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ABSTRACT

A planning model incorporating the concepts of Planning, Programming, and Budgeting Systems (PPBS) was developed in the Duluth, Minnesota public school system to assist in the consolidation of federally funded programs in the district, especially those under the Elementary and Secondary Education Act (ESEA) Title III. A cost effectiveness model for program review and evaluation is described, and the procedures for determining costs and measures of student progress in various domains are presented. Examples of the analytical flow of the model together with examples of the worksheets used for the analysis are provided. (DGC)

A PLANNING MODEL AND COMPLIMENTARY COST-EFFECTIVENESS MODEL FOR INDIVIDUALIZED EDUCATION PROGRAMS

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American Educational Research Association
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PART 1

THE USE OF MANAGEMENT TECHNIQUES IN DEVELOPING AN EDUCATIONAL PLANNING MODEL WHICH COMPLIMENTS COST-EFFECTIVENESS ANALYSIS

DULUTH CONSOLIDATED GRANTS AND PROGRAM MANAGEMENT PROJECT
E.S.E.A. TITLE III
DEPARTMENT OF PLANNING AND EVALUATION
DULUTH PUBLIC SCHOOLS
DULUTH, MINNESOTA

MANAGEMENT TECHNIQUES APPLIED TO THE DEVELOPMENT OF A PLANNING MODEL FOR EDUCATIONAL PROGRAMS

DULUTH CONSOLIDATED GRANTS AND PROGRAM MANAGEMENT PROJECT
E.S.E.A. TITLE III
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DULUTH PUBLIC SCHOOLS
DULUTH, MINNESOTA

I. INTRODUCTION

During the Spring of 1973 the Duluth Public School System was awarded a Title III, E.S.E.A. grant to assist in the consolidation of Federally funded programs. The desire for consolidation led to the need for a management information system which could:

1.) Assist in the coordination of planning efforts directed at developing a consolidated funding proposal.

2.) Assist in managing the implementation of the consolidated programs funded.

3.) Standardize the information flow between program planning and program implementation activities for the purpose of developing educational and cost-effectiveness measures.

This paper describes the management techniques used to develop the planning model for consolidating the funding of Federal programs. The initial application of the model was limited. Since that time it has experienced wider use by the Duluth Public Schools and the Minnesota State Department of Education.

The initial step in developing the planning model was the identification of data components i.e., needs assessment, educational objectives, program description, resource specification, budget specification and evaluation design. After the components had been identified the informational makeup of each component was specified. A review of the literature produced by State Education Agencies involved in the Interstate CoGraM Project begun in 1972 and a review of other educational management systems helped establish the components as well as the informational makeup of each component.

Once the components and their make-up had been established it was necessary to determine:

1.) The sequence of data components within the model.

2.) The sequence of activities for the collection, treatment and reporting of data both within and between components.

3.) A schedule by which the planning effort would be facilitated.

The needs just identified were not resolved in the initial reviews. Further review (Hartley, 1968 and 1972; Cook, 1967) provided the desired input on technique. This made possible the finalization of the model portrayed in Figure 4 of the Appendix.

Sequencing and scheduling the flow of information within the model was accomplished with the following techniques:

<u>Dependency Network</u> (<u>workbreakdown structure</u>) - A technique

which combines system analytic and synthesizing procedures with the flow-graph concept of nodes and branches. The resulting network which is graphically illustrated provides a sequence and relationship between component tasks, events and/or products which can be used for scheduling purposes.

Flow Graph Methodology ("flow charts") The technique of displaying graphically the operations that a system performs upon the information it processes.

System Analysis - The process of breaking down a system into its primary components (subsystems) for the purpose of more clearly defining each component in terms of the tasks, activities, events and products required for fulfillment.

System Synthesis - The process of examining the defined characteristics of each component of the system in terms of tasks, activities, events and products for the purpose of providing a logical and orderly relationship between the components (subsystems) of the system.

II. APPLICATION OF THE MANAGEMENT TECHNIQUES

This section of the paper explains in a step by step manner how management techniques were applied in finalizing the planning model. Reference is made to the Appendix which contains an example of the product obtained in each step.

Step 1: A planning sequence was hypothesized for the purpose of doing systems analysis. Please note Figure

1 in the Appendix.

Step 2: Systems analysis was applied to each component of the hypothesized planning sequence. This analysis identified: 1.) activities needed to collect, treat and report data within each component 2.) the person responsible for the completion of each activity. 3.) the resources required for activity completion 4.) the product resulting from the activity and 5.) the critical date for completion of the activity. Please note Figure 2 of the Appendix. The reader should realize that the activity sequence and critical date were finalized after completion of the workbreakdown structure.

Step 3: Flow charts for each component were developed from the activities identified through systems analysis. This was the first step in synthesizing the system. These flows were initially treated as tentative. Their validity was proven upon incorporation into the work-breakdown structure. Please note the flow chart displayed in Figure 3 of the Appendix.

Step 4: This step involved finalizing the sequence of activities in each component and determining the points of interface between components. This was the second phase of systems synthesis and resulted in the workbreakdown structure.

A final sequence was accomplished by first typing each of the identified component activities onto a slip of paper. Each activity slip was color coded. Color coding was based on the original assignment made in Step 3. The activity slips were grouped by component and placed in the sequence previously established. Each activity was re-examined in terms of the information required for its completion and its informational output for that component. Each activity was also examined as to whether it required information from or produced information needed in another component. Those activities relating to other components became points of interface between components.

The information flows established within and between components provided the base for finalizing the activity sequence within each component and the component sequence within the model. The time schedule for program planning was established at this time. The workbreakdown structure produced by this step is not included in the Appendix because of the difficulty experienced in its reproduction.

Step 5: A summarization of the component interfaces established when developing the workbreakdown structure provided the basis for the final design of the planning model. This model is Figure 4 in the Appendix.

III. SUMMARY

The final design of this planning model reflects three sources of input. These include: 1.) the use of management techniques in its development 2.) the keynote nature of student needs assessment data and 3.) constructs associated with P.P.B.S.

Application of management techniques served to specify intra and inter component structures. The techniques facilitated the integration of the component into a system and helped establish a schedule for its application.

The importance of communicating student data to all decision makers involved in the planning process was based on an inherent danger which exists among planners. Systems analysis and synthesis, P.P.B.S., and management information systems are used by personnel removed from the instructional process. The tendency can exist to process administrative functions with disregard for the available student data. The design of this planning model stresses the need to consider the relationship of current student data to the data of the other components.

The rationale for including P.P.B.S. constructs is best stated by Hartley, 1972:

> "In competing for public funds educators are now being challenged to justify their budgetary requests in terms of student achievement rather than with costs of objects and services".

This rationale has been adopted by the Duluth Public Schools. This fact and the advantages provided by P.P.B.S. constructs for program evaluation led to their inclusion in the planning model.

Application of the planning model resulted in the use of consistent measures of student progress during the needs assessment, monitoring and evaluation processes. These measures combined with the cost data obtained by applying P.P.B.S. constructs made it possible to produce a useable data base for determining measures of cost-effectiveness. The cost-effectiveness model which serves as a base for applying these measures is explained in the second part of this paper.

MANAGEMENT TECHNIQUES USED IN EDUCATIONAL PROGRAM PLANNING MODEL

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INITIAL DESIGN FOR THE DEVELOPMENT OF A CONSOLIDATED GRANTS PROPOSAL TO OBTAIN FUNDING FOR FISCAL YEAR 1975

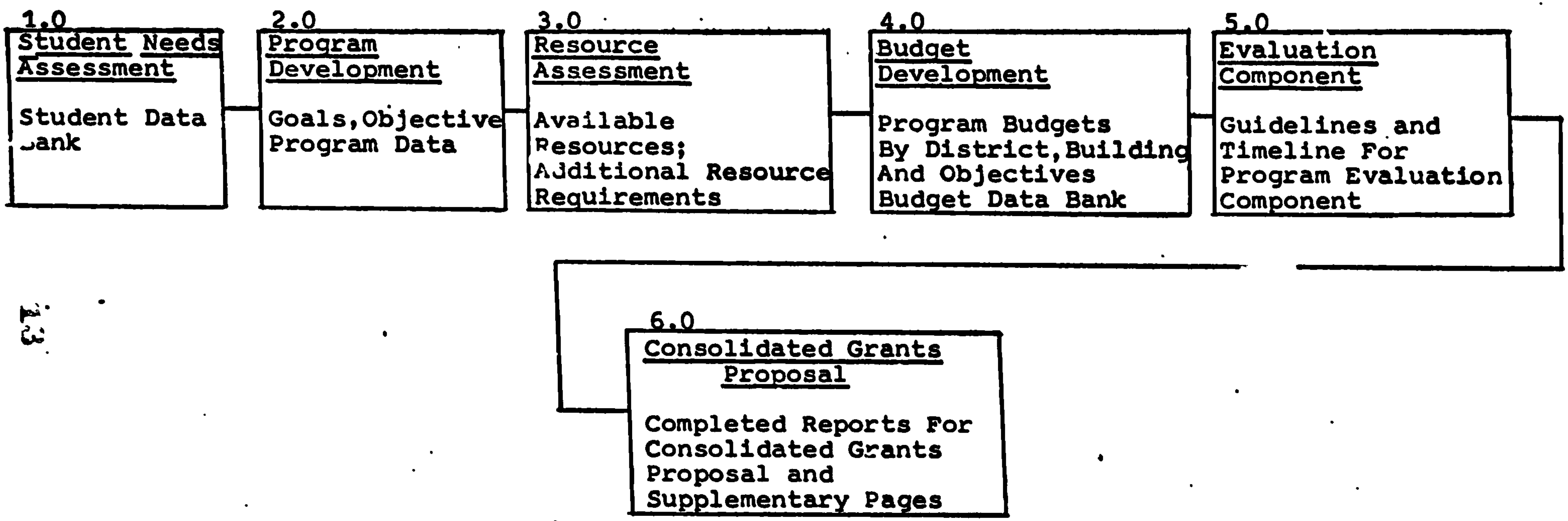

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Figure 1

RESULTS OF SYSTEMS ANALYSIS

1.0 Analysis of student needs assessment process in terms of major responsibility, resources required, product and date of completion.

1.01 Identification of student needs assessment information required by funding agencies completed.

A. Major responsibility: Director of Planning and Evaluation

B. Resource requirements:

1. Time of administrative personnel - central office
2. Secretarial time
3. Office supplies

C. Product: Source document indicating specific information required in terms of funding guidelines

D. Date of completion: 1-21-74

1.02 Development of criterion and method of analysis for examination of student needs completed.

A. Major responsibility: Director of Planning and Evaluation

B. Rescurce requirement:

1. Time of administrative personnel - central office and building
2. Time of instructional personnel
3. Secretarial time
4. Office supplies

C. Product:

1. Designation of measurement instruments

Figure 2

1.0 DEVELOPMENT OF STUDENT DATA BANK AND APPROPRIATE COLLECTION AND REPORTING DOCUMENTS

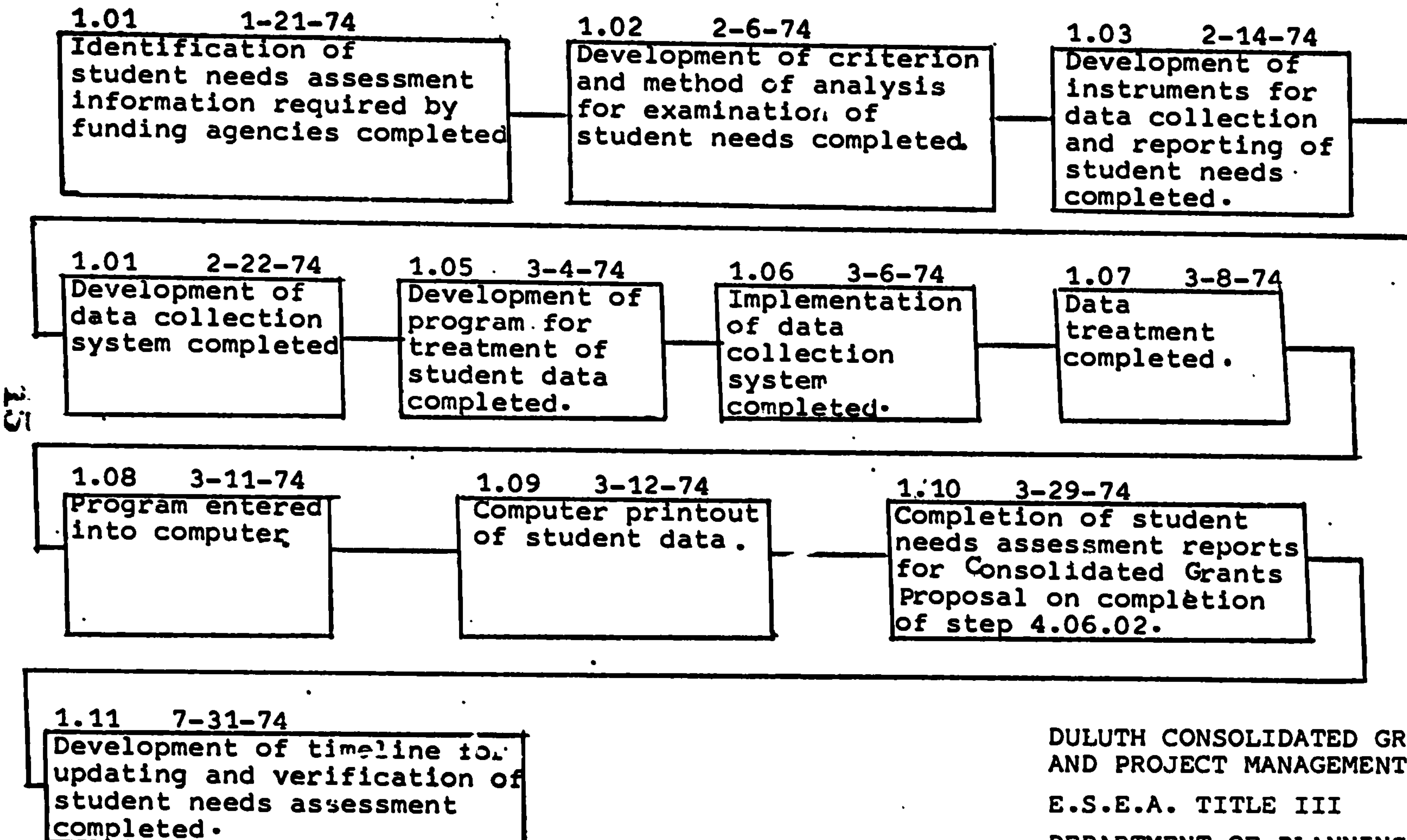

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Figure 3

FINAL DESIGN FOR THE DEVELOPMENT OF A CONSOLIDATED GRANTS PROPOSAL TO OBTAIN FUNDING FOR FY 75

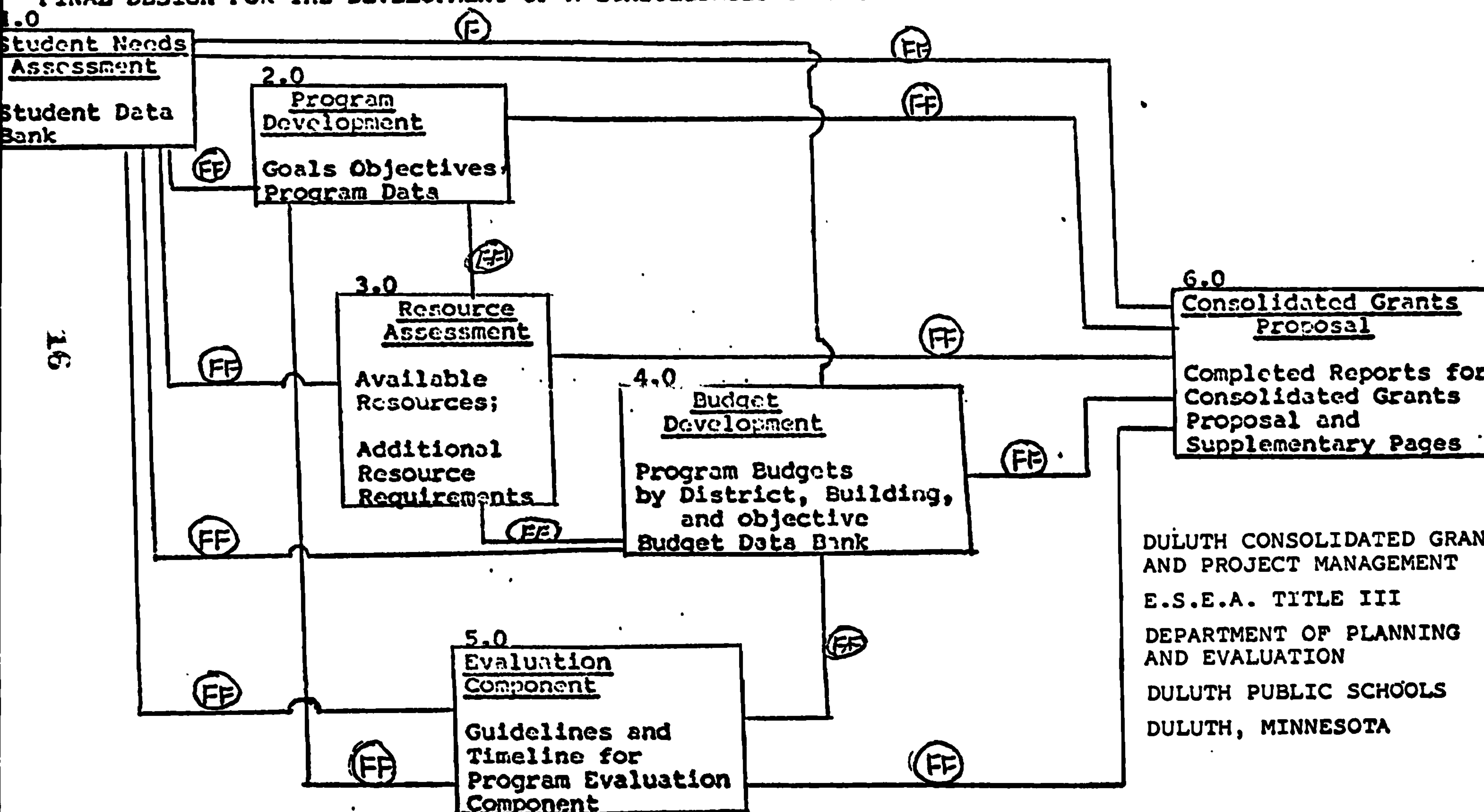

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Figure 4

PART 2

A COST-EFFECTIVENESS MODEL FOR EDUCATIONAL PROGRAMS

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I. INTRODUCTION

The initial intent of this management system was to coordinate the use of educational resources provided by more than one categorical aid. This led to a need for measures of effectiveness which would assist in determining whether or not coordination improved the capabilities of the affected programs to meet the identified needs of children. A second and even more pressing purpose for determining effectiveness was based upon the need for improving the allocation of educational resources in light of the recent financial crunch facing education.

Initial Project efforts centered on the development and implementation of a student information base to assist in the management of E.S.E.A. Title Programs. This base was and is being used to determine the educational effectiveness of these programs.

The stated concern regarding the ability of this management system to affect instructional decisions and in turn improve student performance resulted in a decision to expand upon the measures of effectiveness within the system. This decision resulted in a review of the literature relating to cost-effectiveness.

The review provided considerable assistance in helping isolate and define numerous variables that would have to be dealt with in developing a cost-effectiveness model. It also exposed some weaknessess that needed correction before a meaningful data base could be established for comparing cost changes incurred when altering the mix of resources to attain a specific educational objective.

The patterns of weakness most evident as a result of the review were:

1. The use of gross measures as indicators of educational effectiveness, i.e., student hours or quantity of students served.
2. Inability of numerous models to define the value added resulting from the instructional process.
3. Failure to carry out process and task analysis, i.e., specify the production function for the purpose of refining the analysis of costs.
4. Failure to apply those economic constructs necessary for a meaningful determination of opportunity cost.

Points 1 and 2 above were resolved as a result of the Project's initial efforts in defining a student information base. Research and the application of this research provided a more exact measure of student progress within the programs under analysis. The use of consistent measures during the needs assessment, monitoring and evaluation processes provided a consistency necessary for determining value added.

Points 3 and 4 identified as a result of the literature review denoted the need for an improved cost data base which could be used in combination with the student data base to provide cost-effectiveness measures. The remainder of this paper will center on the constructs and relationships adopted for use in determining the desired cost data, output-input relationships and output-cost relationships needed to determine educational program cost-effectiveness.

The following terminology will be used throughout this report.

Average cost - Total cost divided by total output. Average outlay cost does not include the cost of missed opportunity.

Downward Sloping Demand - The number of consumers for a product remains relatively constant with increases or decreases in product cost.

Fixed cost - A cost that does not vary with output.

Full cost (Total cost) - Variable costs + Fixed costs + Opportunity cost.

Least Cost Principle (Law of Diminishing Returns) (Law of Variable Proportions) - At a certain point in a production function the addition of one additional unit of a variable resource to a set of fixed resources will cause a decline in output.

Long Run - That period of time during which all costs are variable.

Marginal cost - The increase in total cost divided by the increase in output.

Natural Monopoly - A market situation in which a vitally important product is provided by one firm because competition would be wasteful.

Opportunity cost - Cost defined as a missed opportunity; a potential for well being not achieved.

Out Cost - A cost that does not include the cost of missed opportunity.

Output-cost relationship - Total output divided by total outlay cost for the purpose of determining average outlay cost.

Output-input relationship - Total output divided by the total amount of a specific input expended in its production for the purpose of determining the average output per unit of that input expended.

Production function - The relationship between the inputs (resources) and outputs of an instructional program. It is a flow of inputs resulting in a flow of outputs during some period of time.

Short Run - That period of time during which costs are either fixed or variable.

Variable cost - A cost that varies with output.

II Assumptions

Prior to the development and application of the model a number of assumptions were made to solidify the applicability of those constructs and relationships in the model. Each assumption related to one of the following areas of concern: 1.) Inputs (student) 2.) Inputs (resource) 3.) The production function 4.) Outputs (student progress) 5.) Cost analysis and 6.) Output-input and output-cost relationships. Inputs (student) and outputs (student progress) relate to measures of educational effectiveness. This area of concern is addressed in this section of the paper but has not been expanded upon in Section III which describes the model. A definition of the educational effectiveness measures incorporated into this model can be found in a paper presented by Roger M. Giroux at the American Educational Research Association Annual Meeting of 1975.

The assumptions of this model by area of concern are:

1.) Inputs (student)

a.) The inputs (student) are measurable and can be quantified.

b.) The inputs (student) are defined at the beginning of the program year through a needs assessment process.

c.) Educational programs relate to a downward sloping (less than elastic) demand, i.e., State statutes require school attendance through the age of sixteen (16), the lack of a substitute product exists and, in certain cases, guidelines provided by the State Department of Education specify those eligible for inclusion in the program.

2.) Inputs (resource)

a.) The identified inputs (resource are"real" inputs to tasks and processes of the program under analysis.

b.) The inputs (resource) required for carrying on the defired processes can be identified at the beginning of the program year, are measurable and can be quantified.

c.) Each identified unit of input (resource) will initially be considered homogeneous. (Further study is needed to refine the criteria for clarifying this issue.)

3.) Production function

a.) Educational programs exist as non-profit production units.

b.) Though education programs are analogous to natural monopolies the shapes (curvatures) of their production functions and cost curves are similar to non-monopolistic and monopolistic profit seeking organizations because the factors of production (resources) they purchase are obtained in the same resource markets and must be combined into a productive resource mix.

C. Educational programs have defined processes for producing output and these processes can be defined through task analysis.

4.) Output (student progress)

a.) The unit of output for an educational program is the changed behavior of the child and this can be determined by combining those indicators which are appropriate indices of behavior change in terms of program goals and objectives.

b.) The output of an educational program can be quantified.

c.) The unit of output is defined at the beginning of the program year.

5.) Cost analysis

a.) Costs of educational programs are currently defined as outlay costs rather than full costs, i.e., do not include opportunity cost or normal profit.

b.) The costs of educational resources can be identified as fixed or variable.

c.) The costs of educational programs can be identified in the short run (where costs are fixed or variable) and in the long run (where all costs become variable).

6.) Output-input and output-cost relationships.

a.) The relationships between inputs (resources) and outputs (student progress) have been defined at the beginning of the program year.

b.) Educational programs exist as natural monopolies within a specific geographical area (that area served by the school district) and there is flexibility in costing program output within the parameters of an approved budget.

c.) The process for determining marginal cost applicable to natural monopolies is also applicable to educational programs, i.e., educational programs exist as natural monopolies and are non-profit (cognizant of outlay as opposed to full costs).

The assumption categories, i.e., inputs (resource), production function, cost analysis and output-input and output-cost relationships reflect the order in which constructs and relationships were incorporated into this model. The production function, cost analysis and economic constructs used and their sequential relationship in the model were verified by each of the following references: Heilbroner, 1970; McConnell, 1972; Samuelson, 1973; Spencer, 1974; and Watson, 1963.

III. THE MODEL

A. Inputs (Resource)

Initial efforts in developing this model required a base for doing cost analysis. The first step involved the identification of the resources specified in step four of the planning process for each program by school building. Further analysis identified those resources allocated to each building by program component. Goals and objectives had been developed for each component. The components of a Title I, E.S.E.A. Program in Minnesota are reading, mathematics, behavior and adjustment and work habits.

Once this analysis had taken place the identified resources were quantified in terms of the building program and also by building program component. The majority of resources identified and quantified in this process were: administrative and instructional staff time, units of instructional materials expended and units of instructional equipment. All but the school building principal's time was purchased with Title I, E.S.E.A. funds. Building space was not included as a resource because the rooms would have been vacant had they not been used for the program under analysis.

B. Production Function

The second step in determining a base for doing cost analysis required that a task analysis be done. This necessitated an examination of the instructional process by building program component aimed at producing the identified unit of output. The identified tasks were sequenced and related to planning, implementation (instruction) or evaluation activities. Resources were assigned each task by program component and quantified in terms of planning, implementation or evaluation activity. The mix of resources identified for each program component varied from building to building. This variance reflected the results of the needs assessment process

(Step 1 of the planning procedure). Because needs varied between buildings the output units for each building were different and required a different process for attainment. The use of resource identification and quantification procedures and tasks analysis procedures provided an improved base for doing cost analysis.

C. Cost Analysis

The procedures applied up to this point established a base for the analysis and quantification of resource units required to produce a specific type of output unit. Once resource quantification had taken place costs were assigned.

The consumption of certain inputs (resources) varied during the program year, i.e., instructional materials and equipment. The costs associated with these inputs were identified as variable. Other inputs remained constant during the program year, (i.e., administrative and instructional staff time.) The costs of these inputs were fixed. Both types of costs were classified as outlay rather than full cost, i.e., did not include opportunity cost. The rationale for this assignment was based upon the fact that during the initial application of this model a cost base did not exist for making knowledgeable trade offs between resources applied to produce a specific type of output unit as opposed to some other output unit.

At this point it was possible to determine total outlay costs expended to produce an output unit. Total outlay cost was:

T.O.C. = Variable outlay cost + Fixed outlay cost

The current intent is to apply this equality during a given program year to various instructional processes aimed at producing a particular output unit. This application will provide initial cost data for determining how cost effective these instructional processes are when directed at a particular output unit.

The same equality will also be applied to a given instructional process aimed at a specific output unit over a number of program years. As the number of specific input units applied to this process change a base is established for determining marginal cost, i.e., the increase in cost when one additional unit of a specific input unit (resource) is applied to the instructional process. A longitudinal study applying the equality (T.O.C. = F.O.C. + V.O.C.) and the concept of mariginal cost should provide two benefits. These are:

1. Provide educational decision makers a basis for distinguishing between the short run where costs are fixed and variable and the long run where all costs become variable.
2. Establish a cost data base which will eventually make it possible to apply the "Least Cost Principle" and the opportunity cost concept to instructional programs.

Staff costs make up a major portion of most program budgets. The affect of years of experience and number of degrees or credits earned on staff salaries made it necessary to establish an average compensation figure for program staff.

This was done using the following equation:

$$\frac{\text{Total program costs by building incurred for a particular type of staff member}}{\text{Total number by building of a particular type of staff member in the program}} = \text{Average compensation figure for a position by building}$$

This equation is consistent with the assumption related to the homogeneity of specific inputs.

Inflation and/or recession will also affect program costs. A longitudinal study of cost effectiveness will assist in the definition of a base period. This will make it possible to assess cost data not only on a current basis but in terms of a base which negates the effects of these economic conditions.

D. Output-Input and Output-Cost Relationships

The completion of the procedures related to input (resource) analysis and quantification by building program and program component resulted in an information base for determing output-input relationships. Using the appropriate output unit by building program or building program component in conjunction with the appropriate input (resource) the following relationships were determined:

$$\frac{\text{Total units of output for building X}}{\text{Total units of a specific input for building X}} = \text{Average unit of output for building X per unit of a specific input}$$

and

Total units of output by program component for building X / Total units of a specific input expended in that component = Average output unit (component measure) for building X per unit of a specific input

Use of the data derived by applying the first relationship served as a base for determining the effect of using a certain quantity of a specific input to obtain a given building's output unit. The second relationship shows the effect of said quantity of inputs on the improvement of specific skills or attitudes. By computing these relationships over a number of years a data base can be established for determining the effect created on building or program component outputs as the quantity of specific input units are changed.

Completion of cost analysis procedures made possible the following relationships:

Total outlay costs for the program at building X / Total output units produced at building X at program years end = Average outlay cost per unit of output for building X

and

Total outlay costs by a program component at building X / Total output units (skills mastered) produced at building X for that program component at year's end = Average outlay cost per unit of program component output for building X

During the application of the model it was impossible to quantify inputs in terms of a common unit. This resulted in the analysis of the output-input data by type of input. Cost analysis transferred all inputs into a common unit (dollars.) This made it possible to analyze the effect of combined inputs (resource mix) on each output unit by building and by building program component.

The model is currently being used to determine total outlay and average outlay costs. Full costs (total costs) and average total costs will hopefully become reality at some time in the future. A cost data base must first be established which will improve our measure of the full cost incurred by alternate uses of a particular resource.

COST-EFFECTIVENESS MODEL

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COST EFFECTIVENESS MODEL

APPENDIX

Check List for Identification of Resources to be costed by Phase of Operation and Program Component

Type of resource (Examples) \ Phase of Operation	PLANNING					IMPLEMENTATION					EVALUATION				
PROGRAM COMPONENTS	Reading	Mathematics	Behavior & Adjustment	Work Habits		Reading	Mathematics	Behavior & Adjustment	Work Habits		Reading	Mathematics	Behavior & Adjustment	Work Habits	
Personnel															
1. Administrative															
2. Instructional															
3. Evaluation															
Materials															
Equipment															
Fixed Charges															
Travel															

DULUTH CONSOLIDATED GRANTS AND PROJECT MANAGEMENT

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Figure 1 - 32