAMS TILIN AND TICH)

(NOTE: LISTS ARE MATRICES OF 1-8 NAMES; ALL NAMES HAVE 9 OR FEWER CHARACTERS).

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>A VECTOR GIVING THE LENGTH OF EACH VARIABLE LIST SHOWN BELOW</td>
</tr>
</tbody>
</table>

1. PROGLIST PROGRAMS (STUDENT TYPES)
2. PICATLST PROGRAM INCOME CATEGORIES
3. PIULST PROGRAM INCOME UNITS
4. PCCATLST PROGRAM COST CATEGORIES
5. PCULST PROGRAM COST UNITS
6. COURLIST INSTRUCTIONAL SERVICES
7. CICATLST COURSE INCOME CATEGORIES
8. CIULST COURSE INCOME UNITS
9. CCCATLST COURSE COST CATEGORIES
10. CCULST COURSE COST UNITS
11. SERVLIST SUPPORT SERVICES
12. SICATLST SERVICE INCOME CATEGORIES
13. SIULST SERVICE INCOME UNITS
14. SCCATLST SERVICE COST CATEGORIES
15. SCULST SERVICE COST UNITS

B. UNIT CODES (FOR TILIN, SUBROUTINE TISUBU)

THESE CODES PROVIDES KEYS TO THE CORRESPONDANCE BETWEEN UNITS (E.G., PER CREDIT) AND ENROLLMENTS (E.G., NUMBER OF CREDITS). EACH VARIABLE IS A VECTOR GIVING THE CODE FOR EACH UNIT IN THE CORRESPONDING LIST.

THE CODE IS EXPLAINED IN PROGRAM CODELIST, (IN WS LRNPROG).

<table>
<thead>
<tr>
<th>INCOME CODE</th>
<th>COST CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROGRAMS/STUDENT TYPES</td>
<td>IPUI</td>
</tr>
<tr>
<td>INSTRUCTIONAL SERVICES</td>
<td>ICUI</td>
</tr>
<tr>
<td>SUPPORT SERVICES</td>
<td>ISUI</td>
</tr>
</tbody>
</table>
C, ENROLLMENT VARIABLES (FOR ENRVNAMES)

<table>
<thead>
<tr>
<th>VARIABLES + DIMENSIONS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>TOTAL ENROLLMENT</td>
</tr>
<tr>
<td>F (F)</td>
<td>FRACTIONAL ENROLLMENT IN EACH PROGRAM</td>
</tr>
<tr>
<td>PE (F)</td>
<td>PROGRAM ENROLLMENT=FxN</td>
</tr>
</tbody>
</table>
|                        | (USER SPECIFIES EITHER PE OR N AND F,)
| FLM (FxC)              | FRACTIONAL COURSE LOAD MATRIX; FOR EACH PROGRAM/STUDENT GROUP, THE PERCENT COURSE LOAD IN EACH INSTRUCTIONAL SERVICE |
| L (F)                  | COURSE LOAD VECTOR FOR A TYPICAL STUDENT OF EACH TYPE |
| ICLM (FxC)             | INDUCED COURSE LOAD MATRIX=LxFLM |
|                        | FOR EACH PROGRAM/STUDENT GROUP, THE COURSE LOAD IN EACH INSTRUCTIONAL SERVICE |
|                        | (USER SPECIFIES EITHER ICLM OR FLM AND L,)
| DM (FxS)               | INDUCED SERVICE LOAD MATRIX; THE IMPACT ON EACH SUPPORT SERVICE OF A TYPICAL STUDENT OF EACH TYPE |
| IDI (S)                | VECTOR OF KEYS TO EACH SUPPORT SERVICE |
|                        | IDI=0 THE DM VECTOR FOR THE SERVICE IS DEFINED BY THE USER |
|                        | 1 THE DM VECTOR IS A UNIT VECTOR |
|                        | 2 THE DM VECTOR IS L, |

D, ENROLLMENT AND RESOURCE VARIABLE NAMES (FOR ENRVNAMES)


PVARLAB FOR PROGRAMS
CVARLAB FOR INSTRUCTIONAL SERVICES
SVARLAB FOR SUPPORT SERVICES

E, COST AND INCOME VARIABLES (FOR INCOMIN AND INCH)
six arrays must be specified,
GROUP AND DIMENSIONS
PROG/STUDT TYPE (FxCxuu) INCOME COST
INSTR, SERVICES (CxCxuu) DPROGINC DPROGcost
SUPPORT SERVICES (SxCxuu) DCORSINC DCORSCOST

F, RATE VARIABLES (FOR Ratin)
NOTE THAT IF A PARTICULAR ENROLLMENT VARIABLE
HAS NO ASSOCIATED RESOURCE, THE FORMULA
MUST BE SET TO ZERO, SEE ENRINP FOR A
DESCRIPTION OF THE RATE FORMULAS.
INDIVIDUAL BASE FORMULAS HAVE 4 ELEMENTS;
INCREMENT FORMULAS HAVE 2, THERE IS A
SEPARATE FORMULA FOR EACH INDIVIDUAL
PROGRAM, COURSE GROUP OR SUPPORT SERVICE,
(FOR EXAMPLE, CRATB HAS THE DIMENSIONS, Cx4.)

BASE FORMULA INCR FORMULA
PROG./STUDT TYPE PRATB PRATI
INSTR, SERVICE CRATB CRATI
SUPPORT SERVICE SRATB SRATI

II, OUTPUT VARIABLES
A, ENROLLMENTS (FOR ENCALC)
SEE ENCALC FOR MATHEMATICAL DEFINITIONS

<table>
<thead>
<tr>
<th>VARIABLE + DIMENSION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE (C)</td>
<td>ENROLLMENT IN EACH INSTRUCTIONAL SERVICE (E.G., CREDITS TAKEN)</td>
</tr>
<tr>
<td>SE (S)</td>
<td>USE OF EACH SUPPORT SERVICE (E.G., NUMBER OF REGISTRATIONS)</td>
</tr>
<tr>
<td>CWLM (FxC)</td>
<td>INSTRUCTIONAL WORK LOAD MATRIX THE ENROLLMENT IN EACH INSTRUCTIONAL GROUP ATTRIBUTABLE TO EACH PROGRAM</td>
</tr>
<tr>
<td>SWLM (FxS)</td>
<td>SERVICE WORK LOAD MATRIX - USE OF EACH SERVICE ATTRIBUTABLE TO EACH PROGRAM</td>
</tr>
<tr>
<td>CPFM (FxC)</td>
<td>FOR EACH INSTRUCTIONAL GROUP, PERCENT OF TOTAL USE ATTRIBUTABLE TO EACH PROGRAM</td>
</tr>
<tr>
<td>SFEM (FxS)</td>
<td>FOR EACH SUPPORT SERVICE, PERCENT OF USE ATTRIBUTABLE TO EACH PROGRAM</td>
</tr>
<tr>
<td>TCE</td>
<td>TOTAL INSTRUCTIONAL ENROLLMENT</td>
</tr>
<tr>
<td>TL (F)</td>
<td>TOTAL PROGRAM LOAD FOR EACH GROUP OF STUDENTS</td>
</tr>
</tbody>
</table>
### B. Resources (See Resources for Mathematical Descriptions)

<table>
<thead>
<tr>
<th>PR</th>
<th>CR</th>
<th>SR</th>
<th>TPR</th>
<th>TCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>(F)</td>
<td>(C)</td>
<td>(S)</td>
<td>TOTAL RESOURCES DIRECTLY ATTRIBUTED TO PROGRAMS</td>
<td>TOTAL INSTRUCTIONAL RESOURCES</td>
</tr>
</tbody>
</table>

- **Resources Used Directly by Each Program (PR)**
- **Resources Used by Each Instructional Service (CR)**
- **Resources Used by Each Support Service (SR)**
- **Total Resources Directly Attributed to Programs (TPR)**
- **Total Instructional Resources (TCR)**

### C. Direct Budget Variables (For DIRBD; See Also LABUG)

See DIRBD for Mathematical Descriptions.

<table>
<thead>
<tr>
<th>Group and Dimension</th>
<th>Income</th>
<th>Cost</th>
<th>NEI</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs By Category</td>
<td>P %CC</td>
<td>DPIC</td>
<td>DPCC</td>
<td>-----</td>
</tr>
<tr>
<td>Total Program P</td>
<td>TPI</td>
<td>TPC</td>
<td>NDF</td>
<td>DPUC</td>
</tr>
<tr>
<td>Instructional Services (Inst, Serv) By Category</td>
<td>C %CC</td>
<td>DCIC</td>
<td>DCCC</td>
<td>-----</td>
</tr>
<tr>
<td>Total Inst, Serv C</td>
<td>TCI</td>
<td>TCC</td>
<td>TNDP</td>
<td>TDPUC</td>
</tr>
<tr>
<td>Support Services (Supt, Serv) By Category</td>
<td>S %CC</td>
<td>DSIC</td>
<td>DSCC</td>
<td>-----</td>
</tr>
<tr>
<td>Total Supt, Serv C</td>
<td>TSI</td>
<td>TSC</td>
<td>TNDP</td>
<td>TDPUC</td>
</tr>
</tbody>
</table>

**Grand Total**

| TOTINC | TOTCOST | GRANDNET | GRAND UNIT |

### D. Program Budget Variables (For PRBD; See Also LABUG)

See PRBD for Mathematical Descriptions.

<table>
<thead>
<tr>
<th>DIR, PROGRAM</th>
<th>ATTRIB, TO INST, SERV</th>
<th>ATTRIB, TO Supt, SERV</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>INC</td>
<td>COST</td>
<td>NEI</td>
<td>UNIT</td>
</tr>
<tr>
<td>PI</td>
<td>PC</td>
<td>NDF</td>
<td>DPUC</td>
</tr>
<tr>
<td>FCI</td>
<td>PCC</td>
<td>NPCB</td>
<td>PCUC</td>
</tr>
<tr>
<td>FSI</td>
<td>FSC</td>
<td>NPSB</td>
<td>PSUC</td>
</tr>
<tr>
<td>TPBI</td>
<td>TPBC</td>
<td>NETPB</td>
<td>TPRUB</td>
</tr>
</tbody>
</table>

*Same as for Direct Budget.*
A LIST OF PROGRAMS FOR THE LEARN BUDGET MODEL

KEY TO REFERENCES TO PROGRAMS GIVING ADDITIONAL INFORMATION:
1=LEARNHOW 2=DESCINF 3=ENRINF 4=FINF 5=OUPUT
6=DISP 7=SERV

<table>
<thead>
<tr>
<th>PROGRAMS</th>
<th>DESCRIPTION</th>
<th>REF. NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, MAIN PROGRAM</td>
<td>LEARN</td>
<td>1</td>
</tr>
<tr>
<td>II, INPUT PROGRAMS</td>
<td>ENTERS NAMES AND LABELS</td>
<td>2</td>
</tr>
<tr>
<td>TILIN</td>
<td>SUBROUTINES - TISUBU, CODELIST, CVOK</td>
<td></td>
</tr>
<tr>
<td>TICH</td>
<td>CHANGES NAMES AND LABELS</td>
<td>2</td>
</tr>
<tr>
<td>INCOMIN</td>
<td>ENTERS INCOME AND COST DATA</td>
<td>4</td>
</tr>
<tr>
<td>INCH</td>
<td>SUBROUTINE - MONDATIN</td>
<td></td>
</tr>
<tr>
<td>ENRIN</td>
<td>ENTERS AND CHANGES ENROLLMENT DATA AND NAMES OF ENROLLMENT VARIABLES</td>
<td>3</td>
</tr>
<tr>
<td>RATIN</td>
<td>SUBROUTINES - ENCALC, ENVNAME</td>
<td></td>
</tr>
<tr>
<td>III, CALCULATIONS</td>
<td>ENTERS AND CHANGES RATE FORMULAS</td>
<td>3</td>
</tr>
<tr>
<td>RESOURCE</td>
<td>RESOURCES</td>
<td>5</td>
</tr>
<tr>
<td>DIRBD</td>
<td>DIRECT BUDGET</td>
<td></td>
</tr>
<tr>
<td>DSPBD</td>
<td>PROGRAM BUDGET</td>
<td></td>
</tr>
<tr>
<td>IV, DISPLAYS</td>
<td>INCOME AND COST DATA</td>
<td>6</td>
</tr>
<tr>
<td>DISFINP</td>
<td>ENROLLMENTS AND RESOURCES</td>
<td></td>
</tr>
<tr>
<td>DISENR</td>
<td>RATE FORMULAS</td>
<td></td>
</tr>
<tr>
<td>DISRAT</td>
<td>DIRECT BUDGET</td>
<td></td>
</tr>
<tr>
<td>DISBD</td>
<td>PROGRAM BUDGET</td>
<td></td>
</tr>
<tr>
<td>DSPBD</td>
<td>DISPLAY SUBROUTINES - DISPLAY1 (VECTORS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DISPLAY2 (MATRICIES)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DISPLAY3 (3D ARRAYS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FORMAT</td>
<td></td>
</tr>
</tbody>
</table>
GENERAL SERVICE AND LABEL Routines

CHECKON  CHECKS NUMERICAL INPUT
CHECK      CHECKS LITERAL INPUT FOR ≤9 CHAR.
TRANS      CHECKS 0 1 ANSWERS TO QUESTIONS
ADJ        TRANSFORMS VECTORS TO 1 LINE
            MATRICES
RTJUST     RIGHT JUSTIFIES COLUMN HEADINGS
            LABELS, LABELS2, LABELS3, LABUG, LABD

THsese programs provide lists of variables and headings for do loops and displays.
LABELS  - primarily for TILIN and TICH
LABELS2 - primarily for INCOMIN, INCH,
LABELS3 - for most input programs
LABUG  - budget variables for DIRBD and FRBD
LABD  - a subroutine of DISENR

*****************************
NAMING THE VARIABLES THAT DESCRIBE THE SYSTEM

PROGRAMS TILIN AND TICH AND THEIR SUBROUTINES

TILIN
allows user to specify names for:
1] programs (students types)
2] instructional services
3] support services
4] income and cost categories for each of the above

Cv is a vector (length 15) of the number of names on each list, see program learnvars for definitions of variables.

TISUBU
a subroutine of tilin for designating unit indices (see learnvars).

CVOK
program checks cv to make sure that if any category or unit list has no elements, the corresponding unit or category list also has no elements.

TICH
changes elements in input titles one at a time:

a, number of items in any list may be changed,
b, names of items on any list may be changed.

A, LENGTH OF LIST
1] user indicates intention in response to query,
2] user gives number of the list (i.e., element of cv - see learnvars, ia),
3] user gives new list length,
   if a list is lengthened, user may add new names one
   at a time (see b below),
   lists may be shortened one item at a time only;
user will be asked for number of element to be eliminated,
new values, if any, of income, cost, rate, and
enrollment variables are specified by using programs
inch, enrin, and ratin.
b. changing elements within lists

1] user specifies index of list on cv (e.g., 1 for the program list) in response to query,
2] user gives number of element on list (e.g., 2 for the second name on the program list).

changes in numerical data are made as described above.

fixi

a subroutine of tich called if any elements of cv are changed, routine adjusts lengths of title lists.

fixin

a subroutine of tich that adjusts lengths of income and cost matrices when appropriate,

i=1,2,3 for programs, instruct, services, support services,

j=1,2 for income, costs,

k=1,2 for categories, units.

fixu

a subroutine of tich to change length of unit index lists to equal new number of unit types.

fixen

a subroutine of tich called if enrollments or rates have been entered, program changes matrix and vector dimensions to conform to new number of programs, instructional services, or support services,

i indexes enrollment variables (enr, in labels3, gives list),

j=1,2,3 for programs, inst, services, support services,

k indicates which dimension is to be changed (for matrices only).

*****************************************************************************
**ENTERING FINANCIAL DATA**

**INCOMIN**

Program for entering cost and income data,

\[ j=1,2 \] for income, costs,
\[ i=1,2,3 \] for programs, instructional services, support services,

See labels and labels2 for labels and headings used in this program,

**MONDATIN**

A subroutine of INCOMIN that allows data to be entered,

in indexes individual program or service,

in indexes items on the category lists,

**INCH**

Program for changing values of income and cost data,
either percent changes or new amounts can be entered,

\[ i=1,2,3 \] for programs, instructional services, support services,
\[ j=1,2 \] for income cost,

\[ k \] indexes items on category lists,
ENTERING ENROLLMENT DATA AND RATE FORMULAS

PROGRAMS ENRIN AND RATIN AND THEIR SUBROUTINES

ENRIN
A ROUTINE TO ENTER OR CHANGE ENROLLMENT DATA.

WARNING: FAILURE TO ANSWER QUESTIONS ABOUT BASE DATA CORRECTLY CAN CAUSE FATAL ERRORS, IF USER INDICATES A DESIRE TO STORE NEW BASE DATA OR TO IGNORE EXISTING BASE DATA, THE EXISTING BASE DATA WILL BE LOST; IF USER INCORRECTLY INDICATES THAT BASE DATA ALREADY EXIST, PROGRAM RESOURCE WILL FAIL TO EXECUTE IF INCREMENT FORMULAS ARE NEEDED IN THE RUN.

I INDEXES THE ENROLLMENT VARIABLES, ICLM, FLM, F, L, PE, N, DM.
(NOTE THAT THE ORDER PRESENTED TO THE USER IS NOT THE SAME AS THAT USED INTERNALLY BY THE PROGRAM.)

J INDEXES INDIVIDUAL PROGRAMS FOR ICLM AND FLM AND INDIVIDUAL SERVICES FOR IM.

N=TOTAL ENROLLMENT CAN BE CHANGED BY A PERCENTAGE;
ALL OTHER VARIABLES REQUIRE SPECIFIC VALUES.

ENYV NAMES
A SUBROUTINE OF ENRIN THAT ALLLOWS USER TO NAME ENROLLMENT VARIABLES AND THEIR ASSOCIATED RESOURCES (E.G., CREDITS TAKEN AND CREDITS TAUGHT FOR THE ICLM).

J=1, 2 FOR ENROLLMENT, RESOURCE,
K=1 FOR PROGRAMS, 2 FOR INSTRUCTIONAL SERVICES,
3 FOR FIRST SUPPORT SERVICE, ETC.

ENCALC
A SUBROUTINE OF ENRIN THAT CALCULATES THE VALUES OF ALL VARIABLES THAT DEPEND ONLY ON ENROLLMENTS,
SEE LEARNVARS IIA FOR ADDITIONAL INFORMATION.
THE FOLLOWING VARIABLES ARE CALCULATED:
CWL, SWL, CE, SE, CFEM, SFEM, TCE, TL.
IN ADDITION, THE RESOURCE VECTORS, PR, SR, AND CR,
ARE DEFINED AND SET EQUAL TO 0.
BAIU

PROGRAM FOR ENTERING AND CHANGING RATES,
THE USER HAS SEVERAL CHOICES IN DEFINING THE RELATIONSHIPS
BETWEEN ENROLLMENTS OR LEVELS OF USE IN PROGRAMS,
INSTRUCTIONAL SERVICES, AND SUPPORT SERVICES AND
THE CORRESPONDING RESOURCES (FOR EXAMPLE, BETWEEN CREDITS
TAKEN AND CREDITS TAUGHT).

THE RELATIONSHIPS MAY BE OF THE FORM:

BASE RELATIONSHIP
   A) RESOURCE = CONSTANT + VARIABLE\times RATE,
   B) RESOURCE = CONSTANT + STEP FUNCTION(VARIABLE,RATE)

INCREMENTAL RELATIONSHIP
   A) SAME AS BASE RELATIONSHIP (I.E., NO SEPARATE FORMULA)
   B) RESOURCE = BASE + \Delta VARIABLE\times INCREMENT RATE
   C) RESOURCE = BASE + STEP FUNCTION(\Delta VARIABLE,incr,RATE)

NOTE THAT TOTAL ICLM RESOURCES (TCR) ARE COMPUTED BY LEARN;
NO FORMULA CAN BE SPECIFIED.

*************
Calculations for LEARN

Programs resource, DIRBD, PRBD, and subroutine RATID.

**Resource**
Program calculates resource requirements (e.g., number of courses taught) from enrollments or use rates (e.g., number of credits taken),

I=1,2,3 for programs, instructional services,

Support services

J indexes individual programs or services,

IN, JN, and DUM[1:4] determine AD and BD;

AD=1 for base formulas, 0 for increment formula;

BD=1 if calculated base value is to be stored

As new base, 0 otherwise.

**DIRBD**
Program computes direct program and service budgets,

See LABUG and LEARNVARS INC for list of variables,

I=1,2,3 for programs, instructional services,

Support services

J=1,2 for income,cost,

JN indexes unit types,

K indexes individual program or service,

CO, CT, CT+1 identify CV number of appropriate group list, category list, and unit list.

**RATID**
A subroutine of DIRBD that identifies the appropriate enrollment or resource variable for calculating each of the category budgets, the identification codes are specified in subroutine TISUBU of programs TILIN and TICH,

See program CODELIST (in WS LRNPORG) for the code.

**PRBD**
The program computes the program budgets from the direct budgets and program enrollments,
**LEARN DOCUMENTATION: PROGRAM DISP**

**DISPLAY PROGRAMS**

PROGRAMS DISFINP, DISENR, DISEAT, DSSBD, AND DSPBD;
SUBROUTINES DISPLAY1, DISPLAY2, AND DISPLAY3.

**DISFINP**

PROGRAM DISPLAYS FINANCIAL INPUT;
SETS VALUES FOR DISPLAY3 AND CALLS THAT ROUTINE,
(STEPS 6 AND 8 SET THE ROW LENGTH OF THE DISPLAY).

**DISENR**

PROGRAM DISPLAYS ENROLLMENT AND RESOURCE TABLES,
NOTE THAT USER HAS A CHOICE OF DISPLAYING INPUT
VARIABLES ONLY OR DISPLAYING BOTH INPUT AND OUTPUT
VARIABLES; USER MAY ALSO CHOOSE TO DISPLAY
EITHER A SHORT LIST OR A COMPLETE LIST OF
VARIABLES,
SEE LEARNVARS IIC AND IIA,B FOR VARIABLES,
I=1,2,3,4,5 FOR INSTRUCTIONAL SERVICE MATRICES,
support service matrices, program vectors,
INST,SERV,VECTORS, SUPPORT SERV,VECTORS,
J INDEXES VARIABLES LIST,
K INDEXES VARIABLES WITHIN EACH I,

**DISEAT**

PROGRAM DISPLAYS RATE FORMULAS,
NOTE THAT THE BASE FOR EACH INCREMENT FORMULA
IS CALCULATED FROM THE CORRESPONDING BASE FORMULA,
IT IS DISPLAYED AT THE USER'S REQUEST,
I=1,2,3 FOR PROGRAMS, INSTRUCTIONAL SERVICES,
support services,
J=1,2 FOR BASE, INCREMENT,
K INDEXES INDIVIDUAL SERVICE FOR I=3 ONLY,

**DSSBD**

DISPLAYS DIRECT BUDGET,
SEE LEARNVARS IIC FOR VARIABLES.

**DSPBD**

PROGRAM DISPLAYS PROGRAM BUDGET,
SEE LEARNVARS IID FOR VARIABLES.

**DISPLAY1**

SUBROUTINE DISPLAYS HEADING AND ANY VECTOR H,
FROM: TITL1, ANY 120 OR FEWER CHARACTERS,
E (9x9), A LITERAL MATRIX OF COLUMN TITLES,
G (9), THE ROW TITLE, AND
H (9), THE VECTOR TO BE DISPLAYED,
DISPLAY2
SUBROUTINE DISPLAYS HEADINGS AND A $B \times ROWL$ TABLE,
FROM:  TITL1, ANY ROWL OR FEWER CHARACTERS,
        E ($Q \times 9$), A LITERAL MATRIX OF COLUMN HEADINGS,
        G ($R \times 9$), A LITERAL MATRIX OF ROW TITLES,
        H ($R \times 9$), THE NUMERICAL MATRIX, AND
        ROWL, THE ROW LENGTH ($\leq 120$ AND A MULTIPLE OF 10).
ROWS OF ZEROS ARE NOT SUPPRESSED. (THE PROGRAMS CALLING
THIS ROUTINE MAY SUPPRESS TABLES OR ROWS OF ZEROS),

DISPLAY3
SUBROUTINE DISPLAYS HEADINGS AND A $(1 \times B \times ROWL)$ ARRAY,
FROM ROWL, E, G, AND TITL1 AS DESCRIBED FOR DISPLAY2,
        F ($A \times 9$), A LITERAL MATRIX OF SUBTABLE TITLES,
        H ($A \times B \times 9$), THE NUMERICAL ARRAY,
SUPPRESSES ROWS THAT ARE ALL ZEROS,

FORMAT
SUBROUTINE OF DISPLAY1, DISPLAY2, AND DISPLAY3,
THE SUBROUTINE FORMATS ANY NUMERICAL VECTOR TO A
WIDTH IT FOR EACH ELEMENT - IN EXPONENTIAL OR DECIMAL
NOTATION DEPENDING ON THE VALUES OF THE ELEMENTS,
SERVICE AND LABEL SUBROUTINES

GENERAL ROUTINES CHECKON, CHECK, YNS, ADJ, AND RTJUST; LABEL SUBROUTINES LABELS, LABELS2, LABELS3, LABUG, LABD.

CHECKON
CHECKS NUMERICAL INPUT TO MAKE SURE THAT IT IS ALL NUMBERS AND IN THE FORM OF A VECTOR OF LENGTH P.

CHECK
CHECKS LITERAL INPUT TO MAKE SURE THAT NO NAME HAS MORE THAN 9 CHARACTERS, OUTPUT IS A LITERAL VECTOR OF 9 CHARACTERS, INCLUDING BLANKS,

YNS, ADJ, AND RTJUST ARE EXPLAINED IN LEARNFNS.

LABELS, LABELS2, LABELS3, AND LABD ARE EXPLAINED IN LEARNFNS.

LABUG
PROVIDES LABELS FOR BUDGET PROGRAMS,

DDBD LABELS: DIRECT BUDGET VECTORS
TDR : TOTAL DIRECT BUDGETS
DUC : UNIT COST VECTORS
TDUC : UNIT COSTS OF PROGRAMS, INSTRUCTIONAL SERVICES, SUPPORT SERVICE
NETDR : NET INCOME (COST) VECTORS
TNETDR : NET TOTAL INCOME (COST) OF PROGRAMS, INSTRUCT, SERVS., SUPPORT SERVICES
DBUC : CATEGORY BUDGET,

FRBG LABELS: PROGRAM INCOME, COSTS FROM PROGRAMS, INSTR, SERVS., SUPPORT SERVICES
NFRG : NET FROM EACH GROUP
PUC : UNIT COSTS FOR EACH GROUP,
*** LEARN DOCUMENTATION; PROGRAM IOSTOREDATA ***

TO STORE BASE DATA FOR LATER USE, TYPE:

1) )COPY LRNDOC GRPENRV GRFFRV GRPYNAV
   NOTE: THE ABOVE COMMAND CAUSES THE VARIABLE
   NAMES, BUT NOT THEIR VALUES, TO BE COPIED,
2) )SAVE LRNWK (OR NAME OF YOUR CHOICE),
3) )CLEAR
4) )COPY LRNWK ,GRPENRV ,GRFFRV ,GRPYNAV
   NOTE: THIS COMMAND CAUSES VARIABLE NAMES AND
   VALUES TO BE COPIED,
5) )SAVE LRNBASE (OR NAME OF YOUR CHOICE),

TO BEGIN A NEW SET OF RUNS STARTING WITH YOUR BASE CASE,
USE THE PROCEDURES OUTLINED IN DEMONSTRATION - EXCEPT
THAT YOU MUST COPY THE DATA FROM WORKSPACE LRNBASE,
RATHER THAN FROM WORKSPACE LRNDOC.

***************
2. PROGRAM LISTINGS FOR LEARN

Main Program

LEARN

Input

TILIN variable names
TISUBU, CODELIST
CVOK
TICH change variable names
FIXT, FIXIN
FIXU, FIXEN
INCOMIN income and costs
MONDATIN
INCH change income and costs
ENRIN enrollment data
ENCALC ENRVNAMES
RATIN rates

Calculations

RESOURCE resources
DIRBD direct budget
RATID
PRBD program budget
### Displays

<table>
<thead>
<tr>
<th>Subroutine</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISFINP</td>
<td>financial input</td>
<td>501</td>
</tr>
<tr>
<td>DISENR</td>
<td>enrollment input and output, resources</td>
<td>503</td>
</tr>
<tr>
<td>DISRAT</td>
<td>ratio formulas</td>
<td>505</td>
</tr>
<tr>
<td>DSSBD</td>
<td>direct budget</td>
<td>506</td>
</tr>
<tr>
<td>DSPBD</td>
<td>program budget</td>
<td>507</td>
</tr>
<tr>
<td>DISPLAY1,</td>
<td>(subroutines for display programs)</td>
<td>508</td>
</tr>
<tr>
<td>DISPLAY2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISPLAY3,</td>
<td></td>
<td>509</td>
</tr>
<tr>
<td>FORMAT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General Subroutines and Label Routines

<table>
<thead>
<tr>
<th>Subroutine</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHECK,</td>
<td>CHECKON</td>
<td>510</td>
</tr>
<tr>
<td>YNS, ADJ,</td>
<td>RTJUST</td>
<td>511</td>
</tr>
<tr>
<td>LABELS</td>
<td></td>
<td>512</td>
</tr>
<tr>
<td>LABELS2</td>
<td></td>
<td>514</td>
</tr>
<tr>
<td>LABELS3</td>
<td></td>
<td>516</td>
</tr>
<tr>
<td>LABUG</td>
<td></td>
<td>518</td>
</tr>
<tr>
<td>LABD</td>
<td></td>
<td>520</td>
</tr>
</tbody>
</table>
QLearn ST

<table>
<thead>
<tr>
<th>No.</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>LIFELONG EDUCATION FOR ADULTS:</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>RESOURCES AND NEEDS</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>A BUDGET MODEL</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>FOR PART-TIME ADULT EDUCATIONAL PROGRAMS</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>MAIN PROGRAM - LEARN</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>SEE LEARNHOW AND OTHER PROGRAMS IN WS LRNDOC FOR</td>
</tr>
<tr>
<td>7</td>
<td>A</td>
<td>A COMPLETE DESCRIPTION OF THE MODEL,</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>A</td>
<td>ST=1 UNLESS PROGRAM HAS NEVER BEEN RUN, (NO HARM IS</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
<td>DONE, HOWEVER, IF ST=0 IN A LATER RUN,)</td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>A</td>
<td>L1: 'RUN NAME?'</td>
</tr>
<tr>
<td>13</td>
<td>B+1</td>
<td>'CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,'</td>
</tr>
<tr>
<td>14</td>
<td>B+2</td>
<td>'OR 4=DISPLAY.'</td>
</tr>
<tr>
<td>15</td>
<td>B+3</td>
<td>A NOTE: IF USERS CHOOSE 1 OR 2, THEY WILL HAVE A</td>
</tr>
<tr>
<td>16</td>
<td>B+4</td>
<td>A CHANCE TO RUN AND DISPLAY; IF THEY CHOOSE 3, THEY</td>
</tr>
<tr>
<td>17</td>
<td>B+5</td>
<td>A WILL HAVE A CHANCE TO DISPLAY; 4 YIELDS DISPLAYS</td>
</tr>
<tr>
<td>18</td>
<td>B+6</td>
<td>A ONLY,</td>
</tr>
<tr>
<td>19</td>
<td>B+7</td>
<td>L2: CHECK ON 1</td>
</tr>
<tr>
<td>20</td>
<td>B+8</td>
<td>C3A=(1,2,3,4)=B+</td>
</tr>
<tr>
<td>21</td>
<td>B+9</td>
<td>'ANSWER 1, 2, 3, OR 4 ONLY, TRY AGAIN,'</td>
</tr>
<tr>
<td>22</td>
<td>B+10</td>
<td>L2</td>
</tr>
<tr>
<td>23</td>
<td>B+11</td>
<td>L3: A=(3,4)/(LRUN,LDIS)</td>
</tr>
<tr>
<td>24</td>
<td>B+12</td>
<td>'WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN'</td>
</tr>
<tr>
<td>25</td>
<td>B+13</td>
<td>'EXPLANATION,)'</td>
</tr>
<tr>
<td>26</td>
<td>B+14</td>
<td>L4: CHECK ON 4</td>
</tr>
<tr>
<td>27</td>
<td>B+15</td>
<td>L5X1^3x(0 1)1A</td>
</tr>
<tr>
<td>28</td>
<td>B+16</td>
<td>'TYPES: 1)LABELS/NAMES, 2)FINANCIAL INPUT,'</td>
</tr>
<tr>
<td>29</td>
<td>B+17</td>
<td>'3)ENROLLMENT INPUT, 4)RATIO INPUT, TYPE 0 OR 1 FOR '</td>
</tr>
<tr>
<td>30</td>
<td>B+18</td>
<td>'EACH (E.G., '1 0 0 0' MEANS LABELS/NAMES ONLY), '</td>
</tr>
<tr>
<td>31</td>
<td>B+19</td>
<td>'TYPES?'</td>
</tr>
<tr>
<td>32</td>
<td>B+20</td>
<td>L4</td>
</tr>
<tr>
<td>33</td>
<td>B+21</td>
<td>L5+I+1</td>
</tr>
<tr>
<td>34</td>
<td>B+22</td>
<td>CO+A</td>
</tr>
<tr>
<td>35</td>
<td>B+23</td>
<td>L3A=(1)=1</td>
</tr>
<tr>
<td>36</td>
<td>B+24</td>
<td>CN+1</td>
</tr>
<tr>
<td>37</td>
<td>B+25</td>
<td>L6: L7X1+C0[I]=0</td>
</tr>
<tr>
<td>38</td>
<td>B+26</td>
<td>L6[LABCH[I]]=</td>
</tr>
<tr>
<td>39</td>
<td>B+27</td>
<td>L7: L6X1[4]=I+I+1</td>
</tr>
<tr>
<td>40</td>
<td>B+28</td>
<td>LRUN</td>
</tr>
<tr>
<td>41</td>
<td>B+29</td>
<td>L3A: CH+0</td>
</tr>
</tbody>
</table>
[50] L4A:→L5A×1C0[I]=0
[51] "INPUT[I;]
[52] L5A:→L4A×142I+1
[53] LRUN:'RUN? 0= NO RUN, 1=RESOURCE ONLY, 2=RESOURCE AND'
[54] 'DIRECT BUDGET, 3=ALL CALCULATIONS,'
[55] CHECKON 1
[56] →LRUN×1×/(0,1,2,3)=B←A
[57] →L9×1B=0
[58] RESOURCE
[59] →L9×1B=1
[60] DIRD
[61] →0×1ER=1
[62] →L9×1B=2
[63] PRD
[64] L9: 'DISPLAYS?'
[65] YNS
[66] →E0×1YX=0
[67] LDIS: 'WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION,'
[68] L1B: CHECKON 5
[69] →L1A×1×3ε(0 1)A
[70] 'DISPLAYS: 1)FINANCIAL INPUT, 2)ENROLLMENT/RESOURCES'
[71] '(EITHER INPUT OR INPUT AND OUTPUT), 3)RATIO INPUT,'
[72] '4)DIRECT BUDGET, 5)PROGRAM BUDGET, ANSWER 0 OR 1'
[73] 'FOR EACH (E.G., "0 0 1 0 1" WILL YIELD DISPLAYS'
[74] 'OF THE RATIO INPUT AND THE PROGRAM BUDGET), TYPES?'
[75] →L1B
[76] L1A;I+1
[77] CO←A
[78] ' ';
[79] RNM
[80] ' ';
[81] L2A:→L6A×1C0[I]=0
[82] "LABDIS[I;]
[83] L6A:→L2A×152I+1
[84] END: 'LEARN RUN COMPLETE,'
A program to enter names.

A CV gives length of each list, see program.

Variables for an explanation.

'New names and labels'

CN=0

C: 'CV?'

CHECKON 15

LO: LOX \( \times 12 \pmod{0;10} \) \( \setminus A \)

'All elements of CV are integers; \( 0 \leq CV[I] \leq 10 \).

'Try again.'

CO

LOT; CVOK A

LOE; OK=1

'Try again.'

CO

LOB; 'CV='; A; 'OK? answer 0 or 1.'

YNS

CX; YX=0

CO

CV=A

C

I=1

LH; ZRX \( \setminus CV[I] \) = 0

HEAD[I;]

\( \ast (LAB1[I;],\langle(CV[I],9)\rangle)\) \( \langle' ' ' ' \rangle\)

\( J \) + 1

C

LJ; J

CHECK

\( \ast (LAB1[I;],[J;]+H)\)

L4; L4X \( \setminus /X=3,5,8,10,13,15 \)

LB; TN+I; J

TISUBU

L4; L4X \( \setminus CV[I] \) \( \langle J \rangle \) + J + 1

LH; 15 \( \setminus I+1 \)

C

ZF: \( \ast (LAB1[I;],[1,9])\) \( \langle' ' ' ' \rangle\)

LB; 15 \( \setminus V/X=3,5,8,10,13,15 \)

LH; 15 \( \setminus I+1 \)
A SUBROUTINE OF TILIN AND TICHANGE FOR DESIGNATING
INDICES OF UNITS.

CYT+1
JN+1+(TN[1]ε [5, 10, 15])
LOX\(\text{CN}=1\)
LOX\(\text{TN}[2]≠1\)&(CV[\text{TN}[1]]≠0)
ZRX\(\text{CV}[\text{TN}[1]]=0\)
\(\text{IN}=[\text{IN}; \text{JN}]\), '+CV[\text{TN}[1]]=0'
LO: 'UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST,)
CHECK ON 1
\(\text{IN}=[\text{IN};\text{JN}]; '+A'\)
\(\text{IN}=[\text{IN};\text{JN}]; '+1f0'\)
LO: 'NEXT UNIT NAME,'

'CODELIST'
'A 2 DIGIT CODE EXPRESSED AS A SINGLE NUMBER'
'30 INDICATES A CONSTANT, OTHERWISE:'
'1ST DIGIT: 1 FOR APPROPRIATE ENROLLMENT VECTOR,' 
' (\text{PE,CE,SE}),'
'2 FOR APPROPRIATE RESOURCE VECTOR,' 
' (\text{PR,CR,SR}),'
'3 FOR PROGRAM INST, LOAD (\text{PEXL}), NOTE:' 
'3 APPLIES TO PROGRAMS ONLY,' 
'2ND DIGIT: 0 FOR PROGRAMS AND COURSES,' 
' K (INDEX OF SERVICE) FOR SERVICES,'
SUBROUTINE OF TILIN AND ALSO TICH

CT+(2,6);DUM[2,4,7,9,12,14,3,5,8,10,13,15]
IT+1
L1:→CORX.;((CT[1;IT]=CT[2;IT])∨(∧/CT[;IT]≠0))
→L1×16;IT+IT+1
→0
COR; 'IF ANY PROGRAM, COURSE GROUP, OR SERVICE GROUP '
'HAS NO INCOME CATEGORIES, IT CAN HAVE NO INCOME '
'UNITS, THE REVERSE IS ALSO TRUE, AND THE SAME RULE '
'MUST BE 0,'
'CV NOW IS: 1) PROGRAMS - ;DUM[15]
2) COURSE GROUPS - ;DUM[5+15]
3) SERVICE GROUPS - ;DUM[10+15]
OK+0
VTICH;X;TN;Y;DD;DUM
[1] 'CHANGE NAMES AND LABELS'
[2] TN+0 0
[3] CN+1
[5] 'OR RATES ENTERED?
[6] RRR; ' ANSWER ' 0 0 ' FOR NONE; ' 1 0 ' 'FOR COST/INCOME, . . . ,'
[7] 'CHECK ON 2
[9] ->RRRX\13E(0 1)\M+A
[10] RES; 'CHANGE LIST LENGTH? ANSWER 0 OR 1'
[12] Y*YX
[13] 'NUMBER OF TITLE LIST?'
[14] COT; CHECKON 1
[15] ->INCR\12F=\15
[17] ->X\11Y=0
[18] 'SPECIFY NEW LENGTH =CV[,';TN[1];']?'
[19] R; CHECKON 1
[20] ->NNX\1Ae(0,18)
[21] 'NO LIST CAN EXCEED 8 ITEMS; TRY AGAIN,'
[22] R
[23] NN1;->NN1X1X(V/TN[1]=1,6,11)(A=0)
[24] 'NUMBERS OF PROGRAMS, SERVICES, AND COURSE TYPES'
[25] 'CANNOT BE SET TO ZERO,'
[26] '(CV[1,6, AND 11] CANNOT = ZERO),'
[27] 'TRY AGAIN,'
[28] RES
[29] NN1;->NN2X1A<CV[TN[1]]
[30] 'LIST IS ALREADY OF LENGTH ';A' ; TRY AGAIN,'
[31] RES
[32] NN2;X+A
[33] ->L1A1(CV[TN[1]]-A)\11
[34] 'LISTS CAN BE SHORTENED ONLY 1 ELEMENT AT A TIME,'
[35] 'NEW LIST LENGTH HAS BEEN SET TO ';CV[TN[1]]-1
[36] X=CV[TN[1]]-1
[37] L1A;->COSX;CV[TN[1]]=0
[38] CV[TN[1]]+1
[39] ->MRX\X=1
[40] COS;L5+(2,34)f'
[41] LS[1]+('(CV[TN[1]]f1),(X-CV[TN[1]])f0)\1'
[42] LSC+1
[43] ->L2AX1;CV[TN[1]]<X
[44] 'WHAT ELEMENT IS TO BE ELIMINATED?'
[45] DRI+1
[46] ->NX
[47] L3A;DUM+CV[TN[1]]f1
[48] DUM[TN[2]]+0
[49] LS[2];(f*DUM)+1+(DUM)',/'
[50] LSC<2
1. **LSC=1** IF CURRENT ELEMENT OF CV IS LESS THAN X,
   a  I.E., IF LISTS ARE TO BE LENGTHENED, LSC=2 IF LISTS
   a  ARE TO BE SHORTENED.
2. \( L2 \rightarrow L \times 1 \times (T[N[1]] = 11) \times (M[2] = 1) \)
3. SVARLAB \( \rightarrow \) (LS[LSC], [1]SVARLAB)
4. LIX:FIXT
5. \( \rightarrow L(X[1] / T[N[1]] = 3, 5, 8, 10, 13, 15 \)
6. FIXU
7. \( L \rightarrow L \times 1 \times M[1] = 0 \)
8. FIXIN
9. \( L \rightarrow L \times 2 \times (M[2] = 0) \times \times T[N[1]] = 1 6 11 \)
10. FIXEN
11. CV[T[N[1]]] \( + X \)
12. N \( \rightarrow P/E \)
13. F \( + F/E + N \)
14. ENCALC
15. \( \rightarrow MR \)
16. \( \rightarrow L2 \times CV[T[N[1]]] + X \)
17. MR: 'MORE CHANGES IN ' \( \rightarrow H E A D[1][T[N[1]]]; \)' ? 0 OR 1.'
18. YNS
19. \( \rightarrow W X \times Y X = 1 \)
20. 'NEW LIST?'
21. YNS
22. \( \rightarrow (Y X = 0 1) / (E N D, R E S) \)
23. \( \rightarrow W \times 2 \times X \times C V[T[N[1]]] \neq 0 \)
24. 'THIS LIST HAS NO ELEMENTS. CV[; T[N[1]];] = 0.'
25. 'TRY AGAIN,'
26. \( \rightarrow R E S \)
27. W2: 'WHAT ELEMENT?'
28. DD+0
29. NX:CHECKON 1
30. \( \rightarrow I N C O R 2 \times 1 \times A \times C V[T[N[1]]] \)
31. T[N[2]] \( \rightarrow A \)
32. \( \rightarrow L \times 3 \times X \times P D = 1 \)
33. \( \rightarrow L \times 5 \times X \times A / \) \( \rightarrow A + 1 \times (L A B[1][T[N[1]]], [T[N[2]]]) \)
34. \( \rightarrow A + ' N O N E ' \)
35. \( \rightarrow L \times S[1][T[N[1]]]; \) ' ITEM ' ; T[N[2]]
36. 'CURRENT NAME: '; T[N[2]]; NEW NAME?'
37. CHECK
38. \( \rightarrow O N E \times X \times C V[T[N[1]]] = 1 \)
39. \( X \times (L A B[1][T[N[1]]], [T[N[2]]]) + H' \)
40. CHU
41. ONE: \( \rightarrow (L A B[1][T[N[1]]], ' \rightarrow 9 A D J H' \)
42. CHU: \( \rightarrow M R X \times T[N[1]] = 1 3, 5, 8, 10, 13, 15 \)
43. TISUBU
44. \( \rightarrow M R \)
45. INCOR: 'PLEASE GIVE THE INDEX, I, OF THE TITLE LIST; '
46. '1 \( \leq I \leq 15 , T R Y A G A I N , '
47. \( \rightarrow C O T \)
48. INCOR2: 'GIVE THE INDEX OF AN ITEM ON THE'
HEAD1[TN[1]]; 'LIST, THAT LIST HAS '; CV[TN[1]]

'ITEMS, TRY AGAIN,'

END; CVOK CV

LASTX\OK=1

'BEFORE ENTERING DATA OR ATTEMPTING A RUN, YOU MUST'

'CHANGE THE INCORRECT ELEMENTS OF CV AND THE CORRESPONDING TITLES,'

' THIS ROUND OF TITLE CHANGES HAS BEEN COMPLETED'
VFIXT;DUM;DM

[1] DM+0
[2] →ADJ2X1X=0
[3] →CHX;CV[TN[1]]≠1
[4] *LAB1[TN[1]]; '+(2,9)f((xLAB1[TN[1]];),9f' ⋯ ')')
[5] →0X\'=X
[7] DM+1
[8] CH;DUM+1LS[LS];, ']'1(*LAB1[TN[1]];)'
[9] *LAB1[TN[1]]; '9 ADJ DUM'
[10] →0X\'=DM=0
[12] →0
[13] ADJ2+(LAB1[TN[1]];), '+(1,9)f(' ⋯ ')')

VFIXIN;EX;I;J;K;DUM

[1] EX+(3,2,3)f((x),1,(x+5),6,(x+5),11,14,15)
[2] ED+CV[EX]
[5] K+1
[6] J+1
[7] →SP
[8] CO;EX+(0,1,1)/EX
[12] →SPX1X+0
[13] *(LAB2D[I; J;], '+(ED[I; 1; 1],1,1) f0 ')
[14] →0
[15] SP;DUM+2(LS[LS];, ']'K::*LAB2D[I; J;]'
[16] *(LAB2D[I; J;], '+DUM')
[17] →SPX1(K=1)∧(2J+J+1)

\^
\[ \nabla \text{FIXU;IN;JN;DUM} \]

\[
\begin{align*}
[1] & \quad \text{IN}+1+(\text{TN}[1] \in 8, 10, 13, 15) + (\text{TN}[1] \in 13, 15) \\
[2] & \quad \text{JN}+1+\text{TN}[1] \in 5, 10, 15 \\
[3] & \quad \to ((JN=0) \land \text{CV}[\text{TN}[1]]=0) / (L2, L1) \\
[4] & \quad \text{DUM}+1 / (L[\text{LS}[\text{LS}];], '[1]*\text{UNIND}[\text{IN}; JN;])' \\
[5] & \quad \to (\text{UNIND}[\text{IN}; JN;], '+\text{DUM}') \\
[6] & \quad \to 0 \\
[7] & \quad L1; _{1} (\text{UNIND}[\text{IN}; JN;], '+X'0' ) \\
[8] & \quad \to 0 \\
[9] & \quad L2; _{2} (\text{UNIND}[\text{IN}; JN;], '+1'0' ) \\
\end{align*}
\]

\[
\nabla \text{FIXEN;I;J;K;DUM} \]

\[
\begin{align*}
[1] & \quad \text{'RATES ENTERED?'} \\
[2] & \quad \text{THS} \\
[3] & \quad \to L1x; 1x=0 \\
[4] & \quad J+1+(\text{TN}[1] \land 1)+\text{TN}[1]=11 \\
[5] & \quad \text{DUM}+1 / (L[\text{LS}[\text{LS}];], '[1]*\text{LABRAT}[J;])' \\
[6] & \quad \to (\text{LABRAT}[J;], '+\text{DUM}') \\
[7] & \quad \to (\text{LABRAT}[J;], '+\text{DUM}') \\
[8] & \quad \to (\text{LABRAT}[J;], '+\text{DUM}') \\
[9] & \quad L1; _{1} I+1+2XJ=3 \\
[10] & \quad K+1+J1 \\
[11] & \quad L2; _{2} \text{DUM}+1 / (L[\text{LS}[\text{LS}];], '[K]*\text{ENV}[I;])' \\
[12] & \quad \to (\text{ENV}[I;], '+\text{DUM}') \\
[13] & \quad I+I+1 \\
[14] & \quad \to ((J=3), ((J=2) \land (I=2))) / (L4, 0) \\
[15] & \quad \to L2X; 1x3 \\
[16] & \quad \text{L3;DUM}+1 / (L[\text{LS}[\text{LS}];], '*\text{ENV}[I;])' \\
[17] & \quad \to (\text{ENV}[I;], '+\text{DUM}') \\
[18] & \quad \to L3X; 1+I+I+1 \\
[19] & \quad \to 0 \\
[20] & \quad L4; I+I+1 / (L[\text{LS}[\text{LS}];], '*\text{IDI}') \\
\end{align*}
\]
VINCOMIN; AD; BD; CD; I; J

'COST AND INCOME DATA'

ED+CV[13], CV[1, 4, 5], CV[6, 7, 8], CV[6, 9, 10], CV[11, 12, 13]

ED+3 2 3j (ED, CV[11, 14, 15])

I+1

NEXT; AD+9 ADJ*LAB11[I;]

J+1

TH! FX x(j0 = ED[I; j; 2]

BD+9 ADJ*LAB12[I; j;]

CD+9 ADJ*LAB13[I; j;]

DD +(ED[I; j;])PO

MONDATIN

*(LAB2D[I; j;], 'AD')

CO: THXI2J+J+1

NEXTX132I+I+1

->0

FX: *(LAB2D[I; j;], '+(ED[I; 1j;], 1, 1)PO')

->CO

MONDATIN; IN; JN

IN+1

HEAD2[I;]; 'HEAD3[j;]

r((9*1), 0) CD

A THE ABOVE LINE PRINTS UNIT LABELS

R1; JN+1

AD[IN;]

R2; BD[JN;]

A THE ABOVE LINES PRINT AD= PRG/COURSE/SERVICE NAME,

A AND BD = CATEGORY NAME.

CHECKON(FDD)[3]

DD[IN; JN;]+A

R2X1(FDD)[2]; JN+JN+1

R1X1(FDD)[1]; IN+IN+1

\}
CHANGE IN COST AND INCOME DATA

1. WHAT MATRIX? 0 0 0 FOR INFO.
2. CHECK ON 3
3. 'VECTOR OF 3 IS REQUIRED, A[1]=1,2,3 FOR PROGRAM/
4. 'COURSE/SERVICE GROUP; A[2]=1,2 FOR INCOME/COST;
6. 'CATEGORY,'
7. CHECK ON 1
8. 'CHANGE IN ONE ROUND CANNOT EXCEED 10 PERCENT;'  
9. '(ANSWER -0.1<=A<=0.1).'
10. 'PERCENT (1) OR NEW VALUES (0)?'
11. YNS
12. 'WHAT PERCENT? (IN DECIMAL NOTATION)'
13. L5: CHECK ON 1
14. L6: 'DD=(1+A)x1(LAB2D[I;J],'[i;])'
15. L7: IN+1
16. IF (ED[I;J;1],ED[I;J;3])<0
17. 'HEAD2[i;];';'HEAD3[i;];';(LAB12[I;J],'[i;]')
18. ),((9,1),0,0),LAB13[I;J]
19. 'CHANGE IN INCOME OR COST ESTIMATES?'  
20. 'INCOME AND COST CHANGES COMPLETED,'
ENROLLMENT VARIABLE NAMES AND VALUES

[1] C13

STORE NEW PROGRAM AND SERVICE ENROLLMENTS

[4] AS BASE CASE?

[5] YNS

ARE THERE EXISTING BASE VALUES FOR CE, PE, AND SE THAT

[7] YOU WISH TO KEEP?

[8] YNS

CHOOSE TO SPECIFY N AND F (1) OR PE ONLY (0).

[10] YNS

CHOOSE TO SPECIFY FLM AND L (1) OR ICLM ONLY (0).


CHOOSE TO SPECIFY N AND F (1) OR PE ONLY (0).

[14] C:IN+7P1

L1: 'CHANGE PROGRAM/COURSE/SERVICE ENROLLMENT OR'

[27] 'RESOURCE NAMES?'

[28] YNS

L2:ENRVNAMES

[30] L8X\CN=0

L3: 'VARIABLES TO BE CHANGED, TYPE 7 8'S FOR INFO,'

L4: CHECK ON 7

IN=AL[6,5,3,4,2,1,7]

L5X1(~3)(O 1\A(15,7))$A[6]E0 1 2

ENTER VECTOR OF LENGTH 7; 0= NO CHANGE, 1= SPECIFIC

VALUE, 2= PERCENT CHANGE (2 FOR N ONLY).

'1,N 2,FE 3,F 4,L 5,FLM 6,ICLM 7,DM'

L4

L5: L6X\(1E[A(6,3)]$A[5]

L8X\(1E[A(4,2)]$A[1]

L6: 'YOU MAY NOT CHANGE N OR F IF YOU CHANGE FE, LIKE-

'WISE FLM OR L, IF ICLM, IN BOTH CASES ONE DETER-

'MINES THE OTHER, TRY AGAIN.'

L4

L8: I+1

L9: L5AX\IN[I]=0

J+1

ENV[I]; ' ;HEAD2[(2+(I=7));;] ' VECTORS;


L2AX\CN=0
L1A: 'WHICH ' ; (2 7) f ' PROGRAMSERVICE ' })(1+I=7); '? '

'0 OR 1 FOR EACH OF ' jf jn

CHECKON jf jn

L1AX{3}(0 1 lA)

JN+A

L2A; L4AX jn[j]=0

L7X{1}i=7

PROGLIST[j;]

L3A; CHECKON CV[6]

L5Bx{1}i=2

LO; (ENV[i; ], ' [j;]+A')

L4A; L2AX CV[1 +10*i=7] l+j+l

L5A; i+i+1

(L=2,8)/(L9, END)

L6A; CONTx{1}IN[i]=0

'NEW ' ; ENV[i;]

L7A; CHECKON CV[1]

L5Bx{1}i=3

L8A; (ENV[i; ], '+A')

CONT; L6AX5 l+i+1

L2A; (IN[6]=0)/L1B

'NEW N'

L3Bx{1}IN[6]=2

CHECKON 1

N+A

L1B; ((IN[5]=1), (IN[3,5,6]=0))/L2B, L3B

FE=+NF

L3B

L2B; N++/FE

F=FE+N

L3B; ((IN[1]=1), (IN[1,2,4]=0))/L4B, L0

DUM+=CV[6,1] FL

ICLM+DUMXFLM

L0; L9X{1}i=7 i+i+1

L7; SERVLIST[j;]

(LID[i]=1 0)/(CO, COT)

A=L

L1C

CO; A+CV[1] f1

L1C; (2 3) f '1'' SL ' ][ID[i]=j; ]; ' ENTERED. '

L2C

COT; CHECKON CV[1]

L2C; DM[j]+A

L4A

L5B; ((+/A) 10,108) ((+/A)10,02) (I=2,3))/L0, L8A

'VECTOR MUST ADD TO 1 OR - .02. TRY AGAIN. '

L2C; (I=23)/(L3A, L7A)
L6B: 'PERCENT CHANGE IN $n$ EXPRESSED AS A DECIMAL'
L7B: 'FRACTION, (E.G., -.05 FOR A 5 PERCENT REDUCTION),'
L7B: 'CHECK ON 1
L8B: \((A_1 - 0.1)A_1 0.1\)
L9B: 'CHANGE IN ONE ROUND MAY NOT EXCEED 10 PERCENT,'
L10B: 'THAT IS, YOUR ANSWER $A$ MUST BE: \(-0.1A_1 0.1\): '
L11B: 'TRY AGAIN,'
L12B: \((A_1 + 1)A_1\)
L13B: ENDCALC
L14B: 'ENROLLMENT NAMES/VARIABLES ENTERED,'
⊕ENCALC

[8] TCE++/CE
[9] TL+PEXL
[10] →0XR=0
[12] CEB+CE
[13] SEB+SE

▼
ENTRY NAMES; NC; I; J; K; TED

'NAMES FOR ENROLLMENT AND RESOURCE VARIABLES'

'FIRST CHANGE'

L1A; SVARLAB+(CV[11], 2, 9); P

FVARLAB+CVARLAB+(2, 9); P

IDI+CV[11]P0

K+1

L2; J+1

L3L6\((K=3) \land CN=0) \lor (K>3) \land CN=1

L3; TEG+HEAD1[(1+5x((K>1)+K>2));]

VARLAB[J]; 'TED'; 'TED'; '(K>2)/K-2

CHECK

L4; (((K=2), (K>2))/L0, S)

FVARLAB[J]+H

L5A

L0; CVARLAB[J]+H

L3A

S; SVARLAB[(K-2); J]+H

L3A; L3X12J+J+1

AGAINx\CN=1

L2X1(2+CV[11])K+K+1

END

AGAIN; 'ANOTHER ROUND?'

YES

ENDx\Y=0

L4A; 'WHICH VARIABLE? 1<K<; (2+CV[11])

L4; CHECKON 1

L5X\A; (2+CV[11])

'ERROR. SPECIFY 1 FOR PROGRAM VARIABLE, 2 FOR ICLM'

'VARIABLE, 3 FOR FIRST DM VARIABLE, ETC. TRY AGAIN,'

L4

L5; K+4

L2

J+4

L6; 'SERVICE VARIABLE CODE'

L7\CN=1

'VECTOR FOR SERVICES'

L7; CHECKON(1+(CN=0)\(CV[11]-1)

\((n4\((0, 12)\land(CN=0, 1)))/(ON1, ON2)

'CODE: PROPORTIONAL TO ENROLLMENT: ONLY (1);'

'AND L (2); AND USER DEFINED VARIABLE (0),'

L7

ON1; L3X1CV[11]=PIDI+4

ON2; PIDI(K-2)+A

L3

END; 'VARIABLE AND RESOURCE NAMES ENTERED,'
VRATIN;I;J

[1] 'RAIE FORMULAS

[2] →L4X10=CN

[3] L1: 'WHAT VARIABLE? TYPE ' 0 0 ' FOR HELP.'

[4] L2: CHECKON 2

[5] →L3X1\0/(13)=I+4A[1]


[7] L3: 'VECTOR OF 2; FIRST ELEMENT = 1,2,3 FOR'

[8] 'PROGS/COURSES/SERVICES; 2ND ELEMENT INDEXES'

[9] 'INDIVIDUAL PROGRAM, COURSE GROUP, OR SERVICE,'

[10] →L2

[11] L4: I+1

[12] L5: J+1

[13] i(LABRA[I];',+(CR[(1+5X(I-1))],4)\0')

[14] i(LABRAT[(I+3)];',+(0 0 1 1)/(\LABRAT[I];))'

[15] L6: 'FORMULA FOR 'i(LAB11[I];',[J;])'

[16] →LIAX\0/(CN=0)\0(J\#1)\0J\#3

[17] =(I=2,3)/(L8,L9)

[18] PVARLAB[2;]' FROM ';PVARLAB[1;]

[19] →LIA

[20] L8: CVARLAB[2;]' FROM ';CVARLAB[1;]

[21] →LIA

[22] L9: SVARLAB[J;2;]' FROM ';SVARLAB[J;1;]

[23] L1A: CHECKON 4

[24] →L2AX\0(A[3]\0(0,1))\0(A[4]\0(0,1))


[26] 'CONSTANT: RAIE, STEP, INC, STEP = 1 FOR STEP FORM-

[27] 'ULA, 0 OTHERWISE, INC = 1 IF INCREMENT FORMULA IS'

[28] 'TO BE USED, 0 OTHERWISE, ENTER ' 0 0 0 0' IF NO'

[29] 'RESOURCES ARE USED, IF INC = 1, YOU WILL BE ASKED'

[30] 'FOR A TWO ELEMENT FORMULA, INCRAI, INCSTEP,'

[31] 'ENTER FORMULA '

[32] →L1A

[33] L2A: i(LABRAT[I;]',[J;]+A')

[34] →L3AX\0[A4]=1

[35] →L5AX\0CN=0

[36] i(LABRAT[(I+3)];',[J;]+0 0')

[37] →AGAIN

[38] L3A: 'INCREMENT'

[39] CHECKON 2

[40] →L4AX\0[A2]E0,1

[41] 'ANSWER WITH INCRAI, INCSTEP; INCSTEP = 0 OR 1.'

[42] →L3A

[43] L4A: i(LABRAT[(I+3)];',[J;]+A')

[44] →AGAINX\0CN=1
LSA: \( L6x \{ CV[(1+5x(i-1))] \} \) \( j+j+1 \)

\( L5x \{ I+i+1 \} \)

\( \text{END} \)

AGAIN: 'ANOTHER CHANGE IN RATE FORMULAS?'

YNS

\( L1x \{ yx=1 \} \)

\( \text{END}: 'RATE FORMULAS ENTERED,' \)
VRESOURCE; I; J; IN; JN; AD; BI; DUM; DD; R; RR; RRR; TED

1. 'RESOURCE_REQUIREMENTS: IS THIS A BASE CASE?'

2. YNS

3. →L1×1=IN×YX

4. 'RUN WITH CURRENT BASE, IF ANY, (1) OR AS INDEPENDENT?

5. 'DENT RUN (0)?'

6. YNS

7. →L1×YX

8. L1×I+1

9. L2×J+1

10. DUM×LABRAT[I;]

11. DD×LABRAT[(I+3);]

12. R×CENC[I;1;]

13. RR×CENC[I;2;]

14. RRR×CENC[I;3;]

15. L3×AD×V/(IN=1), (JN=0), DUM[J;4]=0

16. BD×(IN=1)×DUM[J;4]×0

17. TED×((AD=1)×DUM[J;3]=1), ((AD=0)×(DD[J;2]=0,1))

18. TED/(L4×L5×L6)

19. RR[J;1]+DUM[J;1,2]×(1,R[J])

20. →(BD=0,1)/(L8×L7)


22. →(BD=0,1)/(L8×L7)


24. →L8


26. →L8

27. L7×DUM[J;4]+RR[J]

28. L8×L3×CV[I+5×I-1]; J+1

29. (LABRAT[I;], 'DUM')

30. R(CENC[I;2;], 'RR')

31. →L2×13×I+1

32. TPR++/FR

33. TCR++/CR

34. (1)
VAR;VARL;AA;JN;R;CO

DIRECT BUDGETS

I+1

L1;J+1

L4;CT+((2XJ)-1)+CO+1+5XJ-1

VARL+(CV[CT]+1);5)0

JN+1

L3;AA+1(UIND[I;J];'[JN]')

RATID

ER=1

VARL[JN;J]+VAR

L3;CV[CT]+1)JN+JN+1

$(DRUC[I;J];'(CV[CO;CT])0')

K+1

F+CV[CT+1]0

L1A;JN+1

L2;R[JN]+VARL[JN;J]

L2X;CV[CT+1)JN+JN+1

DUM+1(LAB2D[I;J];'[K]+.XQR')

$(DBUC[I;J];'[K]+DUM')

L1X;CV[CO]J+K+1

$(DRBD[I;J];'+/(DBUC[I;J];')

$(TDR[I;J];'+/(DRBD[I;J])'

L7;L4X;J+J+1

$(DUC[I];'+(DRBD[I;J])/(CENC[I;J]')

L5X;I=3

$(TRUC[I];'+(TDR[I;J])/(23);'N TCE';'[I]')

L5;$(NEDR[I];'+(DRBD[I;J])-/(DRBD[I;J])'

$(NEDR[I];'+/(NEDR[I]')

L1X;L3;I+I+1

TOTINC+/(TDR[1;1]);(TDR[2;1]);(TDR[3;1])

TOTCOST+/(TDR[1;2]);(TDR[2;2]);(TDR[3;2])

GRANDNET+TOTINC-TOTCOST

GRANDUNIT+TOTCOST-N

TDUC=0

0

L6;$(DBUC[I;J];'(CV[CO]1)0')

$(DRBD[I;J];'+CV[CO]0')

$(TDR[I;J];'+0')

L7

\^
VARATID;

ER+0
[2] ->L1X\((I=1)\AAe10\times14)\v(I=2)\AAe10\times13
[4] L1:->((AA=40),(\AAe30,40))\/(L2,L3)
[5] VAR+'1
[6] ->0
[7] VAR+'TL[K]'
[8] ->0
[9] L3: B+2(1 0 1)\AA
[10] VAR+' ]'
[13] ->0
[14] L4:'FATAL ERROR; UNIT INDEX NUMBER NOT SPECIFIED'
[15] 'CORRECTLY, SEE CODELIST,'
[16] ER+1

VARFBD

A PROGRAM BUDGET CALCULATION; SEE LABUG FOR VARIABLES
[2] I+2
[3] L1:J+1
[4] L2:((FPRB[I;J;]),+(FCLB[(I-1;)]),X(NPRB[I;J;]))
[5] 4L2X2J+J+1
[6] 2((NPRB[I;],+(FPRB[I;1;]),-(FPRB[I;2;])))
[7] 2(FUB[I;],+(FPRB[I;2;])FE')
[8] 4L1X3J+J+1
[9] TPBI+PI+PC1+PSI
[10] TPBC+PC+PCC+PSC
[12] TPRUB+TPBC÷FE
FLP; 'UNIT CODES: SEE PROGRAM ''CODELIST'' FOR KEY'

CD+(29) P 'INCOME COST'

L1:TITL1+HEAD2[1;]

J+1

L2:E+LAB13[I;J;]

G+CID[J;]

H+QUIND[I;J;]

L3X10=+/,H

DISPLAY1

L3=L2X12J+J+1

'ID1; CODES FOR RELATIONSHIP BETWEEN SUPPORT SERVICE'

'ENROLLMENTS AND RESOURCES,'

'HAVE THESE DATA BEEN ENTERED?'

YNS

QX\YX=0

'KEY: PROPORTIONAL TO ENROLLMENT AND; 0=USER DEFINED'

'VARIABLE, 1=1, 2=L, AVERAGE STUDENT INSTR, LOAD,'
[1] DISERN:J;K;IN;JN;KN;IT;ROWL;RR;R;RR;AD;VARLAB:B
[2] I+(2 16)P 'INPUT INPUT AND OUTPUT'
[3] VARLAB+(2 11)P 'ENROLLMENTS RESOURCES'
[4] JN=15f1
[7] 'SHORT (0) OR LONG (1) LIST?'
[8] YNS
[9] JN[1,3,4,6,7,8,9]+B+TYX
[10] 'INPUT (0) OR INPUT AND OUTPUT (1) VARIABLES?'
[22] R+9p' ' [23] RRR+(2 8)P 'PROGLISTR'
[24] I+1+J+T+0
[25] L0:T=T+1
[26] G+*RRR[T;]
[27] L1;AD=E+*LAB11[(2+(v/I=2,5)-I=3)];
[28] K+1
[29] L2;J+J+1
[30] L4x;JN[J]=0
[31] H+IT[J;]
[32] L3x;J>9
[33] TITL1+IT[J;]'; ' ,KN[J;]
[34] ((v/J=1,4,7),(J=8),(v/J=2,3,9))/(L2A,L8A,L3A)
[35] TITL1
[36] L7A
[37] L3A;TITL1+TITL1, ' ', CVARLAB[1;],'
[38] ((v/J=2,3),(J=9))/(L2A,L8A)
[39] L1A;E+SVARLAB[1;]
[40] L2A;DISPLAY2 ROWL
[41] L4
[42] L3;TITL1+IT[J;]'; ' ,RR[(1+(J)11)+(J)13]);', ' [43] TITL1+TITL1,VARLAB[(1+v/J=11,13,15)];'
[44] ((I=4,5)/(L5A,L6A)
[45] TITL1+TITL1, ' ', FVARLAB[(K-2);],'
[46] L8A
[47] L5A;TITL1+TITL1, ' ', CVARLAB[K;],'
[48] L8A
[49] L6A;TITL1
L7A: ' 
Z+(*(FAD[1]+10)F(0,(9F1)) 
RTJUST AD 
TITL1+(10F','),Z\,OUT 
E+SVARLAB;K;] 
L1AX1I=2 
L8A;DISPLAY1 
L4X\^JX11,12,13 
'' 
'TOTAL, T';IT[;];';i('T',IT[;]) 
L4: ' 
L2X\IN[;]k+K+1 
I+I+1 
((I=3),(V/I=2,4,5))/(L0,L1) 
O=XB=0 
TITL1'TL; TOTAL LOAD VECTOR (';SVARLAB[1];',')' 
G=9F' 
E+PROGLIST 
H+TL 
DISPLAY1
RATE FORMULAS: HAVE BASES FOR INCREMENT FORMULAS'

'BEEN COMPUTED (1) OR SHOULD ZEROS BE DISPLAYED (0)?'

YNS

RATE FORMULAS'
DISPLAY 2 50

H="TOTALC, TOTCOST, GRANDNET, GRANDUNIT"
G=""
TITL1='GRAND TOTALS'
DISPLAY

\$DSPB1; ADJ; I; TED
[1] A PROGRAM BUDGET DISPLAY
[2] E+(4 9);'INCOME COST NET UNIT
[3] AD=HEAD2
[4] AD[1;]+"DIRECT PROGRAM";8"
[5] '"
[6] "
[7] G=PROGLIST
[8] I+1
[9] L1; TITL1+AD[I;]
[10] TED+(IPRG[I;1;]),(IPRG[I;2;]),(IIPRG[I;]),(IPUC[I;])
[12] T=2X10^+7;H
[13] TITL1; 'NO INCOME, NO EXPENSES'
[14] T=L3
[15] L2; '
[16] DISPLAY 2 50
[17] '
[18] '
[19] L3; T=1X13;I+I+1
[20] TITL1='TOTAL PROGRAM BUDGET'
[21] H=Q(4,CV[1]) TPBI, TPBC, NETPB, TPRUB
[22] DISPLAY 2 50

\$$
\texttt{DISPLAY1\#Z}

\begin{verbatim}
[1] E9 ADJ E
[2] Z+,((pE)[1],10)p(0,(9\#1))
[3] RTJUST E
[4] TITL1
[5] ((10f','),(Z',OUT))
[6] ((',G')','),(10 FORMAT H)
\end{verbatim}

\texttt{DISPLAY2 ROWL;HEAD;ARR;Z;J}

\begin{verbatim}
[1] E9 ADJ E
[2] Z+,((pE)[1],10)p(0,(9\#1))
[3] RTJUST E
[4] HEAD+(2,ROWL)p' '
[5] HEAD[1]\#TITL1+TITL1
[7] HEAD
[8] J+1
[9] LI;ARR+ROWLp' '
[10] G9 ADJ G
[13] ARR
\end{verbatim}
DISPLAY 3 ROWL; HEAD; ARR; I; J; K; Z

1 E+9 ADJ E
2 Z+1((F E)[1;10]F(0,(9F1))
3 RTJUST E
4 HEAD+(2, ROWL)F'
5 HEAD[1; TITL]+TITL1
6 HEAD[2; (20+(FZ)]+Z\OUT
7 HEAD
8 I+1
9 L1; J+1
10 '
11 K+0
12 L2; ARR+ROWL'F'
13 →L4\X1=A/0=H[I; J;]
14 →L3\X K=1
15 F+9 ADJ F
16 ARR[19]+F[I;]
17 K+1
18 G+9 ADJ G
19 L3; ARR[10+19]+G[J;]
20 ARR[20+(FZ)]+10 FORMAT H[I; J;]
21 ARR
22 L4; L2\X(FG)[1]J+J+1
23 →L1\X(FF)[1]I+I+1

VDD+IT FORMAT DUM; OUT

1 →L0\X A/(O=DUM) V(0, 14; DUM)
2 →L1\X(A/-1000000<,DUM) V(A/10000000, DUM)
3 L0; DDT+(IT, -3)† DUM
4 RTJUST((F DUM), IT)DD
5 DDT, OUT
6 →0
7 L1; DDT+(IT, 2)† DUM

V
\CHECK

[1] A CHECKS USERS LITERAL INPUT.
[2] L0: H+0
[3] →L1X\{(F,H)\{9" MORE THAN 9 CHARACTERS; TRY AGAIN."
[5] →0
[6] L1: H+H, (9-(F,H))F "\n
\CHECKON P; B; BB

[1] A CHECKS USER'S NUMERICAL INPUT.
[2] L0: A+0
[3] →L4X15E('0')\A
[4] L1: L3X23E((',',+(0,19))\A)
[6] L1A: →L2X1B,P,A
[8] →L3X1\A[(B-1),(B+1)]=', '
[10] →L2X1BB\F,A
[12] →L1AX1B=B+BB
[13] L2A+; A
[14] →0X1(FA)=F
[15] L3: 'ONLY NUMBERS ARE PERMITTED; VECTOR OF LENGTH '; P
[16] 'IS REQUIRED, USE — FOR MINUS, TRY AGAIN."
[17] →0
[18] L4: 'NEGATIVE NUMBER OK? 0 OR 1'
[19] YNS
[20] →L1+YX=1
[21] 'TRY AGAIN'
[22] →0
\textbf{RTJUST} $\textit{KN} ; I$

\begin{enumerate}
\item $\text{L1} \times 9 = \textit{f}, \textit{KN}$
\item $\text{KN} \rightarrow \textbf{ADJ} \textit{KN}$
\item $\text{L1} ; I \rightarrow 1$
\item $\text{N} \rightarrow \text{EN} \times ((') \neq (\textit{KN}[I] ; (\textit{f} \textit{KN}) [2])))$
\item $\textit{KN}[I] ; I \rightarrow ('1 \textit{f} \textit{KN}[I] ; I))$
\item $\rightarrow \textit{N}$
\item $\text{EN} ; \rightarrow \text{EN} \times ((\textit{f} \textit{KN}) [1] \text{I} \rightarrow \text{I} + 1$
\item $\text{OUT} \rightarrow \text{KN}$
\end{enumerate}
\$LABELS;LAB0
[1]  LAB1+'PROGLIST,PICATLST,PIULST,FCATLST,FCULST,COURLIST,CICATLST,CIULST,CCCATLST,CCULST,SCCATLST,SCULST
[2]  LAB1+LAB1,'STCICATLST,SCIULST,CCCATLST,CCULST,SCULST
[3]  LAB1+LAB1,'TSICATLST,TSIULST,CCCATLST,CCULST,SCULST
[4]  LAB1+15 8$LAB1
[5]  LAB10+3 5 8$LAB1
[6]  LAB11+(1,4p0)/[2]LAB10
[7]  LAB11+3 8$LAB11
[8]  LAB12+(0 1 0 1 0)/[2]LAB10
[9]  LAB13+(0 0 1 0 1)/[2]LAB10
[10]  A
[11]  HEAD1+'PROGRAMS',(12f '),'PROG INCOME CATS PROG'
[12]  HEAD1+HEAD1,'INC UNITS',(6f '),'PROG COST CATEGORIES'
[13]  HEAD1+HEAD1,'SPROG COST UNITS',(5f '),'COURSE GROUP'
[14]  HEAD1+HEAD1,'S',(7f '),'COURSE INCOME CATS COURSE'
[15]  HEAD1+HEAD1,'INCOME UNITS COURSE COST CATS COURSE'
[16]  HEAD1+HEAD1,'COST UNITS SERVICES',(12f '),'SERVICES'
[17]  HEAD1+HEAD1,'ICE INC CATS SERVICE INC UNITS SERVICES'
[18]  HEAD1+HEAD1,'ICE COST CATS SERVICE COST UNITS'
[19]  HEAD1+15 20$HEAD1

\$}

\$LAB1
PROGLIST
PICATLST
PIULST
FCATLST
FCULST
COURLIST
CICATLST
CIULST
CCCATLST
CCULST
SCCATLST
SCULST

\$LAB11
PROGLIST
COURLIST
SERVLIST
LAB12
PICATLST
PCCATLST
CICATLST
CCCATLST
SICATLST
SCCATLST

LAB13
PIULST
FCULST
CIULST
CCULST
SIULST
SCULST

HEAD
PROGRAMS
PROG INCOME CATS
PROG INC UNITS
PROG COST CATEGORIES
PROG COST UNITS
COURSE GROUPS
COURSE INCOME CATS
COURSE INCOME UNITS
COURSE COST CATS
COURSE COST UNITS
SERVICES
SERVICE INC CATS
SERVICE INC UNITS
SERVICE COST CATS
SERVICE COST UNITS
LABELS2
[1] LAB2D,'PROGINGC PROGCOSTCORSINC CORSCOSTSERVINC SERVC'
[2] LAB2D+LAB2D,'OST'
[3] LAB2D+(0,(8F1))\(6 \ 8F',LAB2D)
[4] LAB2D[;1]+6F'D'
[5] LAB2D+3 2 9FLAB2D
[6] HEAD2,'PROGRAMS/STUDENT TYPESINSTRUCTIONAL SERVICES'
[7] HEAD2+HEAD2,'SUPPORT SERVICES'
[8] HEAD2+3 22FHEAD2
[9] HEAD3+(2,6)'INCOME COST '
[10] LABCH+(4 5)'TICH INCH ENRINRATIN'
[11] LABDIST+(5 7)'DISFINPDISENR DISRAT DSSBD DSPBD '
[12] INPUT+(4 7)'TILIN INCOMENINRIN RATIN '

LAB2D
DPROGINGC
DPROGCOST
DCORSINC
DCORSCOST
DSERVINC
DSERVVCOST

HEAD2
PROGRAMS/STUDENT TYPES
INSTRUCTIONAL SERVICES
SUPPORT SERVICES

HEAD3
INCOME
COST

LABCH
TICH
INCH
ENRIN
RATIN
LABDIS
DISFINP
DISENR
DISRAT
DSSED
DSFED

INPUT
TILIN
INCOMIN
ENRIN
RATIN
\textbf{\textsc{\textcopyright Labeled}}

[1] \textsc{Varlab+}(2,8)\ 'ENROLLM,RESOURCE'
[2] \textsc{Labrat+}(6 5)\ 'PRATB\ CRATB\ SRATB\ PRATIC\ CRATISRATI'
[3] \textsc{Cenc+}(3 2 2)\ 'PEPRCECRSES'
[4] \textsc{Uind+}(3,2,4)\ 'IPUIIPUCICUICUCISUISUC'
[5] \textsc{Env+}(7 4)\ 'ICLMFLM DM F L PE N '
[6] \textsc{Cenc+}(3 3)\ 'PEBCEBSEB'

\textbf{\textsc{Varlab}}

\textsc{Enrollm, Resource}

\textbf{\textsc{Labrat}}

\textsc{Pratb}
\textsc{Cratb}
\textsc{Srati}
\textsc{Prati}
\textsc{Crati}
\textsc{Srati}

\textbf{\textsc{Cenc}}

\textsc{Pe}
\textsc{Pr}
\textsc{Ce}
\textsc{Cr}
\textsc{Se}
\textsc{Sr}
VLABUG

[1] A LABELS FOR BUDGET PROGRAMS
[2] DRBD+(3 2 2)\textasciitilde PIFCCICCSISC\textasciitilde
[3] TDR+(3 2 3)\textasciitilde TPITFCTCITCSCSTSC\textasciitilde
[4] DUC+(3 4)\textasciitilde DPUCDCUCDSUC\textasciitilde
[5] TDUC+(3 5)\textasciitilde TDPUCTDCUCTDSCUC\textasciitilde
[6] METDR+(3 3)\textasciitilde NDPMDCNDS\textasciitilde
[7] TNEDR+(3 4)\textasciitilde TNDPTNDCTNDS\textasciitilde
[8] DRUC+(3 2 4)\textasciitilde DPICDPCCDCICDCCCDSCICDSUC\textasciitilde
[9] PREG+(3 2 3)\textasciitilde PI PC PGIIPCCPSPSIPSC\textasciitilde
[10] NFRG+(3 4)\textasciitilde NDF NPCNPSB\textasciitilde
[11] FUC+(3 4)\textasciitilde DPUCPCUCPSUC\textasciitilde
[12] PLCB+(2 4)\textasciitilde CPEMSPEM\textasciitilde

V

DRUC

DPIC
DPCC
DCIC
DCCC
DSIC
DSCC

DRBD

PI
PC
CI
CC
SI
SC

TDR

TPI
TPC
TCI
TCC
TSI
TSC
K'UC
PUC
T'UC
SUC

TDUC
TDFUC
TDCUC
TDSUC

NETDR
NDF
NDC
NDS

PRBG
PI
PC
PCI
PCC
PSI
PSC

NPRG
NDF
NFCB
NFSB

PUC
DPUC
PCUC
PSUC

PCLB
CPEM
SPEM
\texttt{VLABD}
\texttt{[1] IT='FLM ICLM CWLM CFEM DM SWLMSPEMF L PE PR CE ;}
\texttt{[2] IT=IT,'CR SE SR ;}
\texttt{[3] IT+(15 4)FT}
\texttt{[4] KN=IT'COURSE LOAD MATRIX'IN,COURSE LOAD MATRIX'COURSE;}
\texttt{[5] KN=KN,'WK,LOAD MATRIX PERCENT COURSE ENRLMT'IN,SERV,L ;}
\texttt{[6] KN=KN,'LOAD MATRIX SERV,WORK LOAD MATRIX PERCENT SERV ;}
\texttt{[7] KN=KN,'ENRLMT FRACTIONL LOAD VECTOR STUDENT LOAD VECT ;}
\texttt{[8] KN=KN,'CTOR ;}
\texttt{[9] KN+(9 21)PKN}
\texttt{[10] RR=(3 7)f'PROGRAM COURSE SERVICE' ;}

\texttt{IT}
\texttt{FLM}
\texttt{ICLM}
\texttt{CWLM}
\texttt{CFEM}
\texttt{DM}
\texttt{SWLMSPEMF}
\texttt{F}
\texttt{L}
\texttt{PE}
\texttt{PR}
\texttt{CE}
\texttt{CR}
\texttt{SE}
\texttt{SR}

\texttt{KN}
\texttt{FR,COURSE LOAD MATRIX}
\texttt{IN,COURSE LOAD MATRIX}
\texttt{COURSE WK,LOAD MATRIX}
\texttt{PERCENT COURSE ENRLMT}
\texttt{IN,SERV,LOAD MATRIX}
\texttt{SERV,WORK LOAD MATRIX}
\texttt{PERCENT SERV,ENRLMT}
\texttt{FRACTIONL LOAD VECTOR}
\texttt{STUDENT LOAD VECTOR}

\texttt{RR}
\texttt{PROGRAM}
\texttt{COURSE}
\texttt{SERVICE}
APPENDIX C

LEARN COMPUTER RUNS

1. SAMPLE INPUT AND OUTPUT WITH DUMMY DATA AND
SAMPLE TERMINAL SESSION TO INPUT NEW BASE CASE

The printouts that follow show the terminal session in
which the dummy data for LEARN were entered. See Section 2
for displays of the input and output using these same data.

Note that the data could have been entered in a single
run if that had been the user's preference.

Enter names and labels 522
Correct errors in labels 525
Enter financial data 527
Enter enrollment data 530
Enter ratio formulas 532
Correct error in ratio formulas and perform calculations 533
LOAD LRNPFOG

LRNPFOG 80/08/09 17:20:30
LEARN 0

RUN NAME?

START SAMPLE TERMINAL SESSION TO INPUT NEW DATA

CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN, OR 4=DISPLAY.

1

WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN EXPLANATION.)

1 0 0 0

NEW NAMES AND LABELS

CV? 4 2 3 1 1 3 1 1 5 3 3 1 1 4

CV=4 2 3 1 1 3 1 1 5 3 3 1 1 4 OK? ANSWER 0 OR 1.

PROG INCOME CATS

1 FEES

2 GRANTS

3 PROG INC UNITS

1 PER STUD

UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST.)

10 NEXT UNIT NAME

2 PER CRED

UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST.)

40 NEXT UNIT NAME

3 FIXED

UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST.)

30 PROG COST CATEGORIES

1 FIXED

PROG COST UNITS

1 FIXED
UNIT INDEX NUMBER? (TYPE 'Q' FOR CODE LIST.)
30
COURSE GROUPS
1
EXT, CLASS
2
CORRESP
3
REG CLASS
COURSE INCOME CATS
1
CRED, FEE
COURSE INCOME UNITS
1
PER CRED
UNIT INDEX NUMBER? (TYPE 'Q' FOR CODE LIST.)
10
COURSE COST CATS
1
INST, SAL
2
ADMIN.
3
INST, MAT
4
MAILING
5
ADV.
COURSE COST UNITS
1
PER CR.
UNIT INDEX NUMBER? (TYPE 'Q' FOR CODE LIST.)
10
NEXT UNIT NAME
2
F, CR, TGHT
UNIT INDEX NUMBER? (TYPE 'Q' FOR CODE LIST.)
20
NEXT UNIT NAME
3
FIXED
UNIT INDEX NUMBER? (TYPE 'Q' FOR CODE LIST.)
30
SERVICES
1
COUNSEL
2
REGISTR
3
GEN, ADM
SERVICE INC CATS
1
ADM, STAFF
SERVICE INC UNITS
1

*DEL*
FIXED
UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST,)
30
SERVICE COST CATS
1
ADM, STAFF
SERVICE COST UNITS
1
PER COUNS
UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST,)
21
NEXT UNIT NAME
2
PR RG STF
UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST,)
22
NEXT UNIT NAME
3
PER STUD
UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST,)
13
NEXT UNIT NAME
4
FIXED
UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST,)
0
A 2 DIGIT CODE EXPRESSED AS A SINGLE NUMBER
30 INDICATES A CONSTANT, OTHERWISE:
1ST DIGIT: 1 FOR APPROPRIATE ENROLLMENT VECTOR, (PE, CE, SE),
    2 FOR APPROPRIATE RESOURCE VECTOR, (PR, CR, SR),
    3 FOR PROGRAM INST. LOAD (PEXL), NOTE:
    3 APPLIES TO PROGRAMS ONLY.
2ND DIGIT: 0 FOR PROGRAMS AND COURSES,
    K (INDEX OF SERVICE) FOR SERVICES,
UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST,)
30
RUN? 0 = NO RUN, 1 = RESOURCE ONLY, 2 = RESOURCE AND
    DIRECT BUDGET, 3 = ALL CALCULATIONS,
0
DISPLAYS?
0
LEARN RUN COMPLETE,
LEARN 1

RUN NAME?

CORRECT ERRORS IN TITLE INPUT

CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.

2

WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN EXPLANATION,)

1 0 0 0

CHANGE NAMES AND LABELS

HAVE DATA FOR 11 INCOME/COST OR 21 ENROLLMENTS OR RATES BEEN ENTERED?

ANSWER '0 0' FOR NONE, '10' FOR COST/INCOME, . . .

0 0

CHANGE LIST LENGTH? ANSWER 0 OR 1

0

NUMBER OF TITLE LIST?

4

WHAT ELEMENT?

1

PROG COST CATEGORIES ITEM 1

CURRENT NAME: FIXED , NEW NAME?

COORD,

MORE CHANGES IN PROG COST CATEGORIES ? 0 OR 1.

0

NEW LIST?

1

CHANGE LIST LENGTH? ANSWER 0 OR 1

0

NUMBER OF TITLE LIST?

13

WHAT ELEMENT?

1

SERVICE INC UNITS ITEM 1

CURRENT NAME: FIXED , NEW NAME?

FIXED

UNIT INDEX NUMBER? (TYPE '0' FOR CODE LIST.)

30

MORE CHANGES IN SERVICE INC UNITS ? 0 OR 1.

0

NEW LIST?

1

CHANGE LIST LENGTH? ANSWER 0 OR 1

0

NUMBER OF TITLE LIST?

12

WHAT ELEMENT?

1

SERVICE INC CATS ITEM 1

CURRENT NAME: ADM, STAFF , NEW NAME?
GRANTS
MORE CHANGES IN SERVICE INC CATS ? 0 OR 1.
0
NEW LIST?
0
THIS ROUND OF TITLE CHANGES HAS BEEN COMPLETED
RUN? 0= NO RUN, 1=RESOURCE ONLY, 2=RESOURCE AND
DIRECT BUDGET, 3=ALL CALCULATIONS,
0
DISPLAYS?
0
LEARN RUN COMPLETE,
LEARN 1
RUN NAME?
CONTINUE SAMPLE TERMINAL SESSION TO INPUT NEW DATA
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN
EXPLANATION.)
0 1 0 0
COST AND INCOME DATA
PROGRAMS/STUDENT TYPES INCOME
PER STUD PER CRED FIXED
NURSE BGS
FEES
0 1 0 0
GRANTS
0 3000
ONLY NUMBERS ARE PERMITTED; VECTOR OF LENGTH 3
IS REQUIRED, USE - FOR MINUS, TRY AGAIN,
0 0 3000
POL/F BGS
FEES
0 0 0
GRANTS
150 0 0
OTHER DGR
FEES
0 0 0
GRANTS
0 0 0
GENERAL
FEES
0 0 0
GRANTS
0 0 0
PROGRAMS/STUDENT TYPES COST
FIXED
NURSE BGS
COORD,
1000
POL/F BGS
COORD,
4000
OTHER DGR
COORD,
0
GENERAL
COORD,
0
INSTRUCTIONAL SERVICES INCOME
PER CRED
EXT, CLASS
CRED, FEE
35
CORRESP
CRED, FEE
35
REG CLASS
CRED, FEE
12
INSTRUCTIONAL SERVICES COST
PER CR. P, CR, TGHT FIXED
EXT, CLASS
INST, SAL
0 350 0
ADMIN,
0 0 3000
INST, MAT
3 0 0
MAILING
0 0 100
ADV,
0 0 200
CORRESP
INST, SAL
0 10 300
ADMIN,
0 0 1500
INST, MAT
5 0 500
MAILING
5 0 0
ADV,
0 0 500
REG CLASS
INST, SAL
0 0 500
ADMIN,
0 0 0
INST, MAT
0 0 0
MAILING
0 0 0
ADV,
0 0 800
SUPPORT SERVICES INCOME
FIXED
COUNSEL
GRANTS
0
REGISTR
GRANTS
<p>| | | | | |</p>
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<td>500</td>
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<td>REGISTR</td>
<td>ADM, STAFF</td>
<td>0</td>
<td>100</td>
<td>0</td>
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<tr>
<td>GEN, ADM</td>
<td>ADM, STAFF</td>
<td>0</td>
<td>0</td>
<td>5</td>
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</table>

RUN? 0 = NO RUN, 1=RESOURCE ONLY, 2=RESOURCE AND DIRECT BUDGET, 3=ALL CALCULATIONS.

DISPLAYS?
0

LEARN RUN COMPLETE.
LEARN 1
RUN NAME?
CONTINUE SAMPLE TERMINAL SESSION TO INPUT NEW DATA 2
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
1
WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN
EXPLANATION,)
0 0 1 0
ENROLLMENT VARIABLE NAMES AND VALUES
STORE NEW PROGRAM AND SERVICE ENROLLMENTS
AS BASE CASE?
1
CHOOSE TO SPECIFY n AND f (1) OR PE ONLY (0).
0
CHOOSE TO SPECIFY FLM AND L (1) OR ICLM ONLY (0):
0
NAMES FOR ENROLLMENT AND RESOURCE VARIABLES
ENROLLM, PROGRAMS
STUDENTS
RESOURCE PROGRAMS
NONE
ENROLLM, COURSE GROUPS
CR,TAKEN
RESOURCE COURSE GROUPS
CR,TAUGHT
SERVICE VARIABLE CODE
VECTOR FOR SERVICES
0 2 1
ENROLLM, SERVICES
VISITS
RESOURCE SERVICES
COUNS,
ENROLLM, SERVICES
CR,TAKEN
RESOURCE SERVICES
REG,STF
ENROLLM, SERVICES
STUDENTS
RESOURCE SERVICES
NONE
VARIABLE AND RESOURCE NAMES ENTERED,
ICLM INSTRUCTIONAL SERVICES VECTORS;
NURSE BGS
2.4 0 .6
POL/F BGS
4.2 .6 1.2
OTHER DGR
.8 .9 6.3
GENERAL
1.5 1.2 .3
NEW PE

20 30 50 100

IM SUPPORT SERVICES VECTORS;
COUNSEL
.5 .6 .7 .1
REGISTR L ENTERED,
GEN,ADM
1'S ENTERED,
ENROLLMENT NAMES/VARIABLES ENTERED.
RUN? 0= NO RUN, 1=RESOURCE ONLY, 2=RESOURCE AND
DIRECT BUDGET, 3=ALL CALCULATIONS,
0
DISPLAY?
0
LEARN RUN COMPLETE,
LEARN 1
RUN NAME?
CONTINUE SAMPLE TERMINAL SESSION TO INPUT NEW DATA 3
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
1
WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN
EXPLANATION.)
0 0 0 1
RATE FORMULAS
FORMULA FOR NURSE BGS
NONE FROM STUDENTS
0 0 0 0
FORMULA FOR POL/F BGS
0 0 0 0
FORMULA FOR OTHER DGR
0 0 0 0
FORMULA FOR GENERAL
0 0 0 0
FORMULA FOR EXT, CLASS
CR, TAUGHT FROM CR, TAKEN
0 .06 0 1
INCREMENT
.03 0
FORMULA FOR CORRESP
0 1 0 0
FORMULA FOR REG CLASS
0 1 0 0
FORMULA FOR COUNSEL
COUNS, FROM VISITS
0 1 1 0
FORMULA FOR REGISTR
REG, STF FROM CR, TAKEN
2 .03 0 0
FORMULA FOR GEN, ADM
NONE FROM STUDENTS
0 0 0 0
RATE FORMULAS ENTERED,
RUN? 0= NO RUN, 1=RESOURCE ONLY, 2=RESOURCE AND
DIRECT BUDGET, 3=ALL CALCULATIONS,
0
DISPLAYS?
0
LEARN RUN COMPLETE,
LEARN 1
RUN NAME?
DEMONSTRATION - CORRECT ERROR IN RATIO FORMULA
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
2
WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN
EXPLANATION,)
0 0
ONLY NUMBERS ARE PERMITTED; VECTOR OF LENGTH 4
IS REQUIRED, USE - FOR MINUS, TRY AGAIN.
2 2 2 2
TYPES: 1)LABELS/NAMES, 2)FINANCIAL INPUT,
3)ENROLLMENT INPUT, 4)RATIO INPUT. TYPE 0 OR 1 FOR
EACH (E.G., '1 0 0 0' MEANS LABELS/NAMES ONLY).
TYPES?
0 0 0 1
RATE FORMULAS
WHAT VARIABLE? TYPE '0 0' FOR HELP,
0 0
VECTOR OF 2; FIRST ELEMENT = 1,2,3 FOR
PROGS/COURSES/SERVICES; 2ND ELEMENT INDEXES
INDIVIDUAL PROGRAM, COURSE GROUP, OR SERVICE.
3 1
FORMULA FOR COUNSEL
COUNS, FROM VISITS
0 .01 1 0
ANOTHER CHANGE IN RATE FORMULAS?
0
RATE FORMULAS ENTERED,
RUN? 0= NO RUN, 1=RESOURCE ONLY, 2=RESOURCE AND
DIRECT BUDGET, 3=ALL CALCULATIONS.
3
RESOURCE REQUIREMENTS? IS THIS A BASE CASE?
1
DISPLAYS?
0
LEARN RUN COMPLETE.
2. COMPLETE DISPLAY OF INPUT AND OUTPUT FROM BASE CASE USING DUMMY DATA

INPUT

Financial Data 535
Enrollment Data 538
Ratio Data 540

INTERMEDIATE VARIABLES AND OUTPUT

Ratio Formulas Showing Base Amount for Increment Formulas¹ 541
Enrollments and Resources² 542
Direct Budget 544
Program Budget 546

¹ Only the base amount for the increment formulas is computed; the remainder of this display is identical to input display listed above.

² This display also includes the enrollment data.
LEARN 1
RUN NAME?
DEMONSTRATION RUN WITH DUMMY DATA; FINANCIAL INPUT
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
4
WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION.
1 0 0 0 0

DEMONSTRATION RUN WITH DUMMY DATA; FINANCIAL INPUT
FINANCIAL DATA; DISPLAY UNIT AND RESOURCE CODES?
1

COST AND INCOME DATA

<table>
<thead>
<tr>
<th>PROGRAMS/STUDENT TYPES</th>
<th>INCOME</th>
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<tr>
<td></td>
<td>COST</td>
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<tr>
<td></td>
<td>PER STUD</td>
</tr>
<tr>
<td>NURSE BGS FEES</td>
<td>0.00</td>
</tr>
<tr>
<td>GRANTS</td>
<td>0.00</td>
</tr>
<tr>
<td>POL/F BGS GRANTS</td>
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<th>PROGRAMS/STUDENT TYPES</th>
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<td>POL/F BGS COORD.</td>
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INSTRUCTIONAL SERVICES INCOME

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<td>SERVICES</td>
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<td>PER CR. PER CR. TGHT</td>
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<tr>
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<tr>
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<tr>
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UNIT CODES: SEE PROGRAM 'CODELIST' FOR KEY

PROGRAMS/STUDENT TYPES

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PROGRAMS/STUDENT TYPES

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INSTRUCTIONAL SERVICES

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INSTRUCTIONAL SERVICES

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SUPPORT SERVICES

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SUPPORT SERVICES

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IDI: CODES FOR RELATIONSHIP BETWEEN SUPPORT SERVICE ENROLLMENTS AND RESOURCES, HAVE THESE DATA BEEN ENTERED?

1

KEY: PROPORTIONAL TO ENROLLMENT AND: 0=USER DEFINED VARIABLE, 1=1, 2=L, AVERAGE STUDENT INSTR, LOAD, COUNSEL, REGISTR, GEN, ADM,

IDI 0.00 2.00 1.00

LEARN RUN COMPLETE.
LEARN 1
RUN NAME?
DEMONSTRATION RUN WITH DUMMY DATA; ENROLLMENT DATA
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
4
WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION,
0 1 0 0 0
DEMONSTRATION RUN WITH DUMMY DATA; ENROLLMENT DATA

ENROLLMENT AND RESOURCE DISPLAYS
SHORT (0) OR LONG (1) LIST?
1
INPUT (0) OR INPUT AND OUTPUT (1) VARIABLES?
0

ENROLLMENTS AND RESOURCES: INPUT

N: TOTAL ENROLLMENT 200

FLM : FR,COURSE LOAD MATRIX
  EXT,CLASS    CORRESP REG,CLASS
NURSE BGS    0.80     0.00     0.20
POL/F BGS    0.70     0.10     0.20
OTHER DGR    0.20     0.10     0.70
GENERAL      0.50     0.40     0.10

ICLM: IN,COURSE LOAD MATRIX (CR,TAKEN)
  EXT,CLASS    CORRESP REG,CLASS
NURSE BGS    2.40     0.00     0.60
POL/F BGS    4.20     0.60     1.20
OTHER DGR    1.80     0.90     6.30
GENERAL      1.50     1.20     0.30

DM : IN,SERV,LOAD MATRIX

  COUNSEL, REGISTR, GEN,ADM,
  VISITS CR,TAKEN STUDENTS
NURSE BGS    0.50     3.00     1.00
POL/F BGS    0.60     6.00     1.00
OTHER DGR    0.70     9.00     1.00
GENERAL      0.10     3.00     1.00
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<thead>
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<td>POL/F</td>
<td>BGS</td>
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<tr>
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<td>POL/F</td>
<td>BGS</td>
<td>OTHER</td>
</tr>
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LEARN RUN COMPLETE.
LEARN 1

RUN NAME?

DEMONSTRATION RUN WITH DUMMY DATA; RATIO DATA

CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY,

WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION.

0 0 1 0 0

DEMONSTRATION RUN WITH DUMMY DATA; RATIO DATA

RATE FORMULAS: HAVE BASES FOR INCREMENT FORMULAS

BEEN COMPUTED (1) OR SHOULD ZEROS BE DISPLAYED (0)?

0

RATE FORMULAS

PROGRAMS/STUDENT TYPES

COORD, STF FROM STUDENTS

NO BASE FORMULAS

NO INCREMENT FORMULAS

INSTRUCTIONAL SERVICES

CR., TAUGHT FROM CR., TAKEN

BASE FORMULAS

<table>
<thead>
<tr>
<th></th>
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<th>RATE</th>
<th>STEP?</th>
<th>INCRMNT?</th>
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</thead>
<tbody>
<tr>
<td>EXT, CLASS</td>
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<td>0.00E0</td>
<td>1.00E0</td>
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<tr>
<td>CORRESP</td>
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<td>0.00</td>
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<td>REG, CLASS</td>
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INCREMENT FORMULAS

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<tr>
<td>REG, CLASS</td>
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SUPPORT SERVICES

BASE FORMULAS

COUNS., FROM VISITS

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<tr>
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<td>3.00E-2</td>
<td>0.00E0</td>
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REGISTR. | 2.00E0 | 3.00E-2 | 0.00E0 | 0.00E0   |
GEN, ADM, NO FORMULA

NO INCREMENT FORMULAS
LEARN RUN COMPLETE.

LEARN 1
RUN NAME?
DEMONSTRATION RUN WITH DUMMY DATA: RATIOS WITH BASE
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
4 WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION.
0 0 1 0 0
DEMONSTRATION RUN WITH DUMMY DATA: RATIOS WITH BASE

RATE FORMULAS: HAVE BASES FOR INCREMENT FORMULAS
BEEN COMPUTED (1) OR SHOULD ZEROS BE DISPLAYED (0)?
1 RATE FORMULAS

PROGRAMS/STUDENT TYPES
COORD, STF FROM STUDENTS

NO BASE FORMULAS

NO INCREMENT FORMULAS

INSTRUCTIONAL SERVICES
CR, TAUGHT FROM CR, TAKEN

BASE FORMULAS

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<th>STEP?</th>
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<td>0.00E0</td>
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<tr>
<td>CORRESP</td>
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<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>REG, CLASS</td>
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INCREMENT FORMULAS

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<th>INC STEP?</th>
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<tr>
<td>REG, CLASS</td>
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</table>
SUPPORT SERVICES
BASE FORMULAS
COUNS, FROM VISITS RATE STEP? INCRMNT?
COUNSEL, 0.00E0 1.00E-2 1.00E0 0.00E0
REG,STF FROM CR,TAKEN RATE STEP? INCRMNT?
REGISTR, 2.00E0 3.00E-2 0.00E0 0.00E0
GEN,ADM, NO FORMULA

NO INCREMENT FORMULAS
LEARN RUN COMPLETE.

LEARN 1
RUN NAME?
DEMONSTRATION RUN WITH DUMMY DATA; RESOURCES
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
4
WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION,
0 1 0 0 0
DEMONSTRATION RUN WITH DUMMY DATA; RESOURCES

ENROLLMENT AND RESOURCE DISPLAYS
SHORT (0) OR LONG (1) LIST?
0
INPUT (0) OR INPUT AND OUTPUT (1) VARIABLES?
1

ENROLLMENTS AND RESOURCES: INPUT AND OUTPUT
N: TOTAL ENROLLMENT 200

ICLM: IN,COURSE LOAD MATRIX (CR,TAKEN )
EXT,CLASS CORRESP REG,CLASS
NURSE BGS 2.40 0.00 0.60
POL/F BGS 4.20 0.60 1.20
OTHER DGR 1.80 0.90 6.30
GENERAL 1.50 1.20 0.30
DM : IN, SERV, LOAD MATRIX

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<tr>
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<th>GEN, ADM, STUDENTS</th>
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<td>NURSE BGS</td>
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<td>POL/F BGS</td>
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<td>1.00</td>
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<td>OTHER DGR</td>
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PE : PROGRAM ENROLLMENTS (STUDENTS)

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PR : PROGRAM RESOURCES (COORD, STF)

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TOTAL, TPR : 0

CE : COURSE ENROLLMENTS (CR, TAKEN)

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TOTAL, TCE : 990

CR : COURSE RESOURCES (CR, TAUGHT)

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TOTAL, TCR : 600.84

SE : SERVICE ENROLLMENTS

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SR : SERVICE RESOURCES

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LEARN RUN COMPLETE.
LEARN 1

RUN NAME?
DEMONSTRATION RUN WITH DUMMY DATA; DIRECT BUDGET
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN, OR 4=DISPLAY.
WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION.
0 0 0 1 0

DEMONSTRATION RUN WITH DUMMY DATA; DIRECT BUDGET

DIRECT BUDGET: INCLUDE BUDGETS BY CATEGORIES?
1

DIRECT BUDGET

BUDGETS BY INDIVIDUAL CATEGORIES

PROGRAMS/STUDENT TYPES

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<th>GRANTS</th>
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<td>POL/F BGS</td>
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<td>OTHER DGR</td>
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<td>POL/F BGS</td>
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INSTRUCTIONAL SERVICES

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## Support Services

### Income

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<th>Cost</th>
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### Cost

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<th>Unit</th>
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## General Budgets

### Programs/Student Types

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<th>Type</th>
<th>Income</th>
<th>Cost</th>
<th>Net</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Nurse BGS</td>
<td>3200.00</td>
<td>1000.00</td>
<td>2200.00</td>
<td>50.00</td>
</tr>
<tr>
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<td>4500.00</td>
<td>4000.00</td>
<td>500.00</td>
<td>133.33</td>
</tr>
<tr>
<td>Other Dgr</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
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### Instructional Services

<table>
<thead>
<tr>
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<tr>
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<td>14940.00</td>
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### Support Services

<table>
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<th>Unit</th>
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<td>-500.00</td>
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<tr>
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### Totals

<table>
<thead>
<tr>
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<th>Cost</th>
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<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Prog/StdS</td>
<td>7700.00</td>
<td>5000.00</td>
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<td>Inst Serv</td>
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### Grand Totals

<table>
<thead>
<tr>
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<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Learn Run Compl.</td>
<td>39811.00</td>
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</table>

Learn Run Complete.
LEARN 1

RUN NAME?

DEMONSTRATION RUN WITH DUMMY DATA: PROGRAM BUDGET

CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,

OR 4=DISPLAY.

WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION.

0 0 0 0 1

DEMONSTRATION RUN WITH DUMMY DATA: PROGRAM BUDGET

<table>
<thead>
<tr>
<th>PROGRAM BUDGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIRECT PROGRAM</td>
</tr>
<tr>
<td>INCOME</td>
</tr>
<tr>
<td>NURSE BGS</td>
</tr>
<tr>
<td>FOL/F BGS</td>
</tr>
<tr>
<td>OTHER DGR</td>
</tr>
<tr>
<td>GENERAL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSTRUCTIONAL SERVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
</tr>
<tr>
<td>NURSE BGS</td>
</tr>
<tr>
<td>FOL/F BGS</td>
</tr>
<tr>
<td>OTHER DGR</td>
</tr>
<tr>
<td>GENERAL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUPPORT SERVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
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<tr>
<td>NURSE BGS</td>
</tr>
<tr>
<td>FOL/F BGS</td>
</tr>
<tr>
<td>OTHER DGR</td>
</tr>
<tr>
<td>GENERAL</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL PROGRAM BUDGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
</tr>
<tr>
<td>NURSE BGS</td>
</tr>
<tr>
<td>FOL/F BGS</td>
</tr>
<tr>
<td>OTHER DGR</td>
</tr>
<tr>
<td>GENERAL</td>
</tr>
</tbody>
</table>

LEARN RUN COMPLETE.
3. SAMPLE TERMINAL SESSIONS TO MODIFY EXISTING DATA

Eliminate nursing program with display of enrollments, resources, direct budget, and program budget

10% enrollment increase with display of enrollments, resources, direct budget, and program budget
LEARN 1
RUN NAME?
DEMONSTRATION WITH DUMMY DATA? DROP NURSING
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
2
WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN
EXPLANATION.)
2 2 2 2
TYPES: 1)LABELS/NAMES, 2)FINANCIAL INPUT,
3)ENROLLMENT INPUT, 4)RATIO INPUT, TYPE 0 OR 1 FOR
EACH (E.G., '1 0 0 0' MEANS LABELS/NAMES ONLY).
TYPES?
1 0 1 0
CHANGE NAMES AND LABELS
HAVE DATA FOR 1] INCOME/COST OR 2] ENROLLMENTS
OR RATES BEEN ENTERED?
ANSWER ' 0 0 ' FOR NONE, ' 1 0 ' FOR COST/INCOME......
1 1
CHANGE LIST LENGTH? ANSWER 0 OR 1
1
NUMBER OF TITLE LIST?
1
SPECIFY NEW LENGTH =CV[1]?
3
WHAT ELEMENT IS TO BE ELIMINATED?
1
RATES ENTERED?
1
MORE CHANGES IN PROGRAMS ? 0 OR 1.
0
NEW LIST?
0
THIS ROUND OF TITLE CHANGES HAS BEEN COMPLETED
ENROLLMENT VARIABLE NAMES AND VALUES
STORE NEW PROGRAM AND SERVICE ENROLLMENTS
AS BASE CASE?
0
ARE THERE EXISTING BASE VALUES FOR CE, PE, AND SE THAT
YOU WISH TO KEEP?
0
CHANGE PROGRAM/COURSE/SERVICE ENROLLMENT OR
RESOURCE NAMES?
8 8 8 8 8 8
SPECIFY 1 OR 0 ONLY, TRY AGAIN.
VARIABLES TO BE CHANGED, TYPE 7 8'S FOR INFO.
ENTER VECTOR OF LENGTH 7; 0 = NO CHANGE, 1 = SPECIFIC
VALUE, 2 = PERCENT CHANGE (2 FOR N ONLY),
1, N 2, FE 3, F 4, L 5, FLM 6, ICLM 7, DM

1 0 0 0 0 0 0
NEW N
180
ENROLLMENT NAMES/VARIABLES ENTERED,
RUN? 0 = NO RUN, 1 = RESOURCE ONLY, 2 = RESOURCE AND
DIRECT BUDGET, 3 = ALL CALCULATIONS,
3
RESOURCE REQUIREMENTS: IS THIS A BASE CASE?
0
RUN WITH CURRENT BASE, IF ANY, (1) OR AS INDEPENDENT RUN (0)?
0
DISPLAYS?
1
WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION,
2 2 2 2 2
DISPLAYS: 1) FINANCIAL INPUT, 2) ENROLLMENT/RESOURCES
(EITHER INPUT OR INPUT AND OUTPUT), 3) RATIO INPUT,
4) DIRECT BUDGET, 5) PROGRAM BUDGET. ANSWER 0 OR 1
FOR EACH (E.G., '0 0 1 0 1' WILL YIELD DISPLAYS
OF THE RATIO INPUT AND THE PROGRAM BUDGET). TYPES?
0 1 0 1 1

DEMONSTRATION WITH DUMMY DATA; DROP NURSING

ENROLLMENT AND RESOURCE DISPLAYS
SHORT (0) OR LONG (1) LIST?
0
INPUT (0) OR INPUT AND OUTPUT (1) VARIABLES?
1

ENROLLMENTS AND RESOURCES: INPUT AND OUTPUT
N: TOTAL ENROLLMENT 180
### ICLM: IN, COURSE LOAD MATRIX (CR, TAKEN)

<table>
<thead>
<tr>
<th></th>
<th>EXT, CLASS</th>
<th>CORRESP REG, CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>POL/F EGS</td>
<td>4.20</td>
<td>0.60</td>
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<tr>
<td>OTHER DGR</td>
<td>1.80</td>
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<tr>
<td>GENERAL</td>
<td>1.50</td>
<td>1.20</td>
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</tbody>
</table>

### DM: IN, SERV, LOAD MATRIX

<table>
<thead>
<tr>
<th></th>
<th>COUNSEL, VISITS</th>
<th>REGISTR, CR, TAKEN</th>
<th>GEN, ADM, STUDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>POL/F EGS</td>
<td>0.60</td>
<td>6.00</td>
<td>1.00</td>
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<tr>
<td>OTHER DGR</td>
<td>0.70</td>
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<tr>
<td>GENERAL</td>
<td>0.10</td>
<td>3.00</td>
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</table>

### PE: PROGRAM ENROLLMENTS (STUDENTS)

<table>
<thead>
<tr>
<th></th>
<th>POL/F EGS</th>
<th>OTHER DGR</th>
<th>GENERAL</th>
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<tbody>
<tr>
<td></td>
<td>30.00</td>
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### FR: PROGRAM RESOURCES (COORD, STF)

<table>
<thead>
<tr>
<th></th>
<th>POL/F EGS</th>
<th>OTHER DGR</th>
<th>GENERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</table>

TOTAL, TFR: 0

### CE: COURSE ENROLLMENTS (CR, TAKEN)

<table>
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<tr>
<td></td>
<td>366.00</td>
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TOTAL, TCE: 930

### CR: COURSE RESOURCES (CR, TAUGHT)

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<tr>
<td></td>
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TOTAL, TCR: 585.96

### SE: SERVICE ENROLLMENTS

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<tr>
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<tr>
<th>Program/Student Types</th>
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<th>Cost</th>
<th>Net</th>
<th>Unit</th>
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<tbody>
<tr>
<td>POL/F BGS</td>
<td>4500.00</td>
<td>4000.00</td>
<td>500.00</td>
<td>133.33</td>
</tr>
<tr>
<td>OTHER DGR</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>GENERAL</td>
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<td>0.00</td>
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### INSTRUCTIONAL SERVICES

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<thead>
<tr>
<th>Service</th>
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<th>Cost</th>
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<th>Unit</th>
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<tbody>
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### SUPPORT SERVICES

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<tr>
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<th>Unit</th>
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<tbody>
<tr>
<td>COUNSEL,</td>
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### TOTALS

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<tr>
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<th>Cost</th>
<th>Net</th>
<th>Unit</th>
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<td>PROG/STDs</td>
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<td>19844.00</td>
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<td>6500.00</td>
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### GRAND TOTALS

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<tr>
<td></td>
<td>34787.00</td>
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## Program Budget

### Direct Program

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<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>POL/F BGS</td>
<td>4500.00</td>
<td>4000.00</td>
<td>500.00</td>
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<td>OTHER DGR</td>
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<tr>
<td>GENERAL</td>
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### Instructional Services

<table>
<thead>
<tr>
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<th>Cost</th>
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<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>POL/F BGS</td>
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### Support Services

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<tr>
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<th>Net</th>
<th>Unit</th>
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<tr>
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### Total Program Budget

<table>
<thead>
<tr>
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<th>Cost</th>
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<th>Unit</th>
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<td>GENERAL</td>
<td>13421.11</td>
<td>15834.77</td>
<td>-2413.66</td>
<td>158.35</td>
</tr>
</tbody>
</table>

Learn run complete.
LEARN 1
RUN NAME?
DUMMY DATA: RUN WITH TEN PERCENT ENROLLMENT INCREASE
CHOOSE 1=NEW SYSTEM, 2=CHANGE SYSTEM, 3=RUN,
OR 4=DISPLAY.
2
WHAT TYPES OF INPUT? (TYPE 4 2'S FOR AN
EXPLANATION.)
0 0 1 0
ENROLLMENT VARIABLE NAMES AND VALUES
STORE NEW PROGRAM AND SERVICE ENROLLMENTS
AS BASE CASE?
0
ARE THERE EXISTING BASE VALUES FOR CE, PE, AND SE THAT
YOU WISH TO KEEP?
1
CHANGE PROGRAM/COURSE/SERVICE ENROLLMENT OR
RESOURCE NAMES?
0
VARIABLES TO BE CHANGED, TYPE 7 8'S FOR INFO,
2 0 0 0 0 0 0
NEW N
PERCENT CHANGE IN N EXPRESSED AS A DECIMAL
FRACTION, (E.G., -.05 FOR A 5 PERCENT REDUCTION).
.1
ENROLLMENT NAMES/VARIABLES ENTERED,
RUN? 0= NO RUN, 1=RESOURCE ONLY, 2=RESOURCE AND
DIRECT BUDGET, 3=ALL CALCULATIONS.
3
RESOURCE REQUIREMENTS: IS THIS A BASE CASE?
0
RUN WITH CURRENT BASE, IF ANY, (1) OR AS INDEPENDENT RUN (0)?
1
DISPLAYS?
1
WHAT DISPLAYS? TYPE 5 2'S FOR EXPLANATION,
0 1 0 1 1
DUMMY DATA: RUN WITH TEN PERCENT ENROLLMENT INCREASE

ENROLLMENT AND RESOURCE DISPLAYS
SHORT (0) OR LONG (1) LIST?
0
INPUT (0) OR INPUT AND OUTPUT (1) VARIABLES?
1
ENROLLMENTS AND RESOURCES: INPUT AND OUTPUT

N: TOTAL ENROLLMENT 220

ICLM: IN, COURSE LOAD MATRIX (CR, TAKEN)

<table>
<thead>
<tr>
<th></th>
<th>EXT, CLASS</th>
<th>CORRESP REG, CLASS</th>
</tr>
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<tbody>
<tr>
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<td>POL/F BGS</td>
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<tr>
<td>OTHER DGR</td>
<td>1.80</td>
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<tr>
<td>GENERAL</td>
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<td>1.20</td>
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DM : IN, SERV, LOAD MATRIX

<table>
<thead>
<tr>
<th>COUNSEL VISITS</th>
<th>REGISTR CR, TAKEN</th>
<th>GEN, ADM STUDENTS</th>
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<tbody>
<tr>
<td>NURSE BGS</td>
<td>0.50</td>
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<tr>
<td>POL/F BGS</td>
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<td>6.00</td>
</tr>
<tr>
<td>OTHER DGR</td>
<td>0.70</td>
<td>9.00</td>
</tr>
<tr>
<td>GENERAL</td>
<td>0.10</td>
<td>3.00</td>
</tr>
</tbody>
</table>

PE : PROGRAM ENROLLMENTS (STUDENTS)

<table>
<thead>
<tr>
<th>NURSE BGS</th>
<th>POL/F BGS</th>
<th>OTHER DGR</th>
<th>GENERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.00</td>
<td>33.00</td>
<td>55.00</td>
<td>110.00</td>
</tr>
</tbody>
</table>

PR : PROGRAM RESOURCES (COORD, STF)

<table>
<thead>
<tr>
<th>NURSE BGS</th>
<th>POL/F BGS</th>
<th>OTHER DGR</th>
<th>GENERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</tbody>
</table>

TOTAL, TFR : 0

CE : COURSE ENROLLMENTS (CR, TAKEN)

<table>
<thead>
<tr>
<th>EXT, CLASS</th>
<th>CORRESP REG, CLASS</th>
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<tbody>
<tr>
<td>455.40</td>
<td>201.30</td>
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<tr>
<td>432.30</td>
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TOTAL, TCE : 1089

CR : COURSE RESOURCES (CR, TAUGHT)

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<thead>
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<th>EXT, CLASS</th>
<th>CORRESP REG, CLASS</th>
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<td>26.08</td>
<td>201.30</td>
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<td>432.30</td>
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TOTAL, TCR : 659.682
### SE: SERVICE ENROLLMENTS

<table>
<thead>
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<th>GEN, ADM, STUDENTS</th>
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<td>80.30</td>
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### SR: SERVICE RESOURCES

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<th>GEN, ADM, ADM, STF</th>
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<tr>
<td>1.00</td>
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**DIRECT BUDGET**: INCLUDE BUDGETS BY CATEGORIES?

0

### DIRECT BUDGET

#### GENERAL BUDGETS

**PROGRAMS/STUDENT TYPES**

<table>
<thead>
<tr>
<th>NURSE BGS</th>
<th>POL/F BGS</th>
<th>OTHER DG</th>
<th>GENERAL</th>
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</thead>
<tbody>
<tr>
<td>INCOME</td>
<td>3220.00</td>
<td>4950.00</td>
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</tr>
<tr>
<td>COST</td>
<td>1000.00</td>
<td>4000.00</td>
<td>0.00</td>
</tr>
<tr>
<td>NET</td>
<td>2220.00</td>
<td>950.00</td>
<td>0.00</td>
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<tr>
<td>UNIT</td>
<td>45.45</td>
<td>121.21</td>
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**INSTRUCTIONAL SERVICES**

<table>
<thead>
<tr>
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<th>REG, CLASS</th>
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<tbody>
<tr>
<td>INCOME</td>
<td>15939.00</td>
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<td>COST</td>
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<tr>
<td>UNIT</td>
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<td>33.91</td>
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**SUPPORT SERVICES**

<table>
<thead>
<tr>
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<th>REGISTR,</th>
<th>GEN, ADM,</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
<td>0.00</td>
<td>3467.00</td>
</tr>
<tr>
<td>COST</td>
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<td>-3467.00</td>
</tr>
<tr>
<td>NET</td>
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<td>-3000.00</td>
</tr>
<tr>
<td>UNIT</td>
<td>6.23</td>
<td>3.18</td>
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**TOTALS**

<table>
<thead>
<tr>
<th>PROGRAMS</th>
<th>INST SERV</th>
<th>SUPT SERV</th>
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</thead>
<tbody>
<tr>
<td>INCOME</td>
<td>8170.00</td>
<td>28172.10</td>
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<tr>
<td>COST</td>
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<td>21920.90</td>
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<tr>
<td>NET</td>
<td>3170.00</td>
<td>6251.20</td>
</tr>
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<td>UNIT</td>
<td>22.73</td>
<td>20.13</td>
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**GRAND TOTALS**

<table>
<thead>
<tr>
<th>INCOME</th>
<th>COST</th>
<th>NET</th>
<th>UNIT</th>
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</thead>
<tbody>
<tr>
<td>42842.10</td>
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### DIRECT PROGRAM

<table>
<thead>
<tr>
<th>Category</th>
<th>Income</th>
<th>Cost</th>
<th>Net</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse BGS</td>
<td>3220.00</td>
<td>1000.00</td>
<td>2220.00</td>
<td>45.45</td>
</tr>
<tr>
<td>Pol/F BGS</td>
<td>4950.00</td>
<td>4000.00</td>
<td>950.00</td>
<td>121.21</td>
</tr>
<tr>
<td>Other DGR</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>General</td>
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<td>0.00</td>
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### INSTRUCTIONAL SERVICE

<table>
<thead>
<tr>
<th>Category</th>
<th>Income</th>
<th>Cost</th>
<th>Net</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Nurse BGS</td>
<td>2006.40</td>
<td>1639.10</td>
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<td>Pol/F BGS</td>
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<td>Other DGR</td>
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### SUPPORT SERVICES

<table>
<thead>
<tr>
<th>Category</th>
<th>Income</th>
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</thead>
<tbody>
<tr>
<td>Nurse BGS</td>
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### TOTAL PROGRAM BUDGET

<table>
<thead>
<tr>
<th>Category</th>
<th>Income</th>
<th>Cost</th>
<th>Net</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse BGS</td>
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<td>14041.00</td>
<td>15742.55</td>
<td>-1701.55</td>
<td>143.11</td>
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</table>

Learn run complete.