



A dynamic model of the indirect cost of continuing education in a Maryland public community college
by Walter James Yurek

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Education
Montana State University

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Abstract:

The problem of the study was to develop a mathematical model of the indirect cost of continuing education in a Maryland community college. The model, which was simulated on a computer, determined indirect cost over a fiscal year, provided indirect cost information for subsequent years, and examined the behavior of resource consumption. Development of the model focused on one institution, Wor-Wic Tech Community College, which is located on the Eastern Shore of Maryland.

The introduction to this dissertation outlines the study problem by presenting a brief review of the role of continuing education in the Maryland community college system and the relationship between the management of continuing education and cost analysis.

A review of related literature and research follows the Introduction and was designed to continue the outline of cost analysis and to present a systems approach to modeling. The review addresses the relationship between management science and strategic planning.

Although the study resulted in one indirect cost model, two models were used to examine the indirect cost system for the continuing education program at Wor-Wic Tech Community College. One model was based on the assumption that indirect costs could be calculated from an enrollment ratio. The second model allocated indirect costs from a set of cost pools.

A comparison of the simulation results from the two models showed that the assumption model produced overinflated indirect costs. Consequently, a final model which allocated the indirect cost of the continuing education program at Wor-Wic Tech Community College from cost pools was constructed and simulated through the Year 2000. It was found that the continuing education program generates substantially lower indirect cost rates than the regular credit program.

The study concluded with recommendations for application of the indirect cost model within the planning and management structure of the College.

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by

Walter James Yurek

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This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

The problem of the study was to develop a mathematical model of the indirect cost of continuing education in a Maryland community college. The model, which was simulated on a computer, determined indirect cost over a fiscal year, provided indirect cost information for subsequent years, and examined the behavior of resource consumption. Development of the model focused on one institution, Wor-Wic Tech Community College, which is located on the Eastern Shore of Maryland.

The introduction to this dissertation outlines the study problem by presenting a brief review of the role of continuing education in the Maryland community college system and the relationship between the management of continuing education and cost analysis.

A review of related literature and research follows the Introduction and was designed to continue the outline of cost analysis and to present a systems approach to modeling. The review addresses the relationship between management science and strategic planning.

Although the study resulted in one indirect cost model, two models were used to examine the indirect cost system for the continuing education program at Wor-Wic Tech Community College. One model was based on the assumption that indirect costs could be calculated from an enrollment ratio. The second model allocated indirect costs from a set of cost pools.

A comparison of the simulation results from the two models showed that the assumption model produced overinflated indirect costs. Consequently, a final model which allocated the indirect cost of the continuing education program at Wor-Wic Tech Community College from cost pools was constructed and simulated through the Year 2000. It was found that the continuing education program generates substantially lower indirect cost rates than the regular credit program.

The study concluded with recommendations for application of the indirect cost model within the planning and management structure of the College.

Chapter 1

INTRODUCTION

One of the first international definitions of adult education was written in 1966 at a meeting of twenty-six educators from eight countries. The group stated what adult or continuing education had come to mean:

Adult education is a process whereby persons who no longer attend school on a regular and fulltime basis (unless fulltime programs are especially designed for adults) undertake sequential and organized activities with the conscious intention of bringing about changes in information, knowledge, understanding, skills, appreciation, and attitudes (Knowles and Klevins, 1976: 14).

The development of American adult education, however, dates back to pre-Jeffersonian times when, as early as 1661, private evening schools existed for vocational and cultural studies (Luke, 1969:14). But as Knowles and Klevens indicated, Jeffersonian democracy became a key for the American educational system and strongly influenced the adult education movement by its emphasis on practical application and equality of access to education (1976). The 1862 Morrill Act strengthened the movement by providing the means to establish

technical colleges where adults could complete or continue occupational training (Brubacher and Rudy, 1976). As higher education progressed through the early twentieth century, a "golden age" of education including university extension, night school, vocational education, and recreational studies reflected an enhancement of adult education programs (Stern, 1980:5-6). Although the events of the depression era slowed the growth of programs, they did not slow the work of adult education theorists. By the 1950's, the institutionalization and professionalism of adult education had become a reality (Knowles and Klevins, 1976). When the community colleges began their growth spurt in the 1960's, the change in terminology from adult education to continuing education reflected a more competitive spirit among the providers of adult education services (Luke, 1969; Stern, 1980).

Luke stated that "the rapid growth of community junior colleges has offered one of the most dramatic new opportunities for the extension and expansion of adult education programs" (1969:16). The community colleges have taken advantage of this opportunity and, today, have established themselves as a power in the field of continuing education. Kleis and Butcher, in 1969, stated the function of community college continuing education:

In many communities those seeking post-high school education who are not full-time students exceed in number and intensity of purpose those who are full-time students. No greater justification exists for the development of excellence in all areas of community college work than to serve the continuing education needs of those daily engaged in the professions, homes, services, and governance of the community. Policies, practices, programs, and schedules should be established to serve these expanding needs through virtually every functional unit of the community college (1969: 51).

In Maryland, "continuing education has emerged as one of the most vital components" of the comprehensive community college system (Maryland State Board for Community Colleges, 1981:26). Courses or programs to help adult students, enrolled persons who are at least sixteen years of age, upgrade existing talents and acquire new skills required in the labor market are conducted by continuing education units at all seventeen Maryland community colleges. These units also sponsor community and public service activities in the form of workshops, seminars, and lecture series. A characteristic of Maryland's community college continuing education program is that it has been made available in easily accessible facilities to citizens of all ages, interests, and backgrounds (Maryland State Board for Community Colleges, 1981:26). Maryland's program is not inconsistent with the aims of continuing education which Knowles and Klevins stated:

If a man is to operate successfully in our society, he must be comfortable within his community. It is to this end that the functions of continuing education are aimed: to expand communication skills, develop flexibility to change, improve human relations, facilitate participation, assist personal growth. The basic goal is to help individuals function more effectively in society and within their own community (1976:15).

But like many areas of education today, the Maryland community college continuing education program faces the challenge of simultaneously providing quality education and surviving difficult times (Karvelis, 1980). At some institutions, this challenge manifests itself in the form of threats to its well-being. Floundering departments sometimes perceive the offering of continuing education courses or programs as a way to bail out of financial difficulty. These departments frequently attempt to provide continuing education as a revenue producer with the end effect being the de-emphasis of educational quality (Robertson, 1980:63). Also, there is the threat of decreased support of continuing education programs. Legislators have become more concerned about the way in which funds are used and often view college education as essentially for the young (Gleazer, 1980:10; Richardson, 1978: 67). The solution to these problems may translate to the simple proposition that managers of continuing education need to supplement quality

programming with sound management of resources and financial affairs.

To meet this challenge in the 1980's and 1990's, managers will need to develop attitudes and skills which allow them to use more sophisticated research and planning techniques (Richardson, 1978:67). In Maryland, there is evidence that these attitudes and skills are developing. The Maryland State Board for Community Colleges has made available to all community colleges the Expenditure Forecast Planning Model (EFPM) to anticipate demographic changes and investigate the effects of alternative policy decisions on spending and enrollment levels (Maryland State Board for Community Colleges, 1981b:1). At the present time, state fiscal policy requires that if grant or contract supported programs are to receive state financial aid, a full cost analysis must be completed (Maryland State Board for Community Colleges, 1980:45). The Maryland community college system has come to recognize that providing reliable cost information and conducting cost analysis for continuing education is a vital part of management research and planning. At present, to provide such information and analysis, there exist "developed, tested, and proven" methods which evolved from "simple, back-of-the-envelope calculations to elaborate modeling efforts" (National

Association of College and University Business Officers, 1975:1; Lawrence and Service, 1977:35). The development of such methods in higher education has affected the way in which continuing education programs are managed in the Maryland community college system.

Quantitative and Qualitative Management Methods

The development of quantitative management techniques in higher education progressed slowly until the 1960's when institutions began to explore the value of the applications of statistics and mathematical modeling in administrative affairs. Before that time, institutional managers essentially limited research to casual glances at how the tasks of planning, budgeting, and allocating resources were accomplished (Lawrence and Service, 1977:3,4,34,35). By the early 1970's, experiments with computer models such as the Comprehensive Analytical Model for Planning in the University Sphere (CAMPUS) model integrated analytical mathematical modeling, statistics, and computer science to determine the resource implications of making management decisions based on enrollment and revenue projections. Such integrated modeling demonstrated that more advanced, numerically based management tools were usable in higher education (Mood, Bell, Bogard, Brownlee,

and McCloskey, 1972:51; Masland, 1982). Simple arithmetic examinations of enrollment trends, spending levels, and teaching loads began to give way to a more refined quantitative analysis of information from the perspective that an institution functions as a system of complex interrelated parts. Many of the models and methods, as was the case with CAMPUS, developed out of a need for more effective cost analyses to enhance planning and evaluation.

Cost Analysis

In 1977, Lawrence and Service described cost analysis according to the following four categories: (1) resource acquisition, (2) resource allocation, (3) resource management control, and (4) accountability. Resource acquisition involves the determination and appropriation of funding required to meet an institution's educational goals. The CAMPUS model is capable of relating simple cost information to the fiscal implications of assumed management decisions and demographic changes. An understanding of these implications can help colleges acquire funds and resources more skillfully.

Resource allocation relates to the process of determining to what degree institutional activities will

be supported by financial and physical resources. An alternative to the traditional line-item budgeting procedure (usually based on a percent increase over the previous year) is a newer procedure which is based on staffing, enrollment, and cost projections for each organizational unit. The Resource Requirements Prediction Model 1.6 (RRPM 1.6) calculates such projections and provides information on the educational outcomes of proposed budgets. Another approach to resource allocation is the use of the accounting principles of standard costing. This procedure requires that standard cost measures be set and compared, statistically, to actual costs according to observed variances. The results from this type of analysis can be used to make resource allocation decisions and policies.

Standard costing can also be used to promote resource management and control. Control is achieved by determining the causes of the variances from standard costs and, as a result, making the necessary budget corrections (National Association of College and University Business Officers, 1975). Related to the concept of control is the principle of accountability which grew out of the need to determine whether or not resources were used properly and for their intended

purpose (Lawrence and Service, 1977:38-42; Mood, Bell, Bogard, Brownlee, and McCloskey, 1972:51).

One method commonly used to measure accountability is the determination of full costs. According to the National Association of College and University Business Officers (NACUBO), "full costing is defined as the accumulation of all direct and indirect costs attributed to a cost objective" (1975:11). The full costing method can also be used to determine and substantiate funding requests, program fees, and cost reimbursements; it is an essential component of cost-benefit analysis and historical cost performance study. However, the basis of full cost analysis is the determination of total or full costs (National Association of College and University Business Officials, 1975:9,11).

The two components of full cost are direct and indirect cost. The National Association of College and University Business Officials defines indirect cost as follows:

Indirect costs, in contrast with direct costs, are those that have been incurred for purposes common to a number or all of the specific projects, programs, or activities of an institution, but which cannot be identified and charged directly to such projects, programs, or activities relatively easily with a reasonable degree of accuracy and without an inordinate amount of accounting (1981:1).

As an example, the costs of maintaining campus grounds support the operation of the projects and activities of a university. These are real costs but they cannot easily be charged directly to the projects or activities and are, therefore, indirect.

Mathematical Modeling

The developers of models such as CAMPUS and RRPM 1.6 may have demonstrated that the techniques of mathematical modeling and computer science can help to improve the administration of universities and independent colleges. Although the application of such technology to higher education management is a twentieth century development, the importance of mathematical modeling in science was recognized as early as pre-Christian times. For example, the Pythagoreans around 400 B.C. attempted to explain the relationship of the earth to the universe by examining the properties of a geometric system. They sought to describe their conception of the physical behavior of the universe as a geometric construct. This form of scientific inquiry, although slow to develop, was to become one of the most powerful scientific methods ever used by man (Sagan, 1980). As Dym and Ivey indicated, mathematical

modeling has become "a hallmark of the scientific method" (1980).

In the 1950's, when American business began to take advantage of the power of the scientific method, it naturally inherited the benefits of mathematical modeling (Lawrence and Service, 1977). Business researchers quickly learned that many of the modeling applications from the physical and biological sciences were useful in understanding business systems. For example, the mathematics of dynamic systems, which focuses on applications of differential equations, was developed in the physical sciences and engineering and quickly applied to the biological sciences to examine the growth of organisms. In the business world, many of these models became instrumental in improving the understanding of such business operations as inventory, sales, and production. This development can be attributed largely to the initial effects of the computer revolution when the efforts of Eckert and Mauchly produced the Electronic Numerical Integrator and Computer. Their work eventually led to the construction of the Universal Automatic Computer (UNIVAC) around 1950. UNIVAC demonstrated that speeded up calculations and machine generated logic could assist business in storing, classifying, analyzing, and manipulating information (Shelly and Cashman, 1986).

UNIVAC's success led management researchers to wonder if the power of the computer could not further be used to provide analysis of business and industry problems. The result was the discovery that the scientific method, enhanced by the power of the computer, could be used to provide insight into such operational concerns as controlling inventory levels, allocating resources, and managing business activities. It was then, during the 1950's, that the field of management science began to grow rapidly and eventually to interest researchers in other fields such as industrial engineering, business administration, economics, and education (Lawrence and Service, 1977).

However, it was not until the late 1960's that the needs of higher education managers began to require the mathematical sophistication of the industrial and business approaches to management. The first efforts using more advanced techniques were isolated to independent studies at smaller schools such as Wesleyan University. Later, organizations such as the National Center for Higher Education Management Systems (NCHEMS) emerged and helped more schools research management functions through mathematical methods or models (Baldrige and Tierney, 1979). More recently,

researchers have attempted to help institutions refine their use of models.

Edward Bender (1978) defined a mathematical model as "an abstract, simplified, mathematical construct related to a part of reality and created for a purpose" (1978:2). For example, CAMPUS is a set of simple mathematical equations which describe part of the operations of a university for the purpose of studying and improving management practices. Also, mathematical models possess some distinguishing characteristics. First, they are constructed to represent a real world entity in some mathematically valid way (Graybeal and Pooch, 1980:9). Second, the foundation of a mathematical model is a set of laws of a mathematical theory which holds in the represented real world system (Stoll, 1961:231). Further, the value of a model comes when its laws reveal properties of the real world system that cannot be determined easily from observation. Many modelers, however, caution that the model is only a partial representation of the real world system under study. The representation of CAMPUS forms "an advanced" information system "network" whose laws allow researchers to speculate about the future results of proposed policy changes or management decisions in a university (Baldrige and Tierney, 1979:34; Senn, 1984:11). Thus,

CAMPUS was developed to solve management problems.

Richardson and Pugh emphasized that the primary purpose of constructing a model is to solve a problem, and not to duplicate some real world entity (1981).

There are many types of models probably because of the recent explosion of scientific inquiry into new and specialized disciplines. There may be as many types of models as there are scientific or scientific related disciplines. In the field of higher education, primarily as a result of the revolution in computer technology, present mathematical modeling efforts are almost exclusively developed using computer resources (Mood, Bell, Bogard, Brownlee, and McCloskey, 1972:43; Masland, 1982:10-14). However, a basic assumption of mathematical modeling theory is that insight into the real-world problem can be developed as a result of an analysis of the mathematical structure of the model. Such an analysis usually requires the development of solutions to the model equations which is referred to as a model solution. Models are solved numerically by computer methods or abstractly using mathematical theory. Models solved by the former method are referred to as numerical or simulation models while those solved by the latter method are called analytical models (Gordon, 1978:9). One outcome of this study was the development of a

simulation model of the indirect cost of continuing education. The simulation process, however, involves more than just the application of quantitative methods and computer technology.

Simulations and Qualitative Methods

The enormous use of simulation models in management science since 1960 has caused researchers to clarify the role of qualitative research in simulation studies. Up through the late 1970's reports on simulation studies primarily focused on the quantitative aspects of these studies although many researchers relied, at least casually, on qualitative methods. In higher education management, groups such as NCHEMS and individuals such as Levine did attempt to define system structures, collect data, evaluate model use, and validate models qualitatively. For example, Beatty's three dimensional costing method, although based on the course load matrix, required consideration of written institutional procedures, program performance evaluations, personnel patterns, and pricing policy (1977:88-97). Although somewhat limited, these types of qualitative considerations were common to many of the higher education costing studies conducted during the late 1960's and through the 1970's.

However, the failure of many pre-1980's modelers to recognize the importance of qualitative methodology contributed to a lack of acceptance by some model users and practitioners. Vansteenkiste and Spriet, in 1982, concluded that the failure of some of the simulation models was due in large part to "modelling ill-defined systems." They further stated that "quantitative analysis may not always be necessary" to reach research goals (1982:12,13). Leinkuhler suggested that "tools which soon showed to be too inflexible, simplistic, and restrictive" hampered the acceptance of simulation models" (1982:71). But as Updegrove indicated, "today's models, however, are different from previous approaches - in conception, development, and use" (1981:61). There is a tendency to emphasize the relationship between sub-systems through the notion of developing qualitative dynamical structures (Johnson and Lacher, 1982:28,29). For example, in the modeling philosophy referred to as system dynamics, "the structure of the model is more important than the exact values of parameters and functions" (Lebel, 1982:120). Weil, in 1981, discovered solutions to design problems of management information systems by examining the feedback diagrams of the sub-structures of the information system models (1981:461-474). One of the keys to developing a better

understanding of information systems was to understand the relationships between and among the sub-systems which, together, form the larger information system. Such an approach to research was used throughout this study.

Problem of the Study

The problem of the study was to develop a model of the indirect cost of continuing education in a Maryland community college. The model, which resulted from the study, was simulated on a computer and is capable of determining the indirect cost of a continuing education program over a fiscal year, providing indirect cost information for subsequent years, and simulating cost patterns of the program.

In order to develop such a model, the historical indirect costs of the continuing education program at Wor-Wic Tech Community College in Maryland were analyzed. From the analysis, the concept of indirect cost was represented as a dynamic system which moved from past to future time. A dynamic system is "one in which the behavior of the system is a direct function of the present system condition" (Lyneis, 1974:6). Hence, a dynamic system not only changes over time but also generates its own change. In this study, a dynamic view

of cost was achieved by defining cost as the consumption of resources (Gray and Ricketts, 1982:2).

Need for the Study

The study was needed to provide another means of helping community college managers maintain fiscal responsibility and to improve the application of costing techniques. For institutional managers, "cost information is a vital component of any management information system" (Birch and Cuthbert, 1980:5). Federal, state, and other funding and policy-setting bodies routinely need cost information, especially in the process of appropriating and granting funds (National Association of College and University Business Officials, 1975:3). Specifically, meaningful cost information is required to determine full costs which, in turn, provide institutional managers with the knowledge to make sound decisions about appropriating institutional funds, applying for and accepting funds from external sources, making instructional program decisions, evaluating performance, and planning (National Association of College and University Business Officials, 1975:3; 1981:2).

Continuing education programs face special financial problems. There is pressure from legislators

and state governing bodies to demonstrate that continuing education is self-sufficient and, in some cases, revenue producing (Loring, 1980:147,156). Such a demonstration requires that full cost be compared to the revenues generated. Information about continuing education programs is particularly important since they are typically viewed by many college educators as marginal to or independent of the educational mission itself (Gordon, 1980:184).

Finally, the study provided insight into how important indirect costing is for a community college. Even at the university level, where the indirect cost of sponsored programs has been thoroughly examined, there remains confusion and misunderstanding about the meaning of indirect cost (Comptroller General of the United States, 1979:4; National Association of College and University Business Officials, 1976:1). To what degree this confusion and misunderstanding exists among community college educators needed to be considered.

Applications and Contributions

The model provided an additional tool for the fiscal and instructional management of institutions and its programs or departments. Although the focus of this study was on continuing education, the model can be

revised to examine other programs or departments. With such a model, a community college can compare its method of determining indirect costs with the validated systems approach produced through the modeling in this study. The study also suggested simplified methods as alternatives to the tedious searching of institutional records to provide cost data for study. Much of the study focused on producing information about the validity of such an approach.

As indicated above, many university cost analysts are knowledgeable about the subject of indirect cost. Such knowledge, however, has been derived primarily from the analysis of discrete accounting measures of historical cost data. Previously, modelers have tended to construct static cost models, and the result has been a lack of consideration of the dynamic nature of the consumption of resources by college programs. A result of the study was to provide additional information about the dynamic behavior of indirect consumption of institutional resources by continuing education and other programs.

Perhaps the most significant outcome of the study was to provide information about the validity of the indirect costing methods used in the Maryland community college system. One aspect of the study was to

derive indirect costs according the formulas suggested by the Maryland State Board for Higher Education. The validity of such measures was examined by comparing them to corresponding measures which were derived from the development of indirect cost pools.

General Questions

The study focused on the financial system at Wor-Wic Tech Community College, one of the seventeen public community colleges in Maryland. The following general questions were answered by the study:

1. What is the indirect cost of continuing education for a fiscal year at Wor-Wic Tech Community College?
2. What is the relationship between enrollment patterns and the indirect cost rate of continuing education at Wor-Wic Tech Community College?
3. How does the rate at which college-wide costs are generated affect the indirect cost of continuing education at Wor-Wic Tech Community College?
4. What is the relationship between the direct cost of instruction and the indirect cost of instruction at Wor-Wic Tech Community College?
5. What is the relationship between the indirect cost of regular academic instruction at Wor-Wic

Tech Community College and the indirect cost of its continuing education program?

6. How might future enrollment and expenditure patterns affect the indirect cost of continuing education at Wor-Wic Tech Community College?

7. How can the dynamic behavior of the indirect consumption of resources by the continuing education program at Wor-Wic Tech Community College be described?

The Model Hypothesis

A model hypothesis focuses on the structure of the system which the model represents. Richardson and Pugh, in 1981, suggested that the development of simulation models which address the dynamic behavior of systems is often guided by at least one model hypothesis. For the purposes of this study, a model hypothesis is defined as a statement about the model which suggests how the system will behave. For example, a hypothesis of the proposed study was that a model which computes the indirect cost of continuing education as a function of the indirect cost of instruction for the college will provide valid cost projections. The focus of this hypothesis was on the structure of the model because it suggested that a formula be included in the study model which will compute the indirect cost of continuing

education. However, the primary value of such a hypothesis was that it presented an idea, based on fiscal policy of the Maryland State Board for Community Colleges, from which to initiate development of a model and test current policies in use by the Maryland community colleges. Further, the hypothesis was formulated for the following reasons: (1) the Maryland State Board for Community Colleges includes such a formula in its discipline cost analysis model, (2) there appeared to be little difference between the administrative and student service structures of continuing education and the credit programs at Wor-Wic Tech Community College, and (3) a simple formula approach provides a basis from which to attempt to validly simplify the process of indirect costing. As development of the study model progressed, the above hypothesis was analyzed and reformulated. Upon completion of the study, the final version of the hypothesis reflected conclusions about the research and provided direction for further investigation. In the case of the above hypothesis, although it reflected current costing policy and represented an idea from which to develop a model, initially, its validity appeared somewhat suspect since continuing education programs typically do not provide as many services as traditional college programs. In fact,

the study revealed that such a formula is too simplistic, but not because continuing education does not provide such services, but because such costs are direct at Wor-Wic Tech Community College. Throughout this study, such model hypotheses were formulated and analyzed.

The model which served as the primary research tool for this study provided information about the indirect cost of a community college continuing education program. In order to answer the questions of the study, the initial model contained variables which linked enrollment levels to instructional costs. The relationship between enrollment levels and costs provided a basis for the examination of the relationship between direct costs and indirect costs. This examination was supplemented by an analysis of the model hypotheses to provide insight into the effectiveness of the model structure. The following hypotheses were initially used to guide development of the study model:

1. The ratio of enrollments generated by the continuing education program to the enrollments generated by the college will provide a valid measure of the amount of resources indirectly consumed by continuing education over time.

2. A model which computes the indirect cost of continuing education as a function of the indirect cost

of instruction for the college will provide valid cost projections.

3. A model which captures the common elements of enrollment patterns and cost consumption is capable of providing insight into how a continuing education program generates costs over time.

These hypotheses were not formally tested using statistical methods; however, a qualitative analysis of the hypotheses based on the development of the study model was used to address the study questions. In order to provide additional information to judge the validity of such a model, a second model was developed which computed indirect cost based on the formation and allocation of cost pools.

General Procedures

To examine the problem, a mathematical model of the indirect cost of continuing education as it changes over time at Wor-Wic Tech Community College was constructed and solved on a computer. An analysis of the model output and the insight gained from developing the model was used to address the study questions. The model was defined by a series of equations which were linked together to compute indirect cost information about the continuing education program at Wor-Wic Tech Community

College. The initial version of the model which was developed for this study was constructed by this researcher in 1984 as the result of a preliminary investigation of how continuing education programs determine indirect costs in the Maryland Community College system. Interviews with each of the college officials who direct the continuing education program at two of the seventeen Maryland community colleges helped the modeler to choose the most appropriate set of variables for the model. A review of the Maryland State Board for Community Colleges cost analysis procedures revealed a static cost model which helped the modeler define the system structure (Maryland State Board for Community Colleges, 1980).

Development of the Model

Simulations of the study model, based on historical, financial data from Wor-Wic Tech Community College, were conducted for the purpose of providing insight into the study problem and producing information for model validation. The question of model validity focused on determining if the model was suitable for addressing the study problem and consistent with the part of reality which the model described.

To validate the indirect cost calculations of the model, a second model was developed which computed indirect cost by allocating indirect cost pools to the continuing education program.

When the initial validation process was completed, a final model was written and simulated with data from the administrative records at Wor-Wic Tech Community College and the Maryland State Board for Community Colleges according to scenarios about the study questions. A more detailed explanation of the procedures and the methodology of the study will follow in Chapter 3.

Limitations and Delimitations

Limitations

The study was limited as follows:

1. The validation process was a mixture of qualitative and quantitative activities which were conducted throughout the development of the model. To establish several system variables, mathematical rigor gave way to assumptions and judgments about the behavior of the financial system under examination. For example, a factor in the study was the extent to which the continuing education program used the services of student affairs. For the study, it was necessary to assume a

percentage of use based on an interview with the Dean of Students and other college personnel. Therefore, under such an approach, the determination of the validity of the model was a process where sufficient quantitative and qualitative information was derived in order to make a judgment about the value of the model.

2. An assumption of the study is that community college managers follow rational plans based on factors in this model. To some extent, this assumption ignores political realities and unforeseen circumstances.

The limitations of and problems associated with, as well as the strengths of modeling studies, will be discussed more specifically throughout the remainder of this dissertation.

Delimitations

Model development was based on the structure of the Maryland community college financial system and its relationship to Wor-Wic Tech Community College. Model output resulted from data collected from only one community college.

Description of Institution Under Study

Wor-Wic Tech Community College, one of seventeen public community colleges in Maryland, was founded in

1976 to meet the occupationally-oriented needs of the residents of the southern portion of the Eastern Shore of Maryland by offering associate of arts degree, certificate of proficiency, and non-credit continuing education programs. In September of 1976, the College enrolled its first degree and certificate students. Since that time, enrollment has grown from a total of 200 students during the 1976-1977 academic year to 6,100 students during the 1984-1985 academic year.

Like the other sixteen Maryland public community colleges, Wor-Wic Tech Community College offers credit courses leading to the degree or certificate, and non-credit courses to meet the continuing education needs of community residents. Since 1976, the college has also realized a need to assume the administration of programs which serve geographic regions beyond the Eastern Shore and special populations. For example, the hotel-restaurant management program serves all of Maryland and enrolls students from Pennsylvania, New Jersey, Delaware, and Virginia. The non-credit machine shop training program serves unemployed and disadvantaged students. Wor-Wic Tech Community College is similar to the other Maryland community colleges in that it serves a diverse, changing student population.

However, a unique feature of Wor-Wic Tech is that it has been designated by the Maryland State Board for Higher Education through the State Board for Community Colleges as a community-based college which uses existing resources and facilities to house students, personnel, and equipment. As a result, the College operates one administrative-instructional facility in the town of Salisbury, but leases instructional facilities at twenty different locations to serve the majority of students.

The continuing education program has been designed to complement the College's occupational degree and certificate credit programs. Continuing education has frequently played a key role in providing an immediate response to the educational needs of the community. Courses are typically developed in response to requests from community members, the results of needs assessments, recommendations from instructors, and negotiations with industrial and governmental agencies. Most of the courses offered by the continuing education program are directly related to the development of skills or knowledge in occupational areas. However, several specialized avocational courses are offered each semester. All continuing education courses are non-credit (Wor-Wic Tech Community College, 1983).

Definitions of Terms

Several of the terms used in this study are subject to several meanings. For the purposes of this study, the following terms are defined:

1. System . A collection of entities that operate together for a common purpose.
2. Dynamic Behavior . The patterns of changes which a system develops over time.
3. Structure . The underlying patterns of relationships of a system that determines its behavior.
4. Resource Consumption . The use of resources including money, people, facilities, equipment, materials, information, and services by an educational program as a result of its operation to meet the objectives of the program.
5. Continuing Education . Programs in the Maryland public community college system which offer non-credit courses for adults who wish to acquire occupational skills or upgrade existing talents.
6. FTE . An annual basis full-time equivalent student which represents any accumulation of enrollments in the Maryland public community college system which equals 450 hours of classroom instruction or college credit equivalent to thirty semester hours.

7. Model Solution . A set of quantitative factors or values which meet all of the mathematical constraints of a model. Often there is a best solution and normally this helps the modeler develop insight about a solution to a real-world problem.

8. Simulation . The numerical manipulation or calculation on a computer of a model's equations which results in a model solution.

9. Test of a Model . A simulation of a model.

The initial study model which is based on the costing assumptions developed by the Maryland State Board for Community Colleges is referred to as the assumption model. The system variables for the assumption model are defined or their values are computed as follows:

1. Institutional Enrollment, INSFTE . The enrollment level of all instructional programs in FTES for a fiscal year.

2. Continuing Education Enrollment, CEFTE . The enrollment level of the continuing education program for a fiscal year.

3. Resource Consumption Ratio, CERCR . The ratio of continuing education enrollment (CEFTE) to institutional enrollment (INSFTE).

4. Direct Cost of Instruction, ISTRDCA . The total direct costs associated with the operation of all

instructional programs.

5. Institutional Direct Cost, INSDC . The direct costs associated with the operation of the College.

6. Indirect Cost of Instruction, ISTRICA . The difference between the institutional direct cost (INSDC) and the direct cost of instruction (ISTRDCA).

7. Indirect Cost of Continuing Education, CEINCA . The product of the resource consumption ratio (CERCR) and the indirect cost of instruction (ISTRICA).

8. Direct Cost of Continuing Education, CEDCA . The direct costs associated with the operation of the continuing education program.

9. Full Cost of Continuing Education, CEFCA . The sum of the direct cost of continuing education (CEDCA) and the indirect cost of continuing education (CEINCA).

10. Continuing Education Indirect Cost Rate, CEICRA . The quotient of the indirect cost of continuing education (CEINCA) and the direct cost of continuing education (CEDCA).

The variables and equations for the assumption model are more fully explained in terms of the indirect cost system in Chapter 3 of this dissertation. Appendix A contains the data which were collected or computed to

develop the assumption model.

The system variables for the model which allocated indirect costs, referred to as the allocation model, are defined or their values are computed as follows:

1. Plant Operations and Maintenance Cost Pool, POMCP . The expenses incurred by the central maintenance service organization for the management, supervision, and maintenance of the College's facilities. The expenses incurred include compensation, fringe benefits, rent, supplies and materials, furniture and equipment, utilities, janitorial services, repairs, and facility renovations.
2. General Institutional Cost Pool, GICP . The expenses incurred to provide college-wide services including data processing, communications, postage, legal assistance, and miscellaneous services.
3. General Administration Cost Pool, GACP . The expenses incurred to operate the office of the President and the business office.
4. Departmental and Program Administration, DPACP . The expenses incurred as a result of operation of the office of the Dean of Instruction. The expenses incurred are to provide instructional support services that benefit common or joint department or program

activities such as curriculum development, program evaluation, and inservice training.

5. Student Affairs Cost Pool, SSCP . The expenses incurred as a result of the management of student services which includes activities of the Dean of Students, registration, counseling, advising, career planning and placement, commencement activities, and student record maintenance.

6. Continuing Education Space Use, CESQF . The square feet of space utilized by the continuing education program.

7. Instructional Space Use, ISSQF . The total square feet of space utilized by all instructional programs.

8. Space Use Ratio, SURAT . The ratio of continuing education space use (CESQF) to instructional space use (ISSQF).

9. Direct Cost of Continuing Education, CEDC . The direct costs associated with the operation of the continuing education program.

10. Direct Cost of Instruction, ISDC . The total direct costs associated with the operation of all instructional programs.

11. Direct Cost Ratio, DCRAT . The ratio of the direct cost of continuing education (CEDC) to the direct

cost of instruction (ISDC).

12. Student Affairs Ratio, SSRAT . An estimate of the percentage of costs incurred by the student affairs office for providing services to continuing education students. Such services include maintaining student records and providing information to students.

13. Continuing Education Indirect Cost, CEINC . The sum of all indirect costs allocated to the continuing education program from the cost pools.

14. Regular Credit Program Indirect Cost, RCPIC . The difference between the sum of all of the cost pools and the continuing education indirect cost (CEINC).

15. Indirect Cost of Instruction, ISTRIC . The sum of the continuing education indirect cost (CEINC) and the regular credit program indirect cost (RCPIC).

16. Administrative Cost Pool, ADMCP . The sum of the general institutional (GICP), the general administration (GACP), and departmental and program administration (DPACP) cost pools.

The allocation model variables and equations are more fully explained in terms of the indirect cost system in Chapters 3, 4, and 5 of this dissertation. Appendix B contains the data which were collected or computed to develop the allocation model.

Summary

More sophisticated costing methods will be required to address the issue of financing community colleges through the last two decades of the twentieth century. This study included the construction, validation, and application of a simulation model to examine the indirect cost of continuing education. Use of such a model will help community college managers make policy decisions about continuing education programs. The study also provided additional insight into the concept of indirect costing in a community college.

Chapter 2

REVIEW OF RELATED RESEARCH AND LITERATURE

This chapter is organized to present a review of the following: (1) previous cost models and studies related to indirect costing, (2) mathematical modeling techniques used in costing studies, (3) the system dynamics approach to modeling, and (4) the application of system dynamics to indirect costing of continuing education in a community college. Previous cost models and studies related to indirect costing have primarily focused on examining direct costs although some have been concerned with the allocation of indirect costs to programs within the institution.

Related Cost Models and Studies

Surveys of colleges and universities revealed that by 1979, three methods were being used to model or study indirect costing as follows: (1) the analysis of discrete accounting measures based on historical data, (2) the development and application of management information systems, and (3) the construction of data

base-independent models (Richman and Farmer, 1977:10; Baldrige and Tierney, 1979).

Discrete Accounting Studies

Many studies based on generally accepted accounting procedures have been conducted to provide direct cost information about college programs, but some of these studies address or can be easily modified to address indirect cost information (Baldrige and Tierney, 1979: 34; Walters, 1981: 11-17). The "cost behavior analysis" approach applied at Santa Fe Community College in Florida within the student services department during the 1977-78 academic year is one such example. The primary purposes of the study were to determine to what extent costs are fixed, to estimate resource requirements based on enrollment changes, and to examine policy decisions which affect costs. As the National Association of College and University Business Officers and the National Center for Higher Education Management Systems jointly reported in 1980, the study was based on developing an understanding of "the dynamic characteristics of costs as they change because of changes in volume, policy, and environment" (1980:13,14). Five steps were followed to examine "the cause-and-effect relationships between costs and volume, policy, or

environmental factors". The steps were:

1. Determine policy questions and identify the management level served by the study.
2. For each function under study, identify the activities, activity measures, and factors that affect costs.
3. Determine current levels of service for each activity and assign costs to each activity.
4. Determine the behavior of costs for each activity.
5. Evaluate and document the policy implications of the study.

Although the main result of the study "indicated that need for student services varied by type of service and type of student program," valuable direct and indirect cost information surfaced which "could help the vice president in projecting the budget for student services." A significant aspect of the study was that the required data were collected from existing program and financial records (National Association of College and University Business Officers and National Center for Higher Education Management Systems, 1980). Less comprehensive studies have also provided valuable cost information. Hample, in 1980, devised a relatively accurate "short" method for assigning "faculty salary costs by level of instruction" by allocating "the total faculty salaries expended in a department by the total courses taught". The alternative method required a tedious analysis of records on individual faculty members (1980:1,2). Hample's model, by identifying the major direct program

costs, provided a basis for allocating indirect costs. As was the case with the Santa Fe study, Hample's supporting data came from existing institutional records. While these two projects focused on direct costs, several accounting-based cost studies have been concerned primarily with determining indirect cost information.

The most well-known method for providing indirect cost information, as outlined in the United States Office of Budget and Management Circular A-21, was developed by the federal government to provide guidelines for the recovery of indirect costs of federally sponsored research by universities and colleges. This method requires that indirect costs of programs be allocated to the following cost pools: (1) instruction and departmental research, (2) organized research, and (3) other institutional activities (Woodrow, 1976). The National Association of University and College Business Officers described the principle of this type of methodology:

The indirect cost computation process is aimed at allocating the incurred costs to the functional cost objectives. A judgment must be made as to what is included in each indirect cost category, and the basis to be used in allocating such costs (1981:3).

According to the Comptroller General of the United States, the validity of this model is dependent upon the "accounting practices of individual colleges and

universities" (1979:531). The allocation process can be based on a range of methodology including such simple techniques as using estimated parameters to perform detailed "precision oriented" cost analysis studies (Braun and Jordan, 1973:20).

One feature that all of the methods described in this section have in common is that the link between the model or method and the institutional record keeping system is informal. A number of models have been developed which, through computer technology, include as part of the model an institutional data base or another model. Baldrige and Tierney called these models "advanced management information systems" (1979).

Management Information Systems

The higher education management models which emerged in the late 1960's resulted from the revolution in electronic computer technology which began shortly before the beginning of World War II. An Educational Resources Information Center Higher Education report by Lawrence and Service cited four major developments which influenced this change in higher education management research methodology. They were:

1. The evaluation of operations research which solved logistical problems through scientific methods and mathematical modeling.
2. The sophistication of operations research modeling and the important applications of the

modeling to industrial management achieved ten years after the end of World War II.

3. The emergence of operations research as an organized body of knowledge with applications in organizational analysis, long-range planning and resource development.

4. The adoption of operations research by governmental and human service agencies in planning and analysis (1977:6,7).

These developments led to a more quantitative approach to higher education management. Kieft, Armijo, and Bucklew in 1978 stated:

In recent years, most institutions have created an assortment of committees to formulate plans for curriculum, facilities, fund raising, budget, housing, support services and staff. These committees have sought to be more analytical, as befits the present situation of constrained resources (1978:1).

It was part of the natural course of events that the use of mathematical modeling in college and university administration rose in popularity during the 1970's. The comments of Lawrence and Service reflected the enthusiasm held by many potential modelers:

In many ways, mathematical modeling is the most stimulating, complex, and demanding concept in the entire realm of quantitative approaches to decision-making (1977:57).

There are at least six advantages to the use of models.

They are:

1. They may permit feasible and economical experimentation on real-world systems without incurring the costs, risks, and expenditures of time that may be required in actuality.

2. They allow us to formulate, communicate, and discuss hypotheses.

3. They bring about an understanding of the system variables and their relationships.
4. They make it possible to forecast and project for planning and decision-making.
5. They allow control of the time scale. Real-world processes occur over long periods of time. Modeling can allow long-range intervals to be collapsed.
6. They enable us to control and monitor real-world processes (Wallhaus, 1969:127).

As indicated in Chapter 1, the majority of higher educational management models are solved numerically or simulated through calculations performed by a computer. The CAMPUS model was the first major effort at simulation modeling. Bell summarized the purpose of CAMPUS:

Judy's purposes in constructing CAMPUS were to assess the flexibility of the system simulation approach to university problems, determine the availability of required data, investigate the applicability of statistical methods to these data, and determine the various facets of the university system and inherent modeling difficulties. He envisioned four types of questions that the CAMPUS model could help answer: (1) What are the resource implications (faculty, physical plant, and total budget) of particular enrollment projections? ... (2) What are the resource implications of meeting established goals on educated manpower? ... (3) What are the resource implications of particular changes in curriculum? (4) What are the resource implications of general policy changes? (Mood, Bell, Bogard, Brownlee, and McCloskey, 1972).

Since 1965, CAMPUS iterations have included a consideration of additional variables such as minimum and maximum class size and the maximum number of classes. Unlike Hample's short model, CAMPUS requires substantial

data and calculation to arrive at departmental work loads. As is the case with other simulation models, once work loads are determined, operating costs of departments can be estimated, hence the name "resource allocation model" (Baldrige and Tierney, 1979).

Another resource allocation model which has received international attention is the Resource Requirements Prediction Model (RRPM) which is a generic form of RRPM 1.6. Bingen and Siau after testing RRPM in the British and Belgian university systems stated:

One overall conclusion that can be drawn from this study is that resources needed for the central administration program in a university are related to student numbers in a more indirect way than a mere proportionality (1980:26).

This conclusion demonstrated the general difficulty in using student numbers to allocate general administration directly; that is, as direct cost to departments.

Bingen, Franz, Siau, and Carlos in 1980 also demonstrated the flexibility in application of RRPM. RRPM, because it relies heavily on regression theory, allows users to define individual institutional characteristics. A significant feature of RRPM is that it uses the Induced Course Load Matrix (ICLM) model and enrollment projections "to calculate line-item budgets for each organizational unit, program budgets with departmental contributions, and institutional summary

reports" (Masland, 1982:8). The concept of the ICLM was developed during the late 1950's at the University of California to "project enrollment, measure departmental work load, and compute program costs" (Kieft, Armijo, and Bucklew, 1978:28,31).

CAMPUS, RRPM, and ICLM are representative of established cost simulation models used in higher education management, and they demonstrate some the advantages discussed by Wallhaus. But, as indicated in Chapter 1, development and use of these models was not without problems. Criticisms of CAMPUS, RRPM, ICLM and other cost simulation models in higher education include the following:

1. Models do not form comprehensive decision-making systems.
2. The accuracy of models is questionable.
3. Models seldom include error measures.
4. Computer-based data files are not always easily linked to model computations; hence, operational costs can be high.
5. Models do not account for environmental factors such as political climate.
6. Most of the models are static and are not capable of making meaningful projections (Masland, 1982; Mood, Bell, Bogard, Brownlee, and McCloskey, 1972; Blackman, 1981).

There is, however, evidence that the problems associated with modeling applications in higher education management have not resulted from the lack of the power of models themselves but, rather, from the way in which models have been used. For example, if the model which

resulted from this study is perceived as a final, only solution to the determination of indirect costs, such use would be inappropriate. The solutions are only as good as the assumptions made. Most often assumptions should be changed and tested. Further, the value of the model may be the insight gained from its development and not necessarily the numerical output derived from its solution. Since 1979, there has been much attention to the state of management in higher education. Modeling, because of the potential its developers promised, has been at the heart of much of this attention. The role of modeling in academic planning seems to hold the key to the future improvement of modeling research methodology.

Academic Planning and Modeling

As Keller indicated in 1983, the "time has arrived for college and university leaders to pick up management's new tools and use them." The recent inquiries into the problems associated with the use of models has focused on the relationship between modeling and planning and has caused the proposal of some new approaches to the use of models. Peterson, in 1980, suggested that alternative approaches to planning might help colleges as they attempt to design planning processes for the future (Jedamus and Peterson,

1980:160). One of these approaches which Keller referred to as a "third way" is strategic planning (1983:108). Strategic planning requires the manager to take a dynamic, creative, and long-term view towards planning. Keller further pointed out that, historically, planners were management scientists or incrementalists. The management science approach has emphasized the use of quantitative tools such as RRPM and ICLM and is "rational-economic" while incrementalism assumes that "life is essentially political." Incrementalism is, therefore, "partisan-political" (1983:99-108). But Keller stated that managers are looking for the "third way:"

The search for a third way in planning, one that eschews the arrogant excesses of the highly quantitative management science experts, their disregard for human frailties and politics, and their reams of computer printouts, but also the supine accommodations of the highly political brokers, their neglect of costs, values, and the future, and their ready excuses about how so-and-so "won't buy it," has become the central quest of planning in the past few years. And it has led directly to the creation of the new field of strategic planning.

Strategic planning attempts to use the best wisdom of both approaches; it tries to encompass both the rational-economic and the partisan-political (1983:108).

Based on the concept of strategic planning, a number of planning models have recently surfaced.

Merson, in 1983, suggested four "key stages" in the strategic planning process for small colleges as follows: evaluation, planning, resource allocation, and financial planning (1983:5). The evaluation stage requires a thorough inventory of the health of the institution and its programs and is followed up by a plan which focuses on a revision of the institution's goals coupled with an analysis of the strategies required to meet the new goals. Resources are then allocated to the programs which can best achieve the institutional goals. In the last stage, financial planning, Merson suggested that microcomputer simulation models can help convert "action plans into financial plans" (1983:6-10). Throughout the strategic planning process, senior as well as middle level institutional managers are required to remain active in the planning process and guide faculty and staff involvement in strategic planning.

In 1983, Myron outlined a more general strategic management model for the community college. He suggested that external factors, college policy, and management responses are the strategic forces which influence the quality of management in a community college. To achieve successful strategic management, his model called for "building relationships, assessing goals and trends, forming strategy, and implementing decisions." Merson

saw strategic management as future-oriented, long-termed, creative, and entrepreneurial as opposed to operational management which is present-oriented, short-term, and static. The model assumed that strategic planning is at the core of strategic management (1983:7-20).

Groff, in 1983, offered a model for strategic planning in the community college. His model differed little from Merson's but did reflect a need to assess the college mission and philosophy in the context of the continuing education function, the occupational emphasis, and the diverse student population of the community college. Groff perceived an "action-oriented, dynamic, purposeful" approach to the future (1983:51-58).

The strategic approach to management and planning, as Jedamus and Peterson stated in 1980, strengthens institutional research. They said that the management and planning functions must be "research-based" but must also be integrated into one interrelated management function rather than being conducted separately (1980:ix,x). The "third way", strategic planning for management, provides a plan whereby the potential of quantitative research can be realized by unleashing its power through the use of dynamic strategies. Specific dynamic modeling techniques

are available to researchers and managers to address these current research issues.

Mathematical Modeling Techniques

The concept of dynamic modeling can overcome some of the problems inherent in higher education simulation models. Gordon, in 1978, suggested that dynamic models follow events over time:

Mathematical models, of course, use symbolic notation and mathematical equations to represent a system. The system attributes are represented by variables, and the activities are represented by mathematical functions that interrelate the variables.

A second distinction will be between static models and dynamic models. Static models can only show the values that system attributes take when the the system is in balance. Dynamic models, on the other hand, follow the changes over time that result from system activities (1978:8,9).

Graybeal and Pooch suggested the following "time-tested steps" used in "model-building":

1. Observation of the system.
2. Formulation of hypotheses or theories that account for the observed behavior.
3. Prediction (which some modelers refer to as forecasting) of the future behavior of the system based on the assumption that the hypotheses are correct.
4. Comparison of the predicted behavior with actual behavior (1980:5).

The role of the evolving scientific methods cannot be overlooked as the concept of dynamic modeling is practiced (Forrester, 1982). One approach to modeling

which is sensitive to the "time-tested" scientific methods and the current state of affairs in higher education management is system dynamics.

System Dynamics

System dynamics is a specific type of modeling philosophy which developed as a result of the early attempts during the 1950's to apply natural science methodology to managerial, organizational, and sociological inquiry. The system dynamics approach relies on computer simulation principles, but its distinguishing characteristic is that it assumes that models of systems can best be constructed by examining the flows of people, money, materials, equipment and other resources over time. Further, system dynamics assumes that the behavior of any system is caused by the structure of the system (Roberts, 1981:4). Hence, emphasis is placed on defining the system structure qualitatively. Roberts, Andersen, Deal, Garet, and Shaffer referred to this process as conceptualizing the system or constructing a system definition (1983:9). For example, in a 1975 system dynamics study of the effects of financial policy on an organization's use of financial resources, Lyneis demonstrated the importance of examining the relationships between a large number of

financial variables over time. Lyneis contended that if the multiplicity of policy factors affecting a business's cash flow are examined and considered in the context of short-range versus long-range effects, then the most important policies affecting the financial stability of a business can be identified and properly manipulated. To test this hypothesis, a non-mathematical system model consisting of feedback loops was constructed which outlined the relationships between sales, production, investments, expenses, profits, costs, and marketing. The model was then translated to static equations and simulated over time on a computer. A conclusion of the study was that the rate of cash flow is dependent upon how the variables interact. The study showed that a manager responsible for fiscal control could obtain information about future levels of financial variables based on projected or assumed levels of associated variables. For example, when a business "raises prices to balance the supply and demand for funds", then "price rather than product availability becomes the competitive variable limiting sales" (Lyneis, 1981:485-501).

Lyneis's work and that of other system dynamists came as a result of the post World War II scientific advances in understanding feedback systems, constructing simulation models, and applying modeling results (Roberts, 1981:3).

The use of system dynamics procedures has been limited in the educational setting; however, "any problem area" in education "where a great many variables affect the problem and sustain the problem over time is very suitable for this kind of research study" (Roberts, 1981b:614).

Indirect Costing and System Dynamics

The system dynamics modeling approach fits with the examination of indirect costing of continuing education and other programs in a community college, since resource allocation models can be expanded to include indirect cost components. Blackman, in his system dynamics study of resource allocation, concluded:

The process of model-building can also lead to greatly improved communications among those involved in resource allocation decision-making, because the construction of a model requires explicit statements of those assumptions (regarding the resource allocation process), which generally are different in the minds of different people and which often lead to misunderstanding because they are never explicitly stated (1981:364).

This process lends itself to addressing fiscal issues in continuing education. Loring stated that:

More than any other form of education, continuing education is market-sensitive. It is constructed on business principles related to supply and demand, income and expenses, product and advertising, with slim margin for error and tight management of personnel and facilities (1980:133).

As Woodrow explained about indirect costs, "a form of

scientific method is necessary to understand them" (1976:7).

Summary

Previous indirect costing methods in higher education have essentially relied on cost accounting procedures which have been thoroughly described by governmental agencies. However, such procedures are often tedious and do not consider the growth of costs over time. Computer simulation models which consider direct and allocated indirect costs have been useful in suggesting alternative methods of indirect costing.

Chapter 3

MODELING METHODS AND PROCEDURES

The problem of the study was to develop a mathematical model of the indirect cost of continuing education in a Maryland community college. The model, which resulted from the study, was simulated on a computer and is capable of determining indirect cost information over a fiscal year, providing indirect cost information for subsequent years, and simulating cost patterns of the program. As is explained in this chapter, the model was developed from the work completed on two historical models of indirect cost at Wor-Wic Tech Community College. Chapter 3 is presented by the following categories in order to describe how the problem was investigated: (1) the initial indirect cost model, (2) the allocation of indirect cost pools, and (3) model development and simulation.

The presentation focuses on the iterative process of constructing, simulating, validating, and analyzing the study model. In this chapter, an initial, simplified financial-enrollment system which is represented by a set of simple equations is described.

Next, a description of a second model which computes indirect cost from cost pools is presented. These descriptions are followed by an outline of how a final model was solved and developed into a more complex form to attempt to address the study problem. The general procedure for developing the final model was to conduct tests to produce information which was used to validate and improve the model. The tests focused on simulations using financial and enrollment data from the institutional records at Wor-Wic Tech Community College and from the Maryland State Board for Community Colleges management information system.

Although the primary research methodology for the study was the application of mathematical modeling, the analysis of the model development emphasized the qualitative aspects of understanding any system. For example, in 1981 Balderson discussed the importance of qualitative analysis in the application of strategic planning models:

All of these strategic-planning approaches, taken mechanically, share an important defect. They contain sets of variables, some dynamic considerations, and various nuances of the analytical relationships. What they do not do, unless we employ them with considerable wit, is capture the more subtle qualities of institutional atmosphere, the character of human response to the educational venture, and the institution's claims of loyalty and dedication on its members (1981:60).

As Cook and Campbell indicated in 1979, quantitative educational research tools are weakened when "the presumptive, qualitatively judgmental nature of all science" is overlooked during their use (1979:93). This study emphasized the application of the following qualitative research activities: (1) subjective judgments about the validity of the study models, (2) interviews with college managers to obtain expert opinions, (3) construction and examination of dynamic flow diagrams of the study models to develop insight into the problem, (4) examination of the solutions to the model equations to develop insight into the study problem, and (5) analysis of numerical data to determine behavior patterns of the financial system.

The Initial Indirect Cost Model

To motivate the research methodology for the study, an initial indirect cost model was developed as a result of a preliminary investigation of the indirect cost accounting procedures in the Maryland Community College system. The goal for this phase of the study was to construct and test an initial, general model in order to examine the indirect cost of continuing education at Wor-Wic Tech Community College between the years 1977 and 1985. According to the preliminary investigation, the

construction of such an initial model depended on the following institutional factors being measured in a community college: (1) institutional enrollment, (2) enrollment in the continuing education program, (3) the full cost of operating the institution, (4) the direct cost of instruction, and (5) the direct cost of the continuing education program. In this dissertation, the initial model is referred to as the assumption model since it assumes, as stated in the model hypotheses in Chapter 1, that the above factors can be used to form valid equations from which to compute indirect costs.

More specifically, the following procedures were used to initiate the assumption model:

1. The indirect consumption of resources by a continuing education program in a community college were viewed as a system and defined in terms of the goal of the system, the resources consumed as the system operates over time, the components of the system, the variables which describe the system, and the management structure under which the system operates.

2. The Associate Dean for Continuing Education at Harford Community College in Maryland, the Associate Dean of Community and Continuing Education at Wor-Wic Tech Community College in Maryland, and the Associate Director for Indirect Cost at the University of Delaware

were interviewed to obtain responses to the system definition.

3. Based on the interview responses, previous research, the structure of the Maryland State Board for Community Colleges discipline cost analysis model, and the modeler's experience, the system definition was revised. The result was a model based on the five factors listed above.

4. The system definition was written in flowchart form.

5. The flowchart form of the system definition was translated to mathematical notation.

6. The data required to compute the values for the system variables were collected for each of the fiscal years from 1977 to 1985.

7. The values for the system variables were computed for each of the fiscal years from 1977 to 1985.

The Assumption Model Variables and Equations

The variables and equations of the assumption model were developed in three components as follows: (1) enrollment, (2) direct cost, and (3) indirect cost. The general method of presentation of this section is to define each system variable and describe the equations which represent the component. Throughout this section,

the data collection procedures which were used to support development of the equations are outlined.

The Enrollment Component . The primary purpose of this component was to describe the enrollment patterns at Wor-Wic Tech Community College from Fiscal Year 1977 to Fiscal Year 1985. Two variables, institutional enrollment (INSFTE) and continuing education enrollment (CEFTE), were used to describe, respectively, the institutional enrollment level and the continuing education enrollment level in FTES, full-time equivalent students, for a fiscal year. Enrollment data were collected for each of the fiscal years, 1977 through 1985, from the State Board for Community College Form 4 and the Maryland Community Colleges Selected and Enrollment Data Report. All community colleges in Maryland are required to complete annually the State Board for Community Colleges Form 4 which is a summary of institutional enrollment, revenue, and expenditure information. The sources of information for Form 4 at Wor-Wic Tech Community College are the monthly and annual expenditure reports, the enrollment reporting system, internal audit reports, external audit reports, the payroll system, and the general ledger.

The ratio of continuing education enrollment (CEFTE) to institutional enrollment (INSFTE) formed the continuing education resource consumption ratio (CERCR). This ratio was a key system variable since it was used to compute the indirect cost of continuing education as a percentage of the total indirect cost of instruction. It is important to note that the inclusion of such a ratio in the initial model reflects the ideas about the computation of indirect cost which were stated in the study hypotheses. Hence, the validation of the assumption model depended significantly on the validity of the use of the resource consumption ratio.

Furthermore, since the ratio was replicated from a formula in the State Board for Community Colleges cost analysis model, the validation of the assumption model produced information about the validity of the indirect costing procedures which are used by the Maryland higher education coordinating boards and the state political bodies. The preliminary investigation for this study revealed that such state-wide costing procedures have generally been assumed and retained for use without validation studies. Therefore, the question of how to model indirect cost at Wor-Wic Tech Community College may have state-wide implications. The value of such a ratio, however, could not be determined without addressing the

relationship between enrollment and indirect cost. In order to examine such a relationship, the enrollment component of the model was linked to the indirect cost equations through the direct cost component.

The Direct Cost Component . The direct cost component linked the enrollment and indirect cost components because it provided a basis for calculating the indirect cost of continuing education for a fiscal year. As described above, the resource consumption ratio (CERCR) was multiplied by the indirect cost of instruction (ISTRICA) to compute the indirect cost of continuing education (CEINCA). The indirect cost of instruction (ISTRICA) was represented as the difference of the institutional direct cost (INSDC) and the direct cost of instruction (ISTRDCA). For the purposes of this study, institutional direct cost was defined according to the costing standards and guidelines of the Maryland State Board for Community Colleges as all college-wide "expenditures of the current general unrestricted fund and all expenditures of the current restricted fund with the exception of federal student aid fund expenditures and restricted research fund expenditures" (Maryland State Board for Community Colleges, 1980b:4-1). Each Maryland community college is required to maintain

accounting records of the restricted and unrestricted expenditures under an object classification system and according to functions. The categories of the object classification system are as follows: (1) employee compensation including fringe benefits, (2) contracted services, (3) supplies and materials, (4) communications, (5) conferences and meetings, (6) grants and subsidies, (7) utilities, (8) fixed charges, (9) furniture and equipment, and (10) others. The categories of the functions are as follows: (1) instruction, (2) instructional resources, (3) student affairs, (4) plant operation and maintenance, (5) general administration, (6) general institutional, and (7) other. The direct cost of instruction was defined as all expenditures charged to the instructional function according to the College's accounting system. At Wor-Wic Tech Community College, this includes the compensation cost for the Dean of Instruction, all department heads, teaching faculty, along with all other instructional direct costs. All accounting records at Wor-Wic Tech Community College are maintained by a computerized financial information system. The institutional direct cost and direct cost of instruction information for each of the fiscal years, 1977 to 1985, was derived from the restricted and unrestricted expenditure statements in the Maryland State

Board for Community Colleges Form 4. Next, to complete the set of variables and equations to examine indirect cost, the indirect cost component was established.

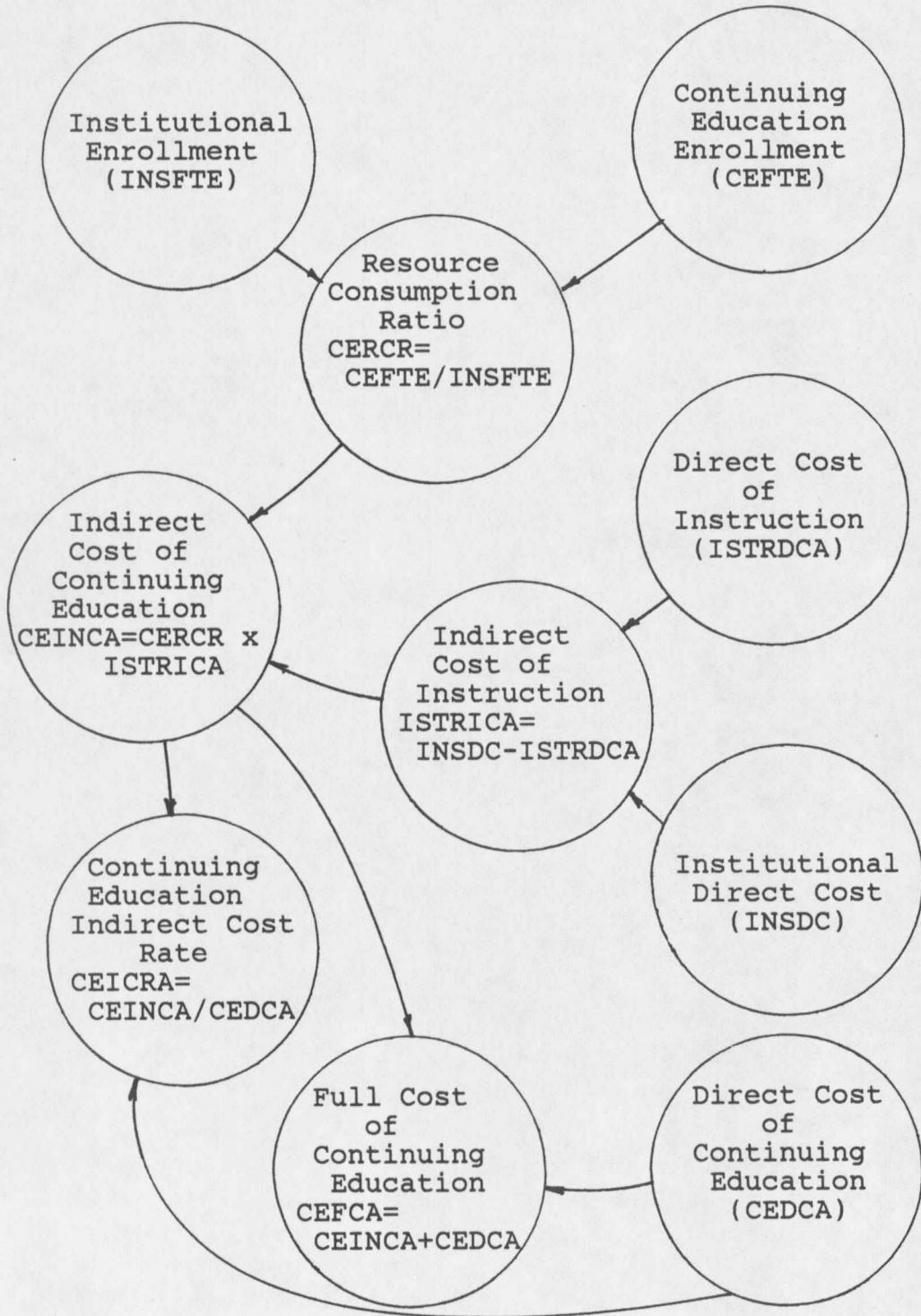
The Indirect Cost Component . The purpose of the indirect cost component was to describe the indirect cost variables addressed in the study questions. In order to achieve this purpose, the full cost of continuing education (CEFCA) was represented as the sum of the indirect cost of continuing education (CEINCA) and the direct cost of continuing education (CEDCA). The continuing education indirect cost rate (CEICRA) was also represented as the quotient of the continuing education indirect cost (CEINCA) and the direct cost of continuing education (CEDCA).

The direct cost of continuing education is defined as all expenditures charged to the continuing education cost objective. At Wor-Wic Tech Community College, this cost objective includes the salary of the Associate Dean for Continuing Education, two program coordinators, teaching faculty, support staff, and other direct costs. These costs for each of the fiscal years from 1977 to 1985 were derived from the College's annual expenditure reports.

To summarize, data for the following variables of the assumption model were collected from institutional records for each of the fiscal years from 1977 to 1985: (1) institutional enrollment (INSFTE), (2) continuing education enrollment (CEFTE), (3) institutional direct cost (INSDC), (4) the direct cost of instruction (ISTRDCA), and (5) the direct cost of the continuing education program (CEDCA). Furthermore, for the same time points, the values for the following variables were calculated: (1) the resource consumption ratio (CERCR) as the quotient of continuing education enrollment (CEFTE) and institutional enrollment (INSFTE), (2) the indirect cost of continuing education (CEINCA) as the product of the resource consumption ratio (CERCR) and the indirect cost of instruction (ISTRICA), (3) the indirect cost of instruction (ISTRICA) as the difference between the institutional direct cost (INSDC) and the direct cost of instruction (ISTRDCA), (4) the full cost of continuing education (CEFCA) as the sum of the direct cost of continuing education (CEDCA) and the indirect cost of continuing education (CEINCA), and (5) the indirect cost rate of continuing education (CEICRA) as the quotient of the indirect cost of continuing education (CEINCA) and the direct cost of continuing education (CEDCA). Figure 1 illustrates the assumption model.

Figure 1

The Assumption Model



Analysis and Validity of the Assumption Model .

As stated in the model hypothesis from Chapter 1, the initial version of the assumption model represented a simplistic approach to indirect costing by determining the indirect cost of continuing education as a function of enrollment, the direct cost of instruction, and institutional costs. However, if confidence could be placed in the validity of a such a model, then, the relationship between enrollment patterns and indirect cost could be established as addressed in study Question 2. Furthermore, the affects of college-wide costs on the indirect cost of continuing education, as addressed in Question 3, could be explained simplistically.

Therefore, in order to help make a judgment about the validity of the assumption model, a second model which computes indirect cost through the allocation of cost pools was developed.

The Allocation of Indirect Cost Pools

A model which establishes and allocates indirect cost pools was used to determine the actual indirect cost of continuing education for each of the fiscal years from 1977 to 1985. The results of this determination were used to judge the validity of the costs produced by the assumption model and develop the final study model.

As discussed in Chapter 2 of this dissertation, the guidelines presented in the United States Office of Budget and Management Circular A-21 are the most widely used in higher education to allocate indirect costs (e.g. non-metered utility costs) to primary programs (e.g. instruction, research) of the institution (Woodrow, 1976). The methods reflected in such an allocation model for this study were adopted from the Circular A-21 guidelines as interpreted by the United States Comptroller General in 1979. However, the methods were modified to fit the cost information system used by the Maryland State Board for Community Colleges and Wor-Wic Tech Community College.

At Wor-Wic Tech Community College, the accounting system includes five major cost functions as listed above: (1) instruction, (2) student affairs, (3) plant operations and maintenance, (4), general administration, and (5) general institutional. Expenditure reports are generated monthly for the major functions by object classification, and the total expenditures for the functions for each fiscal year are reported annually in the State Board for Community Colleges Form 4. The institutional expenditure reports display the direct costs (e.g. instructional supplies) which are directly associated with each function. What

is not displayed is how the costs of the general functions relate back to the primary functions such as instruction. Thus, for this study it was concluded that the cost of instruction is that shown for the first function plus a share of the general function costs. To determine that share required the use of an indirect costing method, an allocation model.

The Allocation Model

The general method to determine the indirect cost of instruction was to establish five indirect cost pools from which indirect costs were allocated to the continuing education program and to the credit instructional program.

This study was concerned with only these two programs which are the primary programs of the College. The five indirect cost pools were established as follows:

1. Plant Operations and Maintenance - These are expenses incurred by the central maintenance service organization for the management, supervision, and maintenance of the College's facilities. The expenses incurred include compensation, fringe benefits, rent, supplies and materials, furniture and equipment, utilities, janitorial services, repairs, and facility renovations. The total expenditures for each fiscal year

for this category were obtained from SBCC Form 4.

2. General Institutional - These are expenses incurred to provide college-wide services including data processing, communications, postage, legal assistance, and miscellaneous services. The total expenditures for each fiscal year for this category were obtained from SBCC Form 4.

3. General Administration - These are expenses incurred to operate the office of the President and the business office. The total expenditures for each fiscal year for this category were obtained from SBCC Form 4.

4. Departmental and Program Administration - The expenses under this category are those incurred as a result of operation of the office of the Dean of Instruction. The expenses incurred are to provide instructional support services that benefit common or joint department or program activities such as curriculum development, program evaluation, and inservice training. Total annual expenditures for this category were available in the section of the institutional expenditure report entitled, the Dean of Instruction cost center report, and includes salaries, contracted services, supplies and materials, furniture and equipment, faculty training, and communications. The expenditure reports are simply the more detailed sources of data used to

prepare the SBCC Form 4 reports. The final fiscal year expenditure summaries for all cost centers were reviewed to determine if costs attributable to this category have been correctly categorized. This category is not of a general institutional nature, as are the other categories. Rather, it is a pool within the instructional function from which instructional administration costs were allocated between the credit and continuing education programs.

5. Student Affairs - The expenses under this category have been incurred as a result of the management of student services which includes activities of the Dean of Students, registration, counseling, advising, career planning and placement, commencement activities, and student record maintenance. The total expenditures for this category were available on SBCC Form 4.

There is no cost pool for depreciation since the College owns no facilities and the since the volume of equipment is small.

A library cost pool, which in the Maryland community college system would represent the instructional resources function, is conspicuously missing. However, the College has a contract for students to use the University of Maryland and Salisbury State College libraries free of charge. Each academic

program makes some library resource purchases for its own local use and provides its own media services. However, these costs are directly charged to the department or program.

The concept of "cross-allocation" of indirect cost pools were not used due to the simplicity of the Wor-Wic financial system. "Cross-allocation" refers to the "process of allocating costs from one indirect cost pool to another" (Hopkins and Massey, 1981: 163).

The cost pools were allocated to continuing education as follows:

1. Plant Operations and Maintenance - The costs for this category were allocated as the ratio of the square feet of space utilized by the continuing education program to the total square feet of space utilized by all instructional programs. Data for the offices, instructional laboratories, and learning centers were collected from lease agreements, floor plans, and facilities planning documents available in the business office. In several cases, it was necessary to interview college personnel to interpret the reports and to make actual measurements of facilities to verify report data. Classroom space data was collected from the master course schedules available in the Dean of Instruction's office. All space-use measurements were based on full-time use of

the facility. In the case of auxiliary facilities, which were not used full-time, the measurements were equated to full-time equivalent use. Facilities which were used at no cost were not included in the study.

2. General Institutional - The cost for this category was allocated as the ratio of the direct cost of continuing education to the direct cost of instruction. The total expenditures for the instructional function, reported in SBCC Form 4, represents the direct cost of instruction and was used for this ratio. The direct cost of continuing education was collected from the cost center report entitled, Continuing Education, which is part the institutional expenditure report used to complete SBCC Form 4.

3. General Administration - The cost for this category was allocated by the formula used for the general institutional category.

4. Departmental and Program Administration - The cost for this category will be allocated by the formula used for the general institutional category.

5. Student Affairs - Two and one-half percent of the costs in this category were allocated to continuing education which was an estimate of the percentage of costs incurred by the student affairs office for providing services to continuing education

students. Such services include maintaining student records and providing information to students. The two and one-half percent figure was reviewed with the Dean of Students and the Dean of Instruction to verify that it was a reasonable percent.

Figure 2 is a schematic illustration of the indirect cost allocation process.

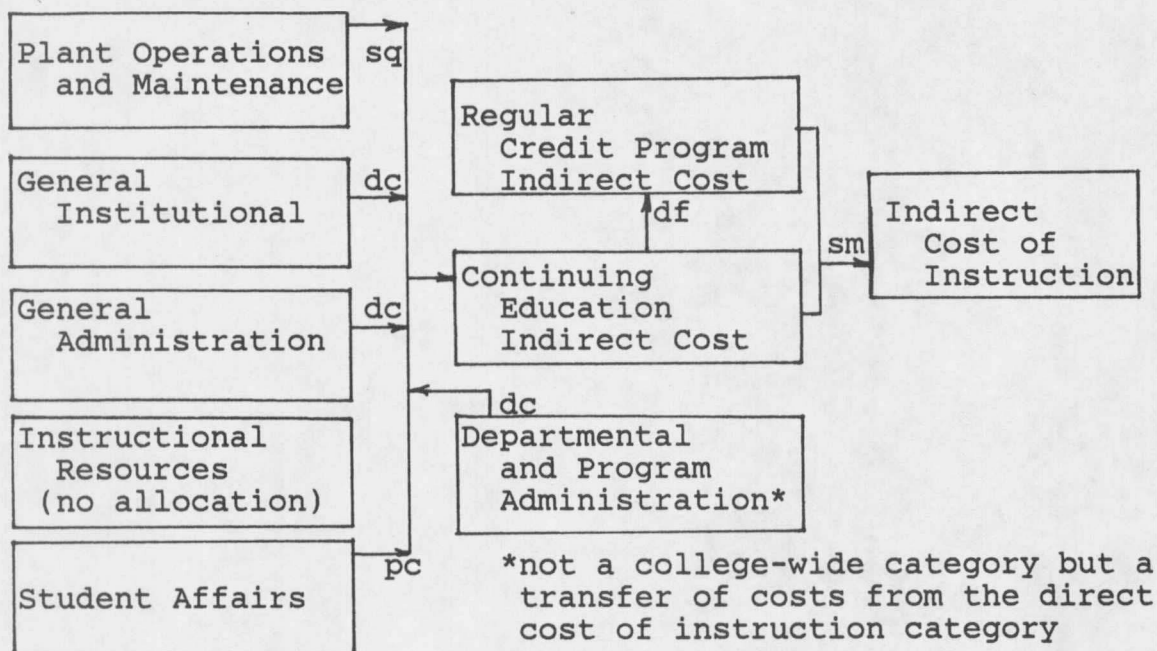
The cost pools could have been allocated to the regular credit program by the same procedure used for continuing education. However, for each cost pool, such a procedure would yield the difference between the amount of the cost pool and the amount of the pool allocated to continuing education. Therefore, the indirect cost of the credit program was determined as the difference between the sum of the amounts of the five cost pools and the indirect cost of the continuing education program.

The above procedures were followed for each of the fiscal years, 1977 to 1985, to determine the actual indirect costs of continuing education and instruction. For each of these years, the indirect cost of instruction was computed as the sum of the indirect cost of continuing education and the indirect cost of the credit program.

Figure 2

The Allocation of Indirect Cost Pools to the Continuing Education and Regular Credit Programs

Indirect Cost Pools



Key

- sq - ratio of the square feet of space utilized by the continuing education program to the total square feet of space utilized by all instructional programs
- dc - ratio of the direct cost of the continuing education program to the direct cost of the instructional program
- pc - percent of the direct cost of student affairs (2.5% to continuing education, 97.5% to the regular credit program)
- df - difference between the sum of all cost pools and the indirect cost of continuing education
- sm - the sum of the indirect cost of continuing education and the indirect cost of the regular credit program

Model Development and Simulation

The purpose of determining the actual indirect costs by the allocation of indirect cost pools was to provide information to help make a judgment about the validity of the indirect costs produced by the assumption model. The actual indirect cost of continuing education for each of the nine fiscal years was compared to the nine years of continuing education indirect costs produced by the model built on assumptions. Similarly, the actual indirect cost of instruction was compared to the indirect cost of instruction produced by the assumption model.

In order to further analyze how well the assumption model determines indirect costs, the resource consumption ratio was applied to the indirect cost pools of the allocation model. The indirect costs which resulted from the resource consumption ratio were compared to the indirect costs which resulted from the use of the allocation model ratios. Also, each ratio of the allocation model was compared to the resource consumption ratio. For each of the comparisons, the mean difference and Pearson product-moment correlation coefficient was computed.

Both the assumption and allocation model were discrete models which computed historical or actual indirect costs. A data base system, which is described in Chapter 4 of this dissertation, was developed to compute and analyze such costs. In order to complete the study problem and examine cost behavior patterns through future time, a final model was developed from the results of the analysis of the two historical models. Further, the final model was expressed as a set of continuous functions over time in order to examine the dynamic behavior of indirect cost. Each of the equations were defined as rates, according to the results derived from the analysis of the assumption and allocation models, and solved as functions using computer simulation techniques. The cost patterns were analyzed by fitting, independently, each of the variables of both of the models to the the following time-series models: (1) linear, (2) exponential, (3) geometric curve, (4) polynomial, (5) autoregressive, (6) Gompertz curve, (7) moving average, and (8) exponential smoothing. The models were analyzed through the use of graphs and the statistics calculated by a regression analysis computer program. The program computed simple linear regression equations, multiple regression equations, power polynomials, descriptive statistics, correlation and

covariance matrices, and multiple and partial correlations. The program displayed an analysis of variance table, a table of coefficients, and a table of residuals, and x-y plots. A computer program was used to compute forecasts of the time-series models.

Summary

The problem of the study was to develop a mathematical model of the indirect cost of continuing education in a Maryland community college. One college, Wor-Wic Tech Community College was selected for the study. A model built on assumptions suggested by the Maryland State Board for Community Colleges was compared to a model which allocates indirect cost pools. Based on the analysis of the comparisons of the two models, a final model which was simulated on a computer was developed for the study. The final model provided insight into the cost patterns generated by the continuing education program at Wor-Wic Tech Community College.

Chapter 4

ANALYSIS OF THE ASSUMPTION AND ALLOCATION MODELS

This chapter presents the results and findings from the analysis of the historical data which was collected and derived for the assumption and allocation models. The chapter is organized according to the following divisions: (1) comparison of the assumption and allocation model results, (2) interpretation of the results, (3) structure and behavior of the allocation model, and (4) a summary. The comparison of the assumption and allocation model results will focus on the indirect costs which were computed from the allocation ratios and formulas. However, an analysis of the ratios and formulas which determined the indirect costs will be presented as part of the interpretation of the results.

Comparison of the Assumption and Allocation Model

The historical data collected for the study were organized into a computerized data base system with two components, the assumption model data base and the allocation model data base. Each of the components contained the following: (1) the data collected according

to the procedures outlined in Chapter 3 for each of the fiscal years from 1977 to 1985, (2) the formulas or ratios which computed or allocated the variables, and (3) the computed or allocated variables. The system was capable of organizing the data into computer files, performing algebraic computations, graphing trends and patterns of the variables, and computing regression and time-series statistics. The first application of the system was to compute and compare the indirect cost of continuing education for each of the models.

The Indirect Cost of Continuing Education

The most significant result of the study was that the indirect costs of continuing education produced by the assumption model were consistently overinflated compared to the indirect costs produced by the allocation model. The results are represented in Table 1.

To determine the cause of such large differences, the resource consumption ratio, which was used to compute the indirect cost of continuing education for the assumption model, was tested with the allocation model indirect cost pools. Each of the allocation model cost pools was allocated to continuing education by the resource consumption ratio, the quotient of continuing education enrollment and institutional enrollment. As

Table 1

A Comparison of the Indirect Costs of Continuing
Education Produced by the Assumption Model
to the Indirect Costs Produced by the
Allocation Model

Indirect Cost of Continuing Education in Dollars			
Fiscal Year	Assumption Model Results	Allocation Model Results	Difference
1977	186,111	98,372	+87,739
1978	61,039	53,735	+7,304
1979	119,931	45,464	+74,467
1980	197,136	73,727	+123,409
1981	230,984	109,251	+121,733
1982	289,895	152,429	+137,466
1983	293,981	199,305	+94,676
1984	345,973	263,251	+82,722
1985	405,920	274,000	+131,920

Mean difference = 95,715 dollars
r = .9407

presented below, such results were compared to the allocations derived from the original allocation model ratios.

Indirect Costs Derived From the Cost Pools

In the case of the plant operations and maintenance cost pool, the results using the resource consumption ratio were close to those derived from the allocation model ratio of the square feet of space utilized by the continuing education program to the total

square feet of space utilized by all instructional programs. The results are represented in Table 2.

Table 2

A Comparison of the Plant Operations and Maintenance Indirect Costs Allocated by the Space Use Ratio to the Indirect Costs Allocated by the Resource Consumption Ratio

Plant Operations and Maintenance Allocations in Dollars

Fiscal Year	By the Resource Consumption Ratio	By the Space Use Ratio	Difference
1977	0	0	0
1978	0	0	0
1979	0	0	0
1980	32,835	31,766	+1,069
1981	56,966	53,844	+3,122
1982	81,681	85,720	-4,039
1983	100,549	101,211	-662
1984	133,579	137,607	-4028
1985	142,001	129,291	+12,710

Mean difference = 908 dollars
 $r = .9963$

In the case of the student affairs cost pool, the results from the allocation model, which were allocated by an estimated percent of use, differed significantly from the results obtained from the use of the resource consumption ratio. Table 3 represents the results.

In the allocation model, the general administration, general institutional, and departmental

Table 3

A Comparison of the Student Affairs Indirect Costs
Allocated by the Percent of Use Ratio to the
Indirect Costs Allocated by the Resource
Consumption Ratio Allocations

Student Affairs Allocations in Dollars			
Fiscal Year	By the Resource Consumption Ratio	By the Percent of Use	Difference
1977	35,009	1,508	+33,501
1978	14,704	1,642	+13,062
1979	16,232	1,374	+14,858
1980	55,799	3,687	+52,112
1981	45,768	2,954	+42,814
1982	43,158	2,646	+40,512
1983	65,701	3,864	+61,837
1984	69,313	4,482	+64,831
1985	94,949	5,787	+89,162

Mean difference = 45,854 dollars
r = .9705

administration cost pools were all allocated by the ratio of the direct cost of continuing education to the direct cost of instruction. The three cost pools were, therefore, collapsed to compare the direct cost ratio from the allocation model ratio to the resource consumption ratio from the assumption model. The large allocations for the fiscal year, 1977, reflected the "start-up" costs incurred during the first full year of operation of the College. The results are represented in Figure 4.

Table 4

A Comparison of the Collapsed Administration Cost Pool
Allocations Produced by the Direct Cost Ratio to
the Resource Consumption Ratio Allocations

Fiscal Year	By the Resource Consumption Ratio	By the Direct Cost Ratio	Difference
1977	163,929	96,864	+67,065
1978	56,341	52,093	+4,248
1979	120,434	44,090	+76,344
1980	131,838	38,274	+93,564
1981	157,179	52,453	+104,726
1982	199,934	64,063	+135,871
1983	172,397	94,231	+78,166
1984	191,055	121,162	+69,893
1985	224,551	138,921	+85,630

Mean difference = 79,501 dollars
r = .6194

Interpretation of the Results

The extreme results of the assumption model computations indicated that little confidence could be placed in the use of such a simplistic approach to determine the indirect cost of the continuing education program at Wor-Wic Tech Community College. Hence, the assumption implied in the model hypothesis, that the ratio of enrollments generated by the continuing education program to the enrollments generated by the college provides a valid measure of the amount of resources indirectly consumed by continuing education,

was not validated. One such formula apparently could not represent effectively the "cause-and-effect" relationship between the indirect costs and the single indirect cost base from which the indirect costs were derived. To the contrary, because of the development of indirect cost pools, the allocation model allows for the use of a range of ratios to more confidently reflect such "cause-and-effect" relationships.

In the case of the allocation of the general administration, general institutional, and departmental administration cost pools, the application of the enrollment ratio of the assumption model did not compare favorably to the application of the direct cost ratio of the allocation model. Over the nine year period, the correlation coefficient between the two allocations was .6194 and the mean difference between the allocations was 79,501 dollars. However, the source of the problem can be traced to the differences in the two ratios. The correlation coefficient between the two ratios was .5855 and the mean difference between the ratios was 19.44 percent. The numerical differences in the ratios indicated that the direct cost of the continuing education program per FTE, historically, has been less than the direct cost of the regular credit program per FTE. Such a finding contradicts the rationale that the

assumption model enrollment ratio would compare favorably to the allocation model direct cost ratio since it might reasonably be assumed that the direct cost of the continuing education program per FTE is close to the ratio of the direct cost of the regular credit program per FTE. Such an assumption might be based on the fact that both the continuing education program and the regular credit program receive the same amount of state and local government funds per FTES generated, and are managed similarly since they utilize the same facilities and rely heavily on the use of part-time instructors. However, such an assumption, as the above data indicated, proved to be invalid. A closer analysis of the direct cost data revealed that direct costs of the two programs were not generated in proportion to the FTES generated by the programs for two reasons. One, part-time instructor salaries of the continuing education program are substantially lower than the part-time instructor salaries of the regular credit program. Two, over the period 1977 to 1983, the number of full-time staff in the regular credit program dramatically increased in comparison to the full-time staff in the continuing education program.

In regard to the student affairs cost pool, it was clear that the assumption model ratio failed to

attribute accurately student affairs indirect costs to the continuing education program because such costs are not indirect but direct. An interview with the Dean of Students revealed that, while the student affairs department is designed to serve all students, most all of the academic advisement for continuing education students is handled by the continuing education staff. Further, the continuing education program maintains and operates its own computer information system to register students and maintain records. The staff also manages and conducts all student registration sessions. Hence, the assumption-model ratio did not reflect the fact that most of the costs of student services for continuing education are reflected as direct costs of continuing education in the Colleges's expenditure reporting system.

The enrollment ratio of the assumption model adequately allocated the plant operations and maintenance cost pool in comparison to the space use ratio allocations as represented in Table 2 above. However, the correlation coefficient between the two ratios was .1863. This result was deceiving, however, since the two ratios compared favorably for the period 1978 to 1985 as Table 5 illustrates. The extreme difference of the ratios for the year 1977 did not show a problem

because the plant operations and maintenance pool for that year contained zero dollars.

Table 5

A Comparison of the Resource Consumption Ratio From the Assumption Model to the Space Use Ratio of the Allocation Model

Fiscal Year	Resource Consumption Ratio (Percent)	Space Use Ratio (Percent)	Difference
1977	58.05	17.94	+40.11
1978	22.39	17.94	+4.45
1979	29.53	17.94	+11.59
1980	37.84	36.61	+1.23
1981	38.73	36.61	+2.12
1982	40.78	42.79	-2.01
1983	42.51	42.79	-0.28
1984	38.66	39.82	-1.16
1985	41.02	37.35	+3.67

Mean difference = 6.64 percent
r = .1863

Clearly, the resource consumption ratio for 1977 was not a representative ratio for the nine years considered in the study. During the first full year of operation of the College, there was an emphasis on the development of the continuing education program since its curriculum was more easily developed and staffed than the regular credit program. The course offerings for the regular credit program during 1977 were limited. However, a full schedule of courses was developed by

1978. The correlation coefficient of the enrollment ratio and the space use ratio for the years 1978 through 1985 was .9444 and the mean difference was 2.45 percent. Further, for these eight years, the square feet of space used by the continuing education program correlated highly to the continuing education enrollment with $r = .9657$. Similarly, the square feet of space used by all instructional programs correlated highly to the total institutional enrollments with $r = .9448$.

Although the analysis of the historical data indicated that little confidence could be placed in the use of the indirect costs derived from the assumption model, the primary question of the study to determine the indirect cost of the continuing education program at Wor-Wic Tech Community College for a fiscal year was addressed by the results from the allocation model represented in Table 1 above. The analysis also provided information about the relationship between enrollment patterns and the indirect cost of continuing education.

The assumption model expressed the indirect cost of continuing education as a function of continuing education enrollment, institutional enrollment, and the direct cost of instruction. However, such a functional relationship was not validated. Further, no substantial evidence resulted from the analysis of historical data

which showed a clear relationship between enrollment patterns and the indirect cost of instruction. To the contrary, a rationale for the use of an enrollment ratio for the allocation of indirect costs in the Maryland community college system is based on the fact that the three major sources of revenue, student tuition, state funding, and county funding are enrollment driven. However, tuition, state funding, and county funding represented only 72.56 percent of the revenue generated by Wor-Wic Tech Community College during the fiscal years 1978 to 1985.

While it seemed possible that regression analysis might help to clarify the relationship between enrollment patterns and the indirect cost of instruction, such was not the case. The enrollment variables from the study were added to the allocation model and a correlation matrix was produced. Table 6 lists the correlation coefficients between enrollment variables and five allocation model cost variables.

The data collected for the study showed a low correlation between institutional enrollment and the direct cost of instruction, but did show a high correlation between institutional enrollment and the indirect cost of instruction.

Table 6

Correlation Coefficients Between Enrollment Variables
and Cost Variables From 1978 to 1985

Enrollment Variable in FTES	Cost Variable in Dollars	Correlation Coefficient
Continuing Education	Direct Cost of Continuing Education	.8839
Continuing Education	Indirect Cost of Continuing Education	.9314
Continuing Education	Full Cost of Continuing Education	.9130
Continuing Education	Indirect Cost Rate for Continuing Education	.9752
Institutional Enrollment	Direct Cost of Instruction	.5378
Institutional Enrollment	Indirect Cost of Instruction	.9706
Institutional Enrollment	Institutional Cost	.8671
Institutional Enrollment	Plant Operations and Maintenance Cost Pool	.9920
Institutional Enrollment	Departmental Administration Cost Pool	.9686
Institutional Enrollment	General Administration Cost Pool	.6896
Institutional Enrollment	General Institutional Cost Pool	.1368
Institutional Enrollment	Student Services Cost Pool	.8662

While the analysis of the historical data showed some numerical relationship between the enrollment variables and the indirect cost of continuing education, no insight was developed which would show how enrollment is a factor in the determination of indirect costs. The use of multiple-regression analysis to further explain a link between enrollment and indirect cost seemed fruitless since there existed a general pattern of high correlation between allocation model variables (enrollment variables included). In order to use an enrollment ratio to allocate indirect costs, such an average would need to produce less inflated indirect costs than the resource consumption ratio and would need to reflect the differences in the way the continuing education program consumes resources as compared to the regular credit program. To the contrary, the ratios of the allocation model determined indirect costs by a measure which reasonably corresponded to the cost pool which was allocated as indirect costs. Therefore, to develop the final model for the study, it was assumed, as does the allocation model, that enrollment patterns have no effect on the allocation of indirect costs.

Structure and Behavior of the Allocation Model

The development of the final model was based on an analysis of the structure and behavior of the allocation model.

The Structure of the Allocation Model

The allocation model represented college-wide cost consumption in a hierarchical fashion. It described institutional costs as being independently generated by the instructional and non-instructional activities. In the real Wor-Wic Tech Community College financial system, these costs are based on expenditures which are generated in accordance with an institutional budget. The budgets are not based on resource allocation formulas but, instead, are developed based on a demonstration of needs by the various programs, departments, and divisions. The allocation model described non-instructional costs as being generated by the plant operations and maintenance, general institutional, general administration, departmental administration, and student affairs functions. Similarly, instructional costs are generated by the various instructional departments and programs, and the office of the Dean of Instruction. To determine the indirect cost of instruction, the allocation model

contains formulas which allocate the non-instructional costs as indirect instructional costs.

The Behavior of the Allocation Model

The general behavior of the allocation model is consistent with William Vatter's views on the limitations of overhead allocation. Vatter in 1945 stated:

Although it may be convenient (perhaps even necessary) to assume a direct correspondence between certain releases of measured consideration and the designated costing unit, it is not always true that in fact such a relation exists. On the contrary, those phenomena that are paired as cause and effect, effort and accomplishment, or cost and the costing unit, are but seldom so simply and directly connected. Every cause has a number of effects, every event arises from many causes; all incidents and observations are bound together by many ties. All costs are more or less interwoven in a complex fabric [sic]; in large measure costs are joint as to their incurrence, as well as to their associations with various costing units (1945:164).

The correlation matrix of the system variables showed a general pattern of high correlation between the pairs of system variables. Therefore, the time-series analysis, in which the system variables were independently regressed over time for the period 1978 to 1985, was used to identify the patterns of cost behavior. Such an approach was helpful in verifying the constants which were used in the simulations of the final model, however, reliance on regressing each of the system variables independently over such a small number of time

points presented a serious limitation in the development of the indirect cost model.

Nevertheless, the eight data points for each of the allocation model variables were fit to the following time-series models: (1) linear, (2) exponential, (3) geometric curve, (4) polynomial, (5) autoregressive, (6) Gompertz curve, (7) moving average, and (8) exponential smoothing.

The Plant Operations and Maintenance Cost Pool .

The plant operations and maintenance cost pool data appeared to fit the linear, second-order, and third-order polynomial models with coefficients of multiple determination of .9732, .9733, and .9808 respectively. A graphical comparison of the fitted data to the historical data for each of the models also indicated a possible good fit for each of the models. Further, for all three models, a plot of the fitted values against the residuals showed no tendency of the residuals to vary systematically. The same result developed for the plot of time against the residuals. However, the forecasted values of the third-order polynomial showed an unrealistic negative growth of the cost pool from 1988 through 1999. Also, for the third-order polynomial with four degrees of freedom, the calculated t-statistic of

-.259, 1.266, and -1.252 respectively for the linear, quadratic, and cubic terms showed problems with the coefficients. While the second-order polynomial showed a reasonable accelerated growth in plant operations and maintenance costs, the calculated t-statistic of .18 for the quadratic term indicated a problem with the coefficient. For the linear model, a calculated t-statistic of 14.754 indicated a non-zero coefficient for the time variable. The analysis indicated the use of the non-zero linear function, $f(t) = 55399t - 78992$, to estimate plant operations and maintenance costs.

The space use ratio which allocated the plant operations and maintenance cost pool was analyzed in terms of its numerator, the space use in square feet of the continuing education program and its denominator, the space use of all instructional programs in square feet. For the continuing education space use data, the coefficient of determination of .9261 and a comparison of the historical data to a fitted second-order polynomial curve indicated a reasonable model of the historical data. However, such a model projected an unreasonable negative growth. While the historical data did not appear to fit the linear model as well, the linear model was judged to best represent the trend in the data. The coefficient of determination for the linear model was

.8177 and the t-statistic was 5.188. The plot of the fitted values against the residuals showed no systematic pattern of behavior. A similar result was obtained from the plot of the residuals against time. The fitted linear model was $f(t) = 2574t + 1744$.

The historical data for the space use of all instructional programs was represented well by the second-order polynomial model, although it forecast a negative unrealistic growth. The linear model provided the best representation of the data with a coefficient of correlation of .8777 and a t-statistic of 6.563. The plot of the residuals against the predicted values and the plot of the residuals against time both showed no systematic pattern of behavior. The fitted linear model was $f(t) = 5223t + 12396$.

The Student Affairs Cost Pool . The student affairs cost pool data fitted to the linear model resulted in reasonable forecasts. The coefficient of determination was .7928 and the t-statistic was 4.791. The plot of the residuals against the predicted values and the plot of the residuals against time showed no systematic patterns of behavior. The fitted linear model was $f(t) = 21324t + 36224$. The allocation ratio for the student affairs cost was the constant, .025.

The Administration Cost Pools . The general administration, general institutional, and departmental administration cost pools were collapsed into one pool which was fitted to the time-series models. The data showed a fluctuating cost pattern with a tendency toward moderate growth. The geometric curve and the linear model provided the most reasonable fit; however, the coefficients of determination were .760 and .7458 respectively. The geometric curve represented a slightly accelerated growth which plateaus while the linear model represented a moderately constant growth.

The direct cost ratio which was used to allocate the general administration, general institutional, and departmental administration cost pools was analyzed in terms of its numerator, the direct cost of continuing education, and its denominator, the direct cost of instruction. The fitted linear model, the exponential curve, the geometric curve, the second-order polynomial model, the third-order polynomial model, the double moving averages model, the double exponential model, and the triple exponential model showed good fits of the historical data for the direct cost of continuing education with coefficients of determination of .8877, .930, .750, .940, .980, .880, .880, and .960 respectively. However, all models except the linear and

double exponential smoothing models showed unrealistic accelerated or decelerated growth. The double exponential smoothing model showed a moderate growth less than that of the linear model.

The direct cost of instruction data was fit well by only the third-degree polynomial model with a coefficient of determination of .820. An analysis of the time-series graph verified the close fit; however, the future behavior of the third-degree polynomial showed a highly accelerated growth of instructional indirect costs.

Summary

The analysis of the historical data showed that the indirect costs of continuing education produced by the assumption model were highly inflated in comparison to the allocation model. The primary cause was the extreme difference between the actual amount of student affairs services used by continuing education and the amount of student affairs costs allocated to the continuing education program. Also, the enrollment ratio used in the assumption model did not reflect accurately how the continuing education program consumes general administration, general institutional, and departmental administration resources. While the enrollment ratio

computed indirect costs from the plant operations and maintenance cost pool which were numerically close to those derived from the allocation model, no evidence resulted from the study which would suggest that the enrollment ratio is a meaningful measure of how the continuing education program indirectly consumes such resources. The allocation model was judged to represent effectively the indirect cost system for the continuing education program at Wor-Wic Tech Community College.

For each allocation model variable, time-series models were developed independently. An analysis of the models indicated that, as hypothesized in the initial version of the assumption model, costs at Wor-Wic Tech Community College have a general tendency to grow linearly. However, the direct cost of instruction showed a potential to accelerate in growth. Despite the limitation of the small set of time points available for the study and the independence of the time-series variables, the computations of indirect costs from the allocation model and the analysis of the behavior of the costs provided information with which to develop an indirect cost model for the continuing education program at Wor-Wic Tech Community College.

Chapter 5

AN INDIRECT COST MODEL FOR CONTINUING EDUCATION

This chapter will present the final model which was developed in an attempt to represent the way in which the continuing education program at Wor-Wic Tech Community College indirectly consumes resources over time. The model, which was based on the results of the analysis of the historical allocation model, was projected into the future over continuous time. To examine the behavior of the indirect cost system, the equations of the allocation model were translated into rates and simulated on a computer. In order to present the model and form a basis from which to discuss its value, the chapter is organized according to the following divisions: (1) introduction, (2) the simulation model, (3) applications to strategic management, and (4) summary.

Much of the chapter is devoted to a discussion of how the information gained from the development of the model can be applied within the management structure of the College. Although each of the allocation model variables were thoroughly analyzed to examine their

behavior over time, such analysis was essentially performed independently on each variable. The failure to develop more links between the system variables, therefore, became a serious limitation in the attempt to describe the indirect cost system over time. As a result, much of what was included in the final model was based on the judgment of the modeler. Therefore, the model presented in this chapter does represent a somewhat limited way to examine the indirect cost system over time.

Introduction

Despite such limitations, the allocation procedures which were used provide a simple but effective way to identify the actual costs which are indirectly consumed by the continuing education program for a fiscal year or period of fiscal years. Also, the development of the model produced some insight into how indirect costs behave. Such efforts at institutional research at Wor-Wic Tech Community College have previously been absent. However, financial and political factors indicate that the College should begin to view more rigorously the economic factors which affect the College's future. During 1985, the College was evaluated by a Middle States Association of Colleges and Schools

reaccreditation team. Both the College's self-study and the team report indicated a need for the College to begin to research issues more extensively, and as a result, to develop a strategic management plan. The President, in response, appointed a planning committee to insure that Wor-Wic Tech Community College can make the transition from a college which has operated programs based on year-to-year plans to a college which will examine, analyze, and plan for the dynamic forces which affect the long-range operation of the College. At the present time, however, the College has no institutional researcher or planner on staff. Further, there are no current plans to add such personnel to the College's staff or to develop an office of institutional research. In terms of personnel, Wor-Wic Tech has a critical mass problem. It experiences many of the management problems of larger colleges, but must maintain a small staff. As a result, there is a tendency for personnel to be less specialized in their responsibilities. Despite these problems, this study demonstrated how the institutional research function at the College can be developed at the department or program level.

The final model of the study computed the indirect costs through the use of the indirect cost pools and allocation formulas which were tested in Chapter 4 of

this dissertation. However, enrollment variables were added to the model to provide unit cost measures. Computer simulations were used to compute and analyze the model variables.

The Simulation Model

The patterns of cost behavior which were determined as described in Chapter 4 were translated to rates and simulated.

The Simulation Equations

As was the case with the discrete allocation model, the final simulation model was organized according to the plant operations and maintenance, student affairs, and administrative cost pools. The indirect costs were computed for each of the cost pools and summed to determine the indirect cost of continuing education. All equations were simulated over the time interval, [1,23], which represented the real-time interval, the year 1978 to the year 2000.

The Plant Operations and Maintenance Indirect Costs . The plant operations and maintenance cost pool was represented by the differential equation, $POMCP'(t) = 55,399$ dollars per year, with the initial value equation, $POMCP(1) = -23,593$ dollars. The numerator of the space

use ratio was represented by the differential equation, $CESQF'(t) = 2,574$ square feet per year, with the initial value equation, $CESQF(1) = 4,318$ square feet. The denominator of the space use ratio was represented by the differential equation, $ISSQF'(t) = 5,223$ square feet per year, with the initial value equation, $ISSQF(1) = 17,620$ square feet.

As was the case with the historical allocation model, the plant operations and maintenance indirect costs which were allocated to continuing education by the formula, $[CESQF(t)/ISSQF(t)][POMCP(t)]$.

The Student Affairs Indirect Cost . The student affairs cost pool was represented by the differential equation, $SSCP'(t) = 21,323$ dollars per year, with the initial value equation, $SSCP(1) = 57,548$ dollars. The percent of the cost pool which was allocated to continuing education was held constant at 2.5 percent.

The student affairs indirect costs were allocated to continuing education as 2.5 percent of $SSCP(t)$.

Administrative Indirect Cost . The administrative cost pool, which was the sum of the general administration, general institutional, and departmental administration cost pools, was represented

by the differential equation, $ADMCP'(t) = 32,835$ dollars per year, with the initial value equation, $ADMCP(1) = 303,990$ dollars. The numerator of the allocation ratio, the direct cost of continuing education, was represented by the differential equation, $CEDC'(t) = 27,910$ dollars per year, with the initial value equation, $CEDC(1) = 93,163$ dollars. The denominator of the allocation ratio, the direct cost of instruction, was represented by the differential equation, $ISDC'(t) = 25,859t(t) - 287,246t + 736,654$ dollars per year, with the initial value equation, $648,365$ dollars. However, the rate was changed to $ISDC'(t) = -32,500t + 736,654$ for the period 1986 to 2000 in order to represent a more reasonable growth in the direct cost of instruction. The assumption of such a growth pattern for the future was based on the projection that Wor-Wic Tech Community College is entering into a "second wave" of development. It is anticipated that the regular credit program will grow substantially due to the need to implement a developmental studies program, increase the number of full-time faculty, develop instructional resources, and respond to recent developments in high technology. It is also anticipated that, even under such essential development, enrollment in the credit programs will stabilize and continue a linear growth pattern. As was the case with the

historical allocation model, the administrative indirect costs were allocated to continuing education by the formula, $[\text{CEDC}(t)/\text{ISDC}(t)][\text{ADMCP}(t)]$.

Auxiliary Output Measures . The following output measures were added to the model: (1) the continuing education indirect cost rate, (2) the full cost of continuing education, (3) the direct cost of continuing education per FTE, (4) the indirect cost of continuing education per FTE, and (5) the full cost of continuing education per FTE. The corresponding measures for the regular credit program were also added to the model.

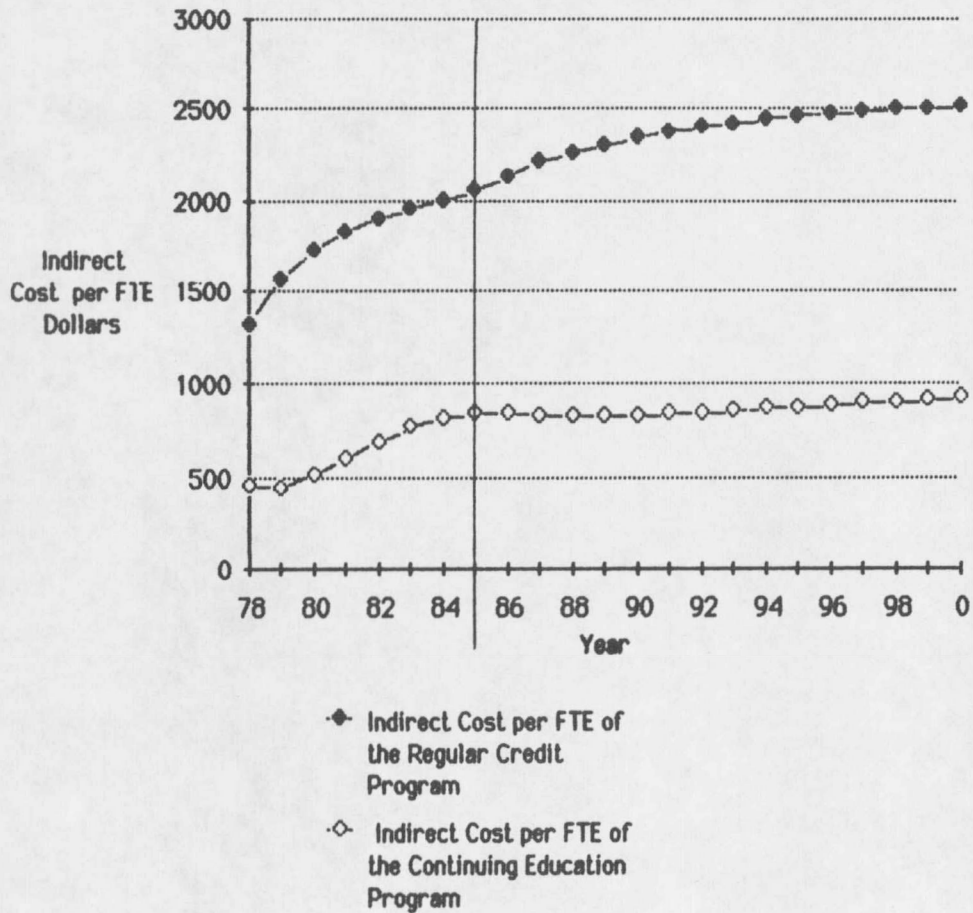
Simulation Results

The simulation of the indirect cost model produced gradually increasing indirect costs for the continuing education program. Also, the actual indirect cost of continuing education per FTE increased gradually between 1978 and 1985 but, according to the simulations, will stabilize in the future. Figure 3 compares the indirect cost of the continuing education program per FTE to the indirect cost of the regular credit program per FTE.

Figure 4 compares the indirect costs of continuing education which were derived from the plant

Figure 3

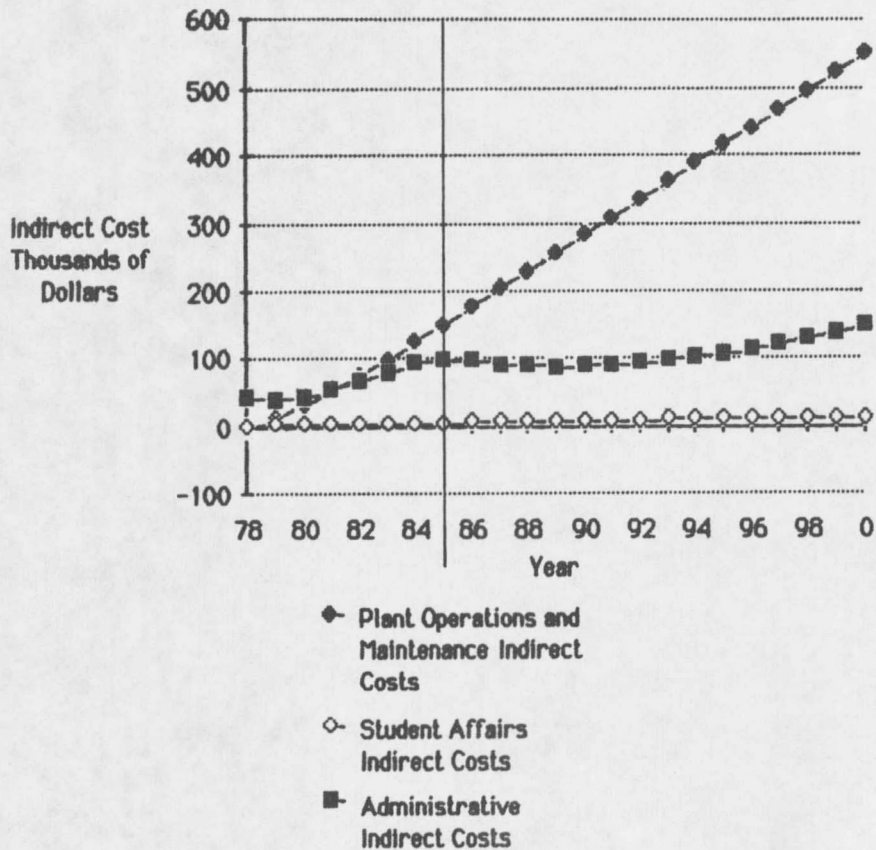
A Comparison of the Indirect Cost of Continuing Education per FTE to the Indirect Cost of the Regular Credit Program per FTE from the Year 1978 to the Year 2000



Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

Figure 4

Behavior of the Indirect Cost of Continuing Education
from the Year 1978 to the Year 2000,
Breakdown by Cost Pool



Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

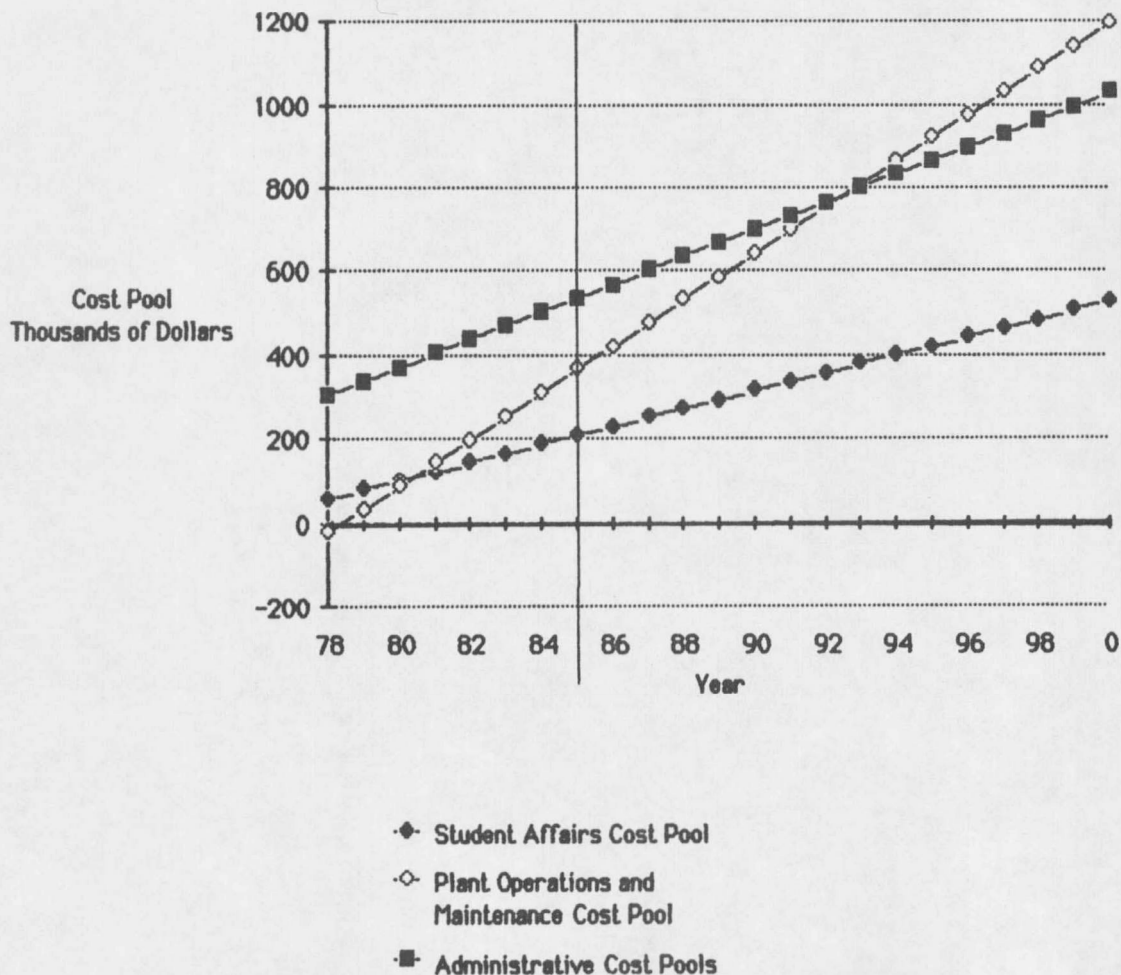
operations and maintenance, student affairs, and administrative cost pools. The plant operations and maintenance indirect costs appear to be the most significant contributor to the indirect cost of continuing education. The actual plant operations and maintenance costs are approaching the administrative costs primarily due to the costs incurred as the result of the expansion of facilities and increased rent. Figure 5 compares the indirect cost pools.

The average increase in rental costs between 1980 and 1985 was 23.59 percent of the previous year's cost. The simulation suggested that if current trends continue, then substantially increasing plant operations and maintenance costs can be expected in the future. The total cost of the continuing education program and other programs would be affected by increased indirect costs. Consequently, the College may need to develop strategies to control facilities costs.

Although the space use, direct cost, and student affairs allocation ratios have the potential to affect dramatically the level of continuing education indirect costs, such does not appear to be the case for the continuing education program at Wor-Wic Tech Community College. Figure 6 compares the allocation ratios. Despite the moderate growth in the space use ratio, the

Figure 5

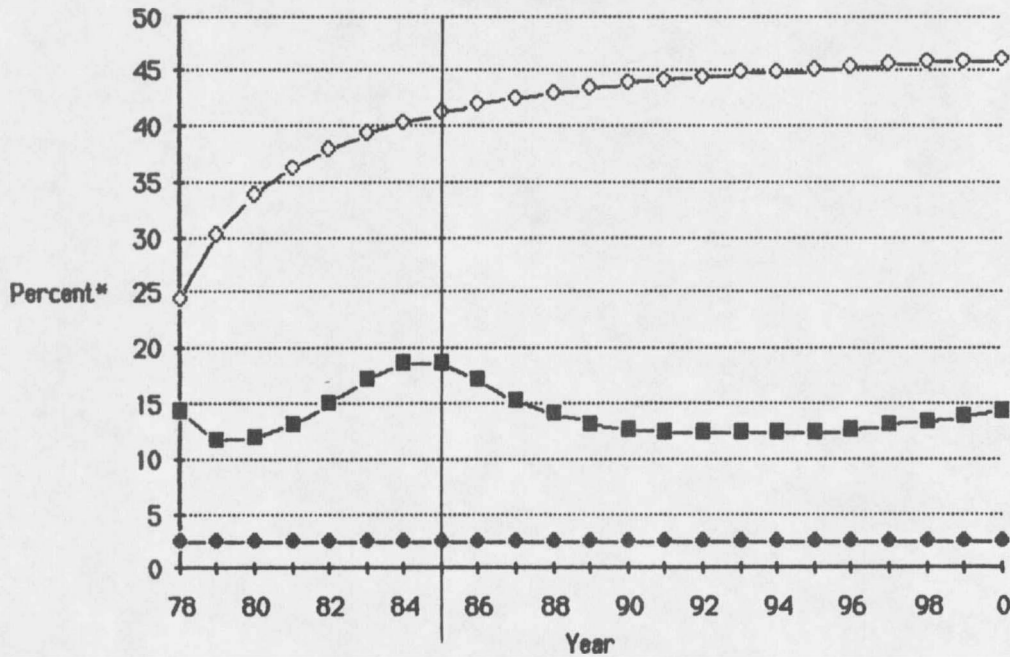
Behavior of the Cost Pools from the
Year 1978 to the Year 2000



Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

Figure 6

Behavior of the Allocation Ratios from the
Year 1978 to the Year 2000



◆ Student Affairs Ratio -
* The percent of the
student affairs services
used by continuing
education.

◇ Space Use - * The ratio of
the square feet of space
used by the continuing
education program to the
square feet of space used
by all of the instructional
programs (as a percent)

■ Direct Cost Ratio - * The
ratio of the direct cost of
continuing education to the
direct cost of the regular
credit program (as a
percent)

Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

substantial growth in the indirect costs allocated from the plant operations and maintenance cost pool, as illustrated in Figure 4, can be attributed to the growth in the plant operations and maintenance cost pool. Hence, the percent of space used by continuing education is not increasing significantly but the cost of space use is increasing substantially.

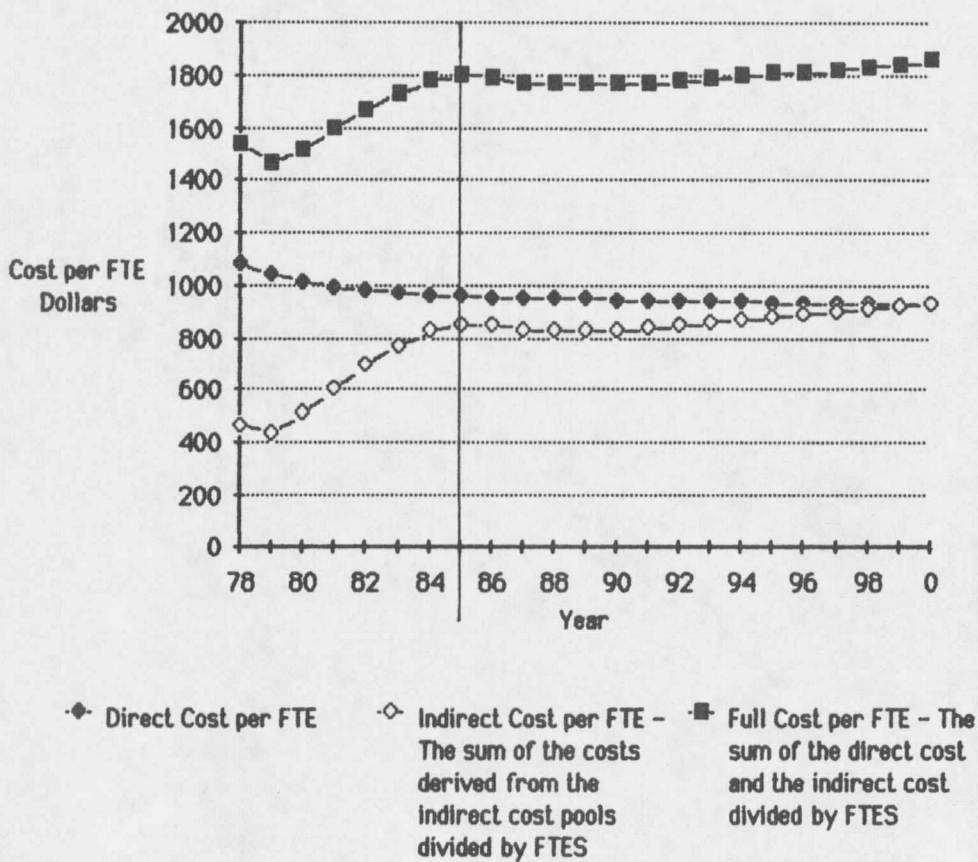
The actual direct cost ratio, the quotient of the direct cost of continuing education and the direct cost of instruction, increased moderately. The simulation projected that the direct cost ratio will decrease moderately and stabilize. Such a projection might be realistic since a pattern at the College has been to channel resources to the regular credit program.

The student affairs indirect costs which were allocated to continuing education reflected the moderate growth which occurred in the student affairs cost pool since, under the assumption of the model, the student affairs ratio is constant.

Figure 7 represents the behavior of the direct, indirect, and full costs of the continuing education program per FTE. For the actual cost period, 1978 to 1985, the slight increase in the full cost of continuing education per FTE is a result of the increase in indirect cost per FTE and the moderate drop in the direct cost per

Figure 7

The Direct, Indirect, and Full Costs per FTE of the Continuing Education Program from the Year 1978 to the Year 2000



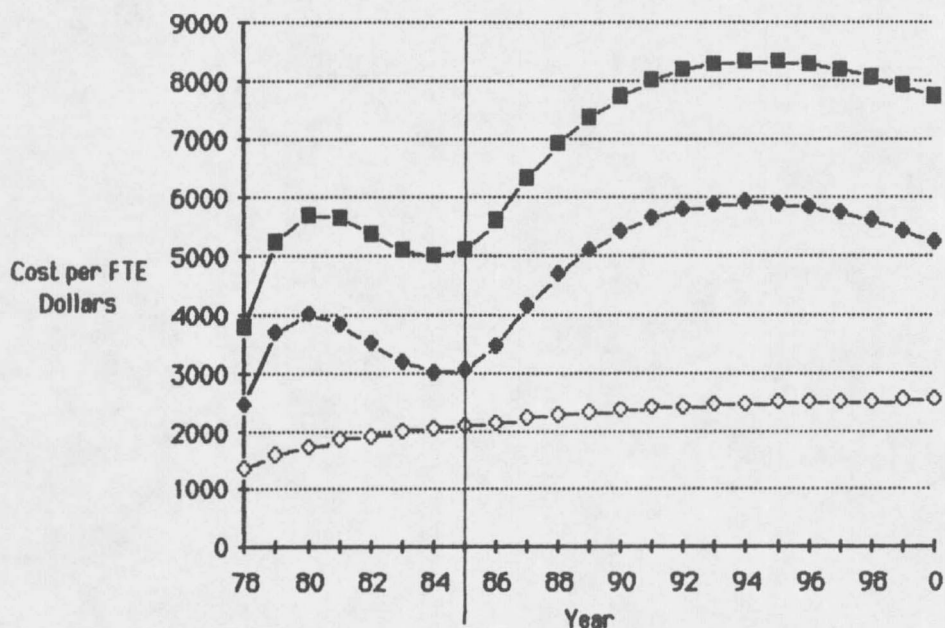
Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

FTE. Although the simulation projected that such costs will stabilize to a pattern of limited growth in the future, the model is suspect in this regard. The model produced the projection because the indirect cost per FTE was moderately increasing while the direct cost of continuing education was moderately decreasing. The actual direct cost of continuing education per FTE did show a declining trend, but how long such a pattern will continue is questionable. There are no current plans at the College which would indicate that continuing education direct costs will grow substantially, but enrollment still has the potential to grow. If such becomes the case, then the simulation projections should be accurate. However, with the pressure on continuing education to produce increased enrollment in the future, it is questionable how long the College can continue to operate the program with minimal resources.

Figure 8 represents the behavior of the direct, indirect, and full costs of the regular credit program per FTE. The steep increase in the actual direct cost of the regular credit program between 1978 and 1981 can be attributed to "start-up" costs and the initial influx of grant and contract revenue to the College. The simulation projection that such a pattern will repeat in the future is somewhat suspect but possible. If Wor-Wic

Figure 8

The Direct, Indirect, and Full Costs per FTE
of the Regular Credit Program from
the Year 1978 to the Year 2000



- ◆ Direct Cost per FTE
- ◇ Indirect Cost per FTE - The difference between the sum of the indirect cost pools and the indirect cost of continuing education divided by FTES
- Full Cost Per FTE - The sum of the direct cost and the indirect cost divided by FTES

Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

Tech is entering into a second phase of development as suggested by the Middle States Association reaccreditation team, then the College can expect increased instructional costs which could eventually taper off, especially if enrollment declines are realized. However, a gradually increasing direct cost per FTE for the regular credit program would appear to be more likely. Whatever the case, College officials need to begin to examine possible future financial patterns to aid in the development of management strategies which might allow the College to exercise some control over future development of the College.

Applications to Strategic Management

While the study presented in this dissertation focused on the financial and enrollment variables which affect the indirect costing system at Wor-Wic Tech Community College, the development and analysis of the final indirect cost model suggested methods by which the model will support a new strategic planning system which is currently under development at the College. The indirect cost model provides the type of research tool which can easily be applied in a small college with limited resources such as Wor-Wic Tech. Although the model presented in this chapter is limited in scope, the

assumptions upon which it is built can easily be changed to consider other alternatives for the future. In a small college setting such as Wor-Wic Tech, the value in the development of such a tool lies in the insight gained by its development and not necessarily in the mathematics produced by its use. Further, the simulations of the study model highlighted the extensiveness of the non-credit program at the College. In this regard, the study raised several important management issues and produced a tool which can support the the development of the institutional research function at the College.

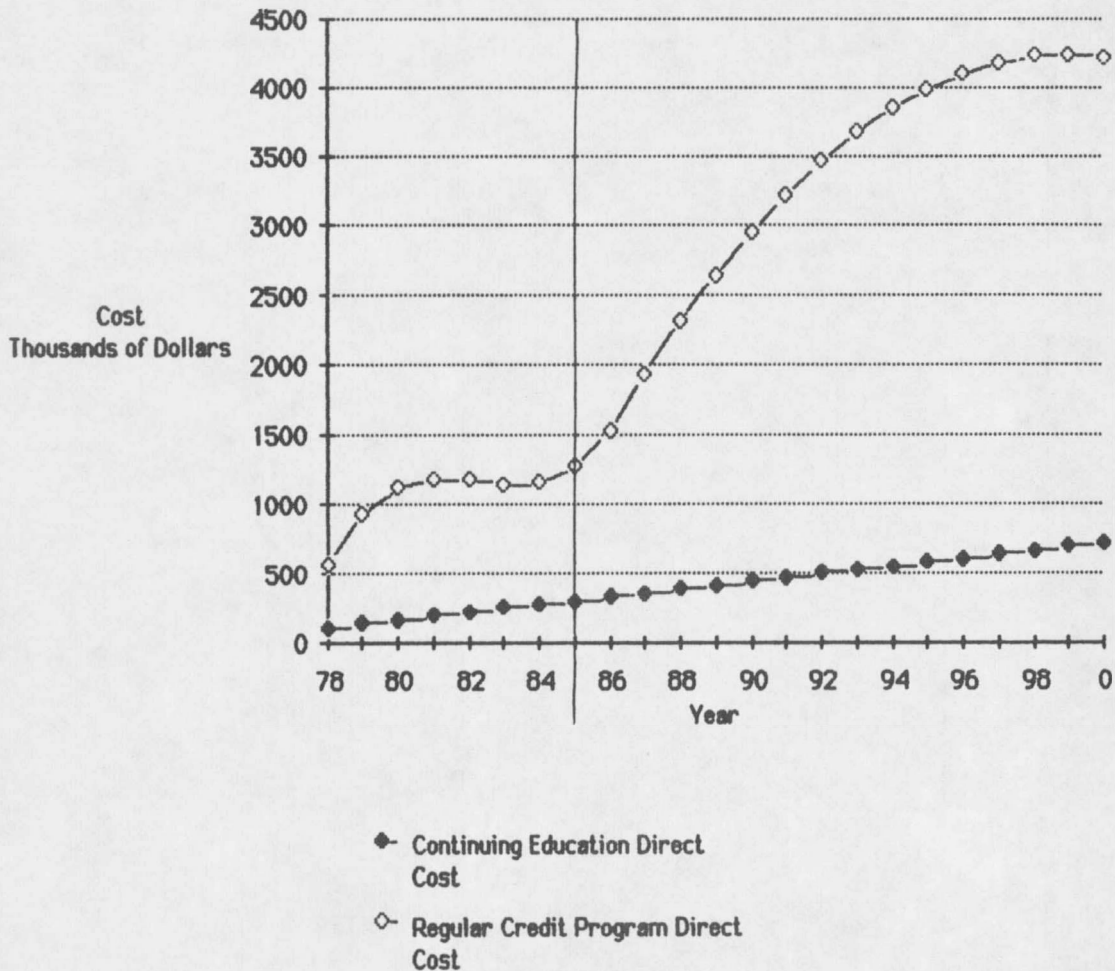
Management Issues

The simulations of the indirect cost model initially focused on cost behavior over time for the purpose of analyzing the historical data. The simulations were then extended in order to examine how indirect costs behave over a longer-range time period. Although the validity of the simulation projections have to be seriously questioned, the analysis of the model results provided information which might be significant as Wor-Wic Tech Community College develops management strategies to focus on long-range plans, and the tactics to move toward its goals over the shorter-range.

An issue which surfaced during this study is the effect which the growth of the continuing education program might have on the operation of Wor-Wic Tech as a degree granting, occupationally oriented community college. The final simulations of the indirect cost model showed a continuing education program which is growing in enrollment at a constant rate 1.16 times faster than the regular credit program. At the same time, the direct cost of the regular credit program has the potential to increase while the direct cost of the continuing education program has grown moderately and appears to be approaching a constant growth rate as illustrated in Figure 9. Of greater significance is the fact that the credit program is consuming the non-instructional resources, which translate to indirect costs, at a rate faster than continuing education as illustrated in Figure 10. A growth pattern in which the continuing program produces a substantial amount of the enrollment while the regular credit program consumes the bulk of the institutional resources appears to be developing beyond reasonable bounds. Such growth, if left uncontrolled, could cause Wor-Wic Tech to evolve into an institution whose primary purpose will have become the offering of credit-free adult continuing education courses and programs. An uncontrolled growth

Figure 9

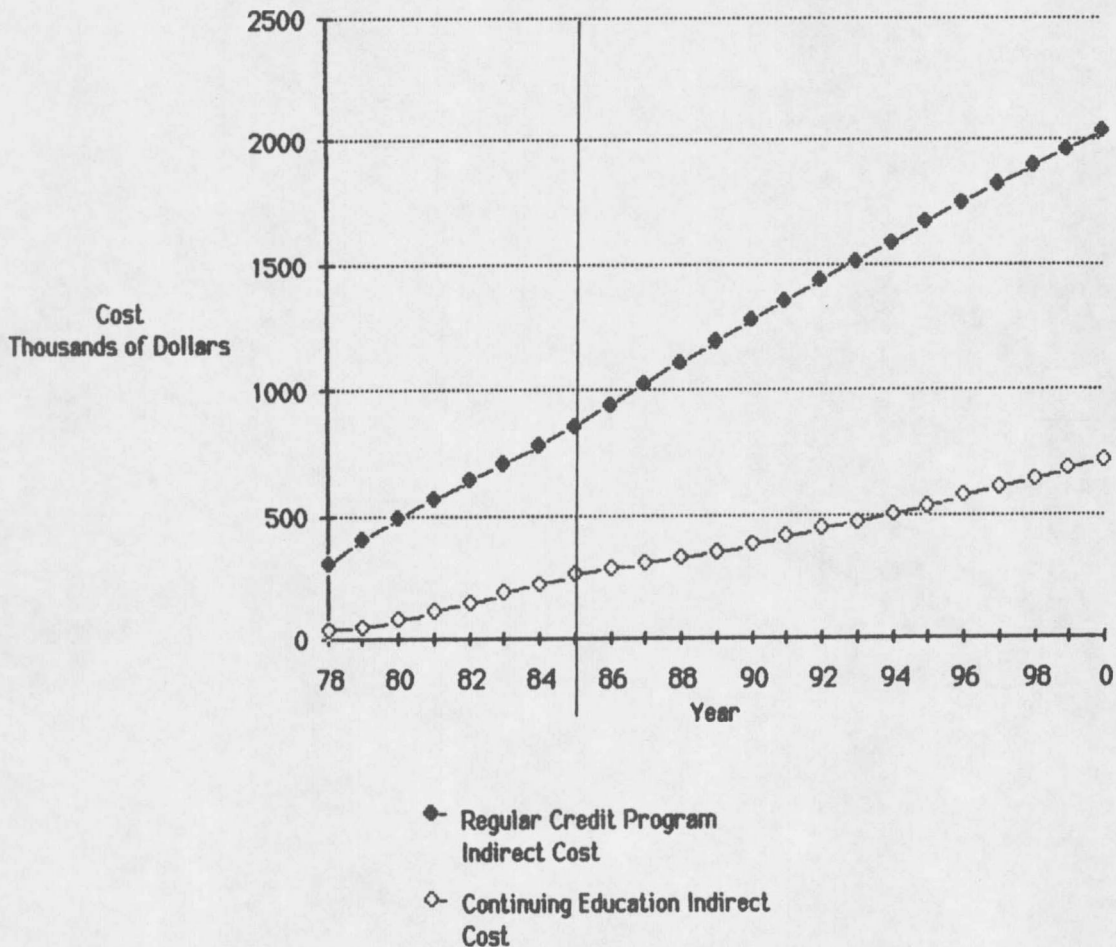
A Comparison of the Direct Cost of the Continuing Education Program to the Direct Cost of the Regular Credit Program from the Year 1978 to the Year 2000



Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

Figure 10

A Comparison of the Indirect Cost of the Continuing Education Program to the Indirect Cost of the Regular Credit Program from the Year 1978 to the Year 2000



Note: The period, 1978 to 1985, represents the actual costs. Beyond 1985 are the projected costs.

of the continuing education program might cause the primary state funding source, the Maryland State Legislature, to decrease state funding for non-credit courses. The Legislature might argue that adult continuing education is diluting the mission of the community college and might further argue that non-credit programs need to be self-supporting. Such a loss of funding to Wor-Wic Tech could be devastating, since, the data clearly indicate that the continuing education program operates at a low cost but is a strong revenue producer. One might say that, to a large extent, the continuing education program is and will continue to be responsible for keeping the College fiscally sound.

Wor-Wic Tech Community College can plan strategically by considering several tactics which will allow the non-credit and credit programs to grow in balance in terms of enrollment and cost. One, it can take the position of planning for moderate growth. Ceilings can be placed on the growth of the direct cost of the credit programs while growth in enrollment of the non-credit programs can be curtailed. A second approach, and one which has already been suggested by College officials, is an effort to improve the level of credit enrollments. A more aggressive approach to recruitment for the credit programs would allow the growth in the

size of the credit faculty to continue, and, in the long run, Wor-Wic Tech's critical mass problem would improve. One obstacle to such a plan, however, would be the imposition of funding ceilings per FTE by the Maryland State Legislature. A third plan for the College would focus on moderating continuing education enrollments.

The significance of indirect cost to this issue is that the systematic measurement of such costs will allow College officials to know more accurately how the operation of continuing education affects the entire College. Further, an extension of such indirect costing procedures to the credit programs and departments can help college officials monitor even more closely the cost and enrollment patterns in the regular credit program.

A college-wide issue, however, which is associated with the improvement of such costing procedures is the strengthening of the institutional research function at Wor-Wic Tech Community College.

A Strategic Management Tool

During the Fall 1985 semester, in response to a recommendation by a Middle States Association of Colleges and Schools reaccreditation team, the College's administration began the development of a new planning system. The team's recommendation was as follows:

It is recommended that planning activities provide for the early involvement of all appropriate constituencies including trustees, students, full and part-time faculty, support staff, administrators, alumni, and interested citizens. The planning process should include priority setting, action timetables, follow-up and evaluation, and a direct relationship to the budgeting process (Middle States Association of Colleges and Schools, 1985:5).

Under Wor-Wic Tech's new planning model, an administrative planning team serves as the central planning group and is responsible for integrating strategic planning, operational planning, and resource allocation by linking the work of the board of trustees, a college-wide planning council, a community advisory council, the support staff, academic departments, and the finance office. An important element to the success of such a system is the easy access to information which measures the health of the institution. At the present time, such an information system is not in place at the College and there is little evidence that the data bases which have been developed by the Maryland State Board for Community Colleges have been utilized by college personnel. In this regard, the Middle States team stated the following:

Furthermore, the College has an opportunity to utilize the internal assessments growing out of the Self-Study process as well as the data bases from the State Board for Community Colleges for use in its planning. The institutional research function,

however, is limited and will have to be strengthened to be effective.

The team further recommended the following:

It is recommended that the institutional research function of the College be strengthened and made more systematic (Middle States Association, 1985:6).

The allocation model which resulted from this study provides Wor-Wic Tech Community College with an institutional research tool which can be applied to any instructional department or program. The very fundamental measures of program cost and unit cost which are computed in the final model for this study have been non-existent at the College, but can be easily installed on the College's main computer system for any instructional department or program. In some cases, such technology is available at the department level. However, Wor-Wic Tech's institutional research problems are more serious than the lack of a few measures of institutional health or vitality. There has been no systematic effort to establish an institutional information system which will support strategic planning, operational planning and control, and resource allocation. The indirect cost model which was developed for this study, however, suggests a format for the development of a departmental or program cost model

which will interface with strategic and operational planning at the institutional and state-wide levels.

If such a model is to be effectively used by institutional managers, the model needs to be installed in a management information system which is accessible at the department level and above. Department heads, the Dean of Instruction, the college planning council, the finance office, and the administrative planning team should have access to the system. The indirect cost model which emerged from the study served as a prototype for the development of an information system which can focus on costs and the related cost measures for an instructional department or program. The development of the final indirect cost model was supported by the data bases which organized the data and information collected during the study. In the context of the planning structure at Wor-Wic Tech Community College which includes the longer-range strategic planning, the shorter-range tactical planning, and the routine operation of the institution, the management information system suggested by the study should be organized according to the following: (1) its data base, (2) the model equations, (3) the tools or programs to analyze the information produced by the system, and (4) a set of programs which link the data, equations, and tools.

The data base for the information system should be organized, as was the indirect cost model, according to the following schema of data: (1) the indirect cost pools, (2) the data required to compute the allocation ratios, (3) enrollment data, and (4) a description of the relationships between and among the data base records. Records or measures of the system variables are to be maintained for each fiscal year. The student affairs, plant operations and maintenance, general administration, general institutional, and departmental administration cost pools which were developed for this study proved to be effective and should be used to establish an initial set of cost pools. The data required to compute the allocation ratios, as was the case with the study model, should be organized according to a direct cost category and a space utilization category. The enrollment data should include institutional enrollment, enrollment for the program which is to be costed, total non-credit enrollments, and total credit enrollments. The data base should be supplemented by a description of the relationship between records or system variables as described in Chapter 3 of this dissertation.

The indirect cost model provides the definition of the model for the system. The information system variables should be re-defined for the program which is

to be costed. The tools or programs to analyze the information produced within the information system should include programs to graph data and compute simple statistics..

In order to apply and manage the information system effectively, computer technology should be used to: (1) store, retrieve, and update data, (2) provide directories of data organization, models, tools, and programs, (3) operate the computer system, and (4) interface the data with the models, tools, and programs.

In the Wor-Wic Tech Community College setting, such an information system can easily be modified to address new issues. Modifications can be made when issues emerge which have the potential to make an impact on the strategic planning and management processes. For example, while the final model which was developed for the study was the result of applying a set of validation procedures, the model was judged to hold validity for its purpose, to analyze and attempt to describe the indirect costing system for continuing education. However, in the context of the Wor-Wic Tech Community College accounting system, the system could be used to improve the expenditure reporting system to include a tiered approach to costing as suggested by NACUBO (1982). While the current expenditure reporting system at the College

includes the tier one costs, direct costs, it does not include the tier two costs, indirect costs. The proposed system includes tier two costs. If tier three costs, depreciation or special facilities use charges are needed, the indirect cost model can easily be expanded to include equations which compute such costs.

Statewide Implications

The analysis of the indirect cost system at Wor-Wic Tech Community College suggested that the assumption model does not hold validity at other Maryland community colleges. If the management of continuing education programs at other institutions focuses on low personnel costs and high enrollments, then the use of the enrollment ratio to calculate indirect cost is not appropriate, as was the case at Wor-Wic Tech. If the enrollment ratio is not valid for continuing education programs, then it would not be valid for the regular credit program; as a whole, since if indirect costs are over allocated to continuing education, then they will be under allocated to the regular credit program. If the enrollment ratio is applied to the individual credit programs or departments then, it should calculate reasonable indirect costs for all of the programs or departments. However, unless enrollment levels and direct

costs are homogeneous over all of the credit programs of a college, it would appear that the enrollment ratio could not possibly compute reasonable indirect costs for all of the programs. While one cannot prove exactly if indirect costs have been calculated correctly, any user of indirect cost information should have confidence that the overall amount which has been allocated to a program or department is, at the least, reasonable. The assumption model which proved to be ineffective in the Wor-Wic Tech setting would likely be ineffective at other institutions.

Summary

A final indirect cost model for the continuing education program at Wor-Wic Tech Community College was developed and simulated over the time period, the year 1978 to the year 2000. The results of the simulations were analyzed for the management structure at the College.

It was recommended that the College examine the impact of growth of the continuing education program in order to determine how such growth will affect the future direction of the institution. Evidence surfaced which indicated that the College may be evolving into an institution whose primary mission will become the

offering of adult continuing education services. Several strategies were presented which might allow the College to prevent such a development.

A plan was presented whereby Wor-Wic Tech can begin to develop its institutional research function by expanding the indirect cost model into a management information system. The system should include a data base and a set of tools to process and analyze the data and information produced by the system.

Finally, a question was raised about the validity of the use of the enrollment ratio at other community colleges to compute indirect costs. It was determined that such use is clearly ineffective.

Chapter 6

SUMMARY AND DIRECTIONS FOR FURTHER RESEARCH

The problem of the study was to develop a model of the indirect cost system for the continuing education program at Wor-Wic Tech Community College. The model which was developed for the study addressed the following topics at the College: (1) the determination of the indirect cost of the continuing education program for a fiscal year, (2) the relationship between enrollment patterns at the College and the indirect cost of continuing education, (3) the effect of college-wide costs on the indirect cost of the continuing education program, (4) the relationship between the direct cost of instruction and the indirect cost of instruction, and (5) the relationship between the indirect cost of the regular credit program and the indirect cost of the continuing education program. An attempt was made to develop a model which described the behavior of the indirect cost system over time.

Summary

A "two-model" approach was used in the study. An initial indirect cost model, which was based on the indirect costing procedures which are recommended by the Maryland State Board for Community Colleges, was developed. The model described the financial system at Wor-Wic Tech Community College in terms of the above issues for the years 1977 through 1985. The model computed the indirect cost of continuing education as the ratio of the continuing education enrollment in FTES to the total enrollment of the College in FTES times the indirect cost of instruction. To motivate the development of the model, it was hypothesized that such a simplistic approach to indirect costing would validly compute indirect costs. However, in order to validate the initial model, a second model was developed for the same time frame which allocated indirect costs from the following indirect cost pools: (1) plant operations and maintenance, (2) student affairs, (3) general administration, (4) institutional administration, and (5) departmental administration. Plant operations and maintenance was allocated by the square feet of space used by the continuing education program to the square feet of space used by all of instruction. Student

affairs was allocated as an estimated percent of use. The general administration, the institutional administration, and the departmental administration cost pools were allocated by the ratio of the direct cost of the continuing education program to the direct cost of the instructional program. Both models were simulated on a computer using institutional data for the years 1977 to 1985.

The results of the historical simulations were used to address Question 1 of the study, what is the indirect cost of continuing education for a fiscal year at Wor-Wic Tech Community College? A comparison of the results from both models, as presented in Table 1, indicated that the assumption model produced consistently overinflated indirect costs because the single enrollment ratio which computed such indirect costs did not, in all cases, reasonably represent how the continuing education program consumes other college resources. In one case, it did not take into account the low volume of use of the student affairs function by the continuing education program. It also did not take into account the significantly different way in which the continuing education program generates direct costs as compared to the regular credit program. It was found that the direct cost of the continuing education program per FTES

generated by the program was significantly less than the direct cost of the regular credit program per FTES generated by that program. The failure of the enrollment ratio of the assumption model to account for such factors caused the model to compute the overinflated indirect costs. It was, therefore, determined that the assumption model would not validly represent the indirect costing system at the College.

However, to continue to address the study problem, the indirect cost model was developed from the structure of the allocation model. Specifically, an attempt was made to address Question 2 of the study, what is the relationship between enrollment patterns and the indirect cost rate of continuing education? While the final model did not describe a link between enrollment patterns and indirect cost, an examination of the correlation matrix of the assumption model variables showed some correlation between continuing education enrollment and the indirect cost of continuing education. An examination of the correlation matrix of the assumption model variables revealed that there was a pattern of high correlation between the enrollment variables and the other system variables. However, no evidence was found which would explain a link between enrollment and indirect cost. Therefore, it was judged

that the indirect cost system could be effectively described without a mathematical link to enrollment patterns.

The analysis of the allocation model addressed Question 3 of the study, how does the rate at which college-wide costs are generated affect the indirect cost of continuing education at Wor-Wic Tech Community College? While, during the initial stages of the study, the allocation model was judged to compute indirect costs validly since it was based on university models which compute indirect costs, the development of the study reinforced the confidence placed in the allocation model. It appeared to address the shortcomings of the assumption model because it allocated the indirect costs of a program or department from cost pools whose allocation formulas were based on the use of the services of the function which the cost pool represented. The cost pools represented the college-wide costs.

The analysis of the allocation model also addressed Question 4 of the study, what is the relationship between the direct cost of instruction and the indirect cost of instruction at Wor-Wic Tech Community College? According to the allocation formulas of the cost pools, the total expenditures of a college can be divided into two categories as follows: (1) those

expenditures which are reported under the instructional function, and (2) those which are reported under the non-instructional function. From category one, the direct costs and some indirect costs are derived, and from category two, the major share of indirect costs are derived. The matter of determining the indirect cost of an instructional program or department then becomes one of allocating from well-defined cost pools the reasonable share of indirect costs to the program or department, as does the allocation model.

The results from the allocation of the cost pools addressed Question 5 of the study, what is the relationship between the indirect cost of regular academic instruction at Wor-Wic Tech Community College and the indirect cost of its continuing education program? The indirect cost of regular academic instruction, referred to as the regular credit program indirect cost, was judged to be validly determined as the difference between the sum of the cost pools and the indirect cost of continuing education as illustrated in Figure 2.

Since the study also attempted to address how indirect costs are generated over future time, the allocation model was simulated into future time. The results of the simulations, which were analyzed and

presented in Chapter 5, were used to address Question 6 of the study, how might future enrollment and expenditure patterns affect the indirect cost of continuing education at Wor-Wic Tech Community College? Although the study failed to establish a mathematical link between enrollment patterns and the costs associated with the determination of indirect costs, several enrollment variables were added to the final model in order to examine cost trends in relationship to the enrollment patterns. The following output measures for the continuing education program and the regular credit program were added to the final model: (1) the direct cost per FTE, (2) the indirect cost per FTE, and (3) the full cost per FTE. Despite the limitation that such enrollment variables were independent of the allocated indirect cost system, they provided an intuitive idea of how future enrollment and expenditure patterns might affect indirect cost in the context of the management structure. The behavior of the enrollment based variables were presented in Figures 3, 7, and 8. It was found that if the current enrollment and expenditure patterns continue, then the indirect cost of continuing education will stabilize to a pattern of very moderate growth.

Finally, the study model was analyzed to address Question 7 of the study, how can the dynamic behavior of the indirect consumption of resources by the continuing education program at Wor-Wic Tech Community College be described? In a more general sense the final model provided a basis from which to attempt to determine how the indirect cost system might behave over a long-range time period. However, in this regard, the final model was limited. The failure to establish more links between system variables required that they be examined independently over time. Although the analysis was quite rigorous, in the end, much of the future behavior of the system was left up to the judgment of the modeler.

Despite such limitations, it was determined that the primary variables of the indirect cost system, the cost pools and allocation ratios, are growing linearly. The direct cost of instruction, however, appears to have the potential to accelerate due to the need to substantially expand the number of faculty and instructional services.

In terms of the management structure of Wor-Wic Tech Community College, the analysis of the indirect cost system raised several important issues. First, the model demonstrated how an understanding of the financial status of an instructional program can contribute to the

understanding of the financial condition of the institution. In the case of Wor-Wic Tech Community College, the computation of the full cost of continuing education, which was possible because indirect costs were computed, provided concrete information about how such a program supports the institution. After the study model was simulated, there was no doubt that the continuing education program operates at a low-cost but produces substantial revenues. If the model were to be expanded to examine the other instructional programs, then the understanding of the financial system would be further enhanced.

A second issue which was raised by the study was the role of institutional research at the College. It was recommended that development of the institutional research function be initiated by establishing a program cost information system for all instructional programs. The allocation model could be integrated with the College's accounting system to form a system of cost data bases.

Perhaps the most significant management issue which was raised by the study was the relationship of the growth of the continuing education program to the growth of the regular credit program. Financial projections, in relationship to enrollment patterns, revealed that there

is the potential for the continuing education program to substantially strengthen its role of providing non-credit, occupational training for the adults in Wicomico and Worcester Counties in Maryland. However, there also appeared to be potential for this role to overshadow the primary mission of Wor-Wic Tech Community College to offer two-year degree programs. It would be difficult to discourage such growth since the continuing education program provides strong fiscal support to the College. However, a function of the continuing education program should not be to offset the higher indirect costs of the regular credit programs. Several management strategies were suggested which might allow the College to continue a meaningful non-credit program and, at the same time, develop the regular credit programs.

Directions for Further Research and Development

The study suggested several directions for indirect cost research in higher education. However, the study also suggested the need for the continued development of an indirect cost model for application in the Maryland community college system.

The indirect cost model at Wor-Wic Tech Community College can be further developed by applying it as a management tool. Under such an application, more

information about how the continuing education program consumes resources would be obtained. For example, the model for this study excluded the concept of cross-allocation which would transfer parts of one cost pool to another cost pool. For example, if a function of student affairs is administrative in nature, such as the management of computer systems, then such costs might be more reasonably allocated from an administrative cost pool than from the student services cost pool. The concept of cross-allocation of cost pools was not considered in this study due to the extensive time frame of the model and the corresponding data which was collected. Another factor which could affect the computation of indirect costs, but was not addressed in the model is depreciation of equipment. However, it might be important to know how such processes affect the computation of indirect costs at Wor-Wic Tech Community College. Related to the refinement of the indirect cost model is the question of how much rigor is needed in the computation of indirect costs in a small college. If the indirect cost model is further developed, then such questions can be addressed in a qualitative sense.

Another way in which the study model could be further developed is to apply it to other instructional programs at Wor-Wic Tech Community College as was

suggested in Chapter 5. Valid information about the full cost of programs would then be available. Judgments could be made about the need for such information in a small college setting.

Although the study examined only one program at Wor-Wic Tech Community College, the results from the analysis of the assumption model clearly suggested that the State of Maryland needs to examine its method of determining indirect costs. An indirect cost model based on the allocation of cost pools would allow other colleges to identify indirect costs more effectively.

In a more general sense, the study suggested the need to examine indirect cost as a theoretical, financial system. Even in the accounting literature where much has been reported about indirect cost, most research has focused on the reasonableness rather than the exactness of the allocation process. For those who attempt to understand indirect cost in higher education, most appear to accept the view of Woodrow as stated in 1976:

The computation and application of indirect costs (rates) are clearly not an exact science. Nor are they exact in the sense that accounting is usually exact. A form of the scientific method is necessary to understand them, since each bit of costs, whether direct or indirect, has an interacting effect upon other types of costs. The maze, as it has been called earlier, can only be penetrated to the end if careful attention is paid to the steps along the way (1976:7).

However, early in the development of the model for this study an attempt was made to describe indirect cost in terms of feedback loops which would suggest that the effects of one cost upon another could be mathematically isolated. While the effort was not successful, the systems and modeling approach to understanding cost behavior appeared to present some potential for addressing this problem. Although theory does not often match up with reality, it might be possible to develop theoretical systems which will shed more light on the behavior of indirect cost systems.

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APPENDICES

APPENDIX A
DATA FOR THE ASSUMPTION MODEL

Table 7

Data for the Assumption Model

FISCAL YEAR	INSFTE (ftes)	CEFTE (ftes)	CERCR (ratio)	ISTRDCA (dollars)
1977	246.70	143.20	.5805	294,754
1978	318.77	71.37	.2239	691,954
1979	344.39	101.69	.2953	1,101,125
1980	437.20	165.43	.3784	1,187,332
1981	485.45	188.01	.3873	1,328,859
1982	538.24	219.47	.4078	1,424,524
1983	607.45	258.25	.4251	1,138,980
1984	708.72	273.98	.3866	1,283,358
1985	665.50	272.97	.4102	1,297,012

Key:

INSFTE - Institutional enrollment
CEFTE - Continuing education enrollment
CERCR - Resource consumption ratio
ISTRDCA - Direct cost of instruction

Table 7 -- Continued

FISCAL YEAR	INSDC (dollars)	ISTRICA (dollars)	CEINCA (dollars)	CEDCA (dollars)
1977	615,379	320,625	186,111	93,517
1978	964,582	272,628	61,039	133,990
1979	1,507,291	406,166	119,931	112,903
1980	1,708,325	520,993	197,136	123,653
1981	1,925,271	596,412	230,984	162,093
1982	2,135,477	710,953	289,895	174,942
1983	1,830,475	691,495	293,981	240,258
1984	2,178,306	894,948	345,973	284,207
1985	2,286,643	989,631	405,920	294,742

Key:

INSDC - Institutional direct cost
 ISTRICA - Indirect cost of instruction
 CEINCA - Indirect cost of continuing education
 CEDCA - Direct cost of continuing education

Table 7 -- Continued

FISCAL YEAR	CEFCA (dollars)	CEICRA (rate)
1977	279,628	1.9901
1978	195,029	.4556
1979	232,834	1.0622
1980	320,789	1.5943
1981	393,077	1.4250
1982	464,837	1.6571
1983	534,239	1.2236
1984	630,180	1.2173
1985	700,662	1.3772

Key:

CEFCA - Full cost of continuing education
CEICRA - Continuing education indirect cost rate

APPENDIX B
DATA FOR THE ALLOCATION MODEL

Table 8

Data for the Allocation Model

FISCAL YEAR	POMCP (dollars)	GICP (dollars)	GACP (dollars)	DPACP (dollars)
1977	0	163,021	97,291	22,100
1978	0	131,270	75,685	44,689
1979	0	183,326	167,868	56,677
1980	86,776	139,123	147,627	61,674
1981	147,088	239,498	91,652	74,694
1982	200,320	280,757	124,034	85,539
1983	236,509	203,959	96,486	105,063
1984	345,537	230,262	139,852	124,098
1985	346,199	269,524	142,422	135,508

Key:

- POMCP - Plant operations and maintenance cost pool
- GICP - General institutional cost pool
- GACP - General administration cost pool
- DPACP - Departmental and program administration
cost pool

Table 8 -- Continued

FISCAL YEAR	SSCP (dollars)	CESQF (sq ft)	ISSQF (sq ft)	SURAT (ratio)
1977	60,313	2,769	15,439	.1794
1978	65,673	2,769	15,439	.1794
1979	54,972	2,769	15,439	.1794
1980	147,467	13,080	35,731	.3661
1981	118,174	13,080	35,731	.3661
1982	105,842	18,424	43,055	.4279
1983	154,541	18,424	43,053	.4279
1984	179,297	19,233	48,295	.3982
1985	231,486	18,847	50,466	.3735

Key:

SSCP - Student affairs cost pool
 CESQF - Continuing education space use
 ISSQF - Instructional space use
 SURAT - Space use ratio
 sq ft - square feet

Table 8 -- Continued

FISCAL YEAR	CEDC (dollars)	ISDC (dollars)	DCRAT (ratio)	SSRAT (ratio)
1977	93,517	294,754	.3430	.025
1978	133,990	691,954	.2070	.025
1979	112,903	1,101,125	.1081	.025
1980	123,653	1,187,332	.1098	.025
1981	162,093	1,328,859	.1292	.025
1982	174,942	1,424,524	.1307	.025
1983	240,258	1,138,980	.2324	.025
1984	284,207	1,283,358	.2452	.025
1985	294,742	1,297,012	.2538	.025

Key:

CEDC - Direct cost of continuing education
 ISDC - Direct cost of instruction
 DCRAT - Direct cost ratio
 SSRAT - Student affairs ratio

Table 8 -- Continued

FISCAL YEAR	CEINC	RCPIC	ISTRIC	ADMCP
	(dollars)	(dollars)	(dollars)	(dollars)
1977	98,372	244,353	342,725	282,412
1978	53,735	263,582	317,317	251,644
1979	45,464	417,379	462,843	407,871
1980	73,727	508,940	582,667	348,424
1981	109,251	561,855	671,106	405,844
1982	152,429	644,063	796,492	490,330
1983	199,305	597,253	796,558	405,508
1984	263,251	755,795	1,019,046	494,212
1985	274,000	851,139	1,125,139	547,454

Key:

- CEINC - Continuing education indirect cost
- RCPIC - Regular credit program indirect cost
- ISTRIC - Indirect cost of instruction
- ADMCP - Administrative cost pool

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