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

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.

A DYNAMIC MODEL OF THE INDIRECT COST OF CONTINUING EDUCATION IN A MARYLAND PUBLIC COMMUNITY COLLEGE

by

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APPROVAL

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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

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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 (Baldridge 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 (Baldridge 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.