Determining Instructional Costs Through Functional Cost Analysis

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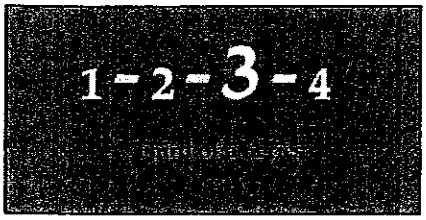

Abstract: Conventional procedures for recording and reporting educational costs require that costs be reorganized in order to coincide with educational outcomes. This article describes a cost analysis model and procedures which permit the realignment of costs with outcomes. The article also briefly discusses full costs versus direct costs, alternative approaches, accuracy of the selected approach, and the cost analysis report. Examples are provided which show how to format data for subsequent analysis.

EDITOR'S NOTE

This is the third in a series of articles on the use of cost-effectiveness analysis to evaluate instructional programs. The first article (Doughty, *JID*, 2(4), Summer, 1979, 17–25) provided an overview of conceptual and practical criteria for judging and designing cost-effectiveness studies. The second article (Lent, *JID*, 3(1), Fall, 1979, 26–33) provided a detailed model of the methods of cost-effectiveness analysis as it is used to inform decisions about instructional development efforts, and other applications of educational technology.

The present article goes into more detail about Phase IV of Lent's cost-effectiveness model, "Determine Costs." It presents a model and procedures for cost analysis.

The concluding article of this series, to appear in the spring 1980 issue of *JID*, will present an applied case study of cost-effectiveness analysis in an instructional development context that demonstrates many of the features, methods, and problems of the kind of studies described in the first three articles.

Introduction

Educational institutions do not typically report costs in a way that coincides with the educational outcomes of interest to instructional developers and evaluators. The evaluator/instructional developer should be concerned with separating the cost of designing instruction from the cost of implementing it. He or she should also seek cost data that relate to an academic year or some other academic period. At most institutions, however, costs are aggregated by jurisdiction—by organizational units such as departments—and by fiscal, not academic, time periods.

Thus, when the evaluator/instructional developer attempts to determine costs for a particular instructional function involving persons from several departments and to organize the costs by semesters or by some other academic period, he or she must assume the role of cost analyst and reorganize costs in a unique configuration. How to identify, collect, and organize these costs is the topic of this article.

A cost model is presented, followed by a discussion of whether the analysis should consider full costs or direct costs. A discussion of data collection concerns and procedures is then provided. The article concludes with a brief section on what a cost analysis report should contain.

The Cost Model

The cost model identifies data that are to be collected and suggests how the data might be organized. There are three dimensions to the model: life cycles, cost categories, and cost centers.

Life Cycles

The life cycle concept is particularly relevant to instructional designers because it clusters costs into three developmental stages: design, investment, and operation. *Design* refers to the planning and development that occurs to improve instruction, *investment* refers to capital outlays, and *operation* refers to the actual implementation of instruction. The stages are operationally defined in Figure 1 in terms of activities.

The primary benefit of using life cycles as a cost dimension is that they isolate the costs of actual instruction (operation) from start-up costs (design and investment). In addition, life cycle costs permit reasonable comparisons among alternative instructional strategies and among design costs associated with various approaches.

Cost Centers

A cost center refers to that which is being costed; it may be a course, a small unit within a course or a program involving several courses. It may also refer to a particular organizational unit or function such as a library or administration. It is frequently desirable to have several cost centers in a single cost analysis—particularly when the analysis is at a program or department level.

Two examples of cost centers which might be appropriate to an interdisciplinary science program sharing a common learning resource center are shown in examples 1 and 2. These examples demonstrate that naming cost centers is subjective and names can be tailored to needs.

Example 1	*Example 2*
Biology	Learning Center
Physics	Program Administration
Chemistry	Biology Instruction
Math	Chemistry Instruction
	Physics Instruction
	Math Instruction

Cost Categories

Whereas the life cycle and cost center dimensions of the cost model represent functions (e.g., design functions or instructional functions), the cost category dimension represents resources. All resources assigned to or consumed by the cost center are organized into categories. The amount and cost of each resource is determined and reported by category.

The number of cost categories is determined by the level of information needed by decision-makers. It is important that the cost categories account for all resources consumed by the cost center.

The author examined 20 studies containing a total of 119 different cost category labels (Doughty and Beilby, 1974). One study contained a single cost category while another contained 20. The single category study aggregated resources to the point that much meaning was lost. Furthermore, not all resources were accounted for. Cost studies with more than 20 categories present unnecessary detail and even then, may not include all pertinent resources.

Six major cost categories which have —with occasional modification—been used successfully by the author in several cost analyses are:

- Personnel salaries and benefits (includes project staff, design staff, consultant fees).
- Administrative salaries and benefits.
- Services (printing, rentals, travel, etc.).
- Hardware and equipment.

DESIGN	INVESTMENT	OPERATION
Planning the format, structure, and general content of course or program	Purchase of hardware or equipment	Classroom instruction
Planning and designing specific content and nature of instructional materials to be used	Purchase of office supplies (option: may be an operation cost)	Advising/counseling students
Selecting from existing instructional materials	Renovating facilities	Purchase/production of instructional materials for class use
Planning required facilities	Rentals for noninstructional purposes	Evaluating/assessing students
Personal research to gain knowledge/information		Diseminating information about course or program
Developing evaluation plan/ procedures		Instructional support activities (list type of activity and personnel involved)
Evaluating (course or program)		Preclass review and preparation
		Rentals for class purpose

FIGURE 1. Life cycle stage activities and costs.

- Software.
- Facilities.

Subcategories may be added to this list, and it may at times be useful to add other major categories. The important point is to exercise parsimony categorizing resources. A large number of cost categories is cumbersome to work with, may direct attention to extraneous details, and may confuse readers who are not intimately familiar with the cost centers. Detailed lists of resources that comprise the cost categories can be placed in a report appendix or supplied on request.

The Model

Figure 2 presents the cost model dimensions. The entire matrix represents one cost center. The vertical axis represents life cycle stages; the horizontal axis indicates cost categories. Figure 3 is a more complete representation of the cost model. Multiple cost centers are shown. Costs may be aggregated in all three dimensions, i.e., by life cycle stages, by cost category, and by cost center.

Full Costs Versus Direct Costs

Before collecting data to satisfy the cost model, the analyst must decide whether the analysis will express full costs or direct costs. Full costs include indirect overhead costs. These are typically expressed as a proportional share of utilities, maintenance, administrative salaries, and service units, such as a library. Direct costs include only those costs incurred directly by the cost center.

Most conventional educational cost studies employ full costs. The underlying assumption is that various departments share overhead according to some proportional rule. For example, a program occupying one-tenth of available floor space will be charged for 10 percent of the utilities, maintenance, debt on interest, etc. Similarly a program with one-tenth of the personnel or students will be charged for 10 percent of administrative costs and 10 percent of the cost of library operations.

The ease of the mathematics involved may help to explain why full costing is so frequently employed.

There are fewer assumptions involved with direct costs than with full costs, and they are easier to defend. No overhead *per se* is included; facility costs are limited to renovations specific to a program; and administrative costs are used only when interaction between administration and the cost center is documented. Overhead costs can be estimated and added to direct costs if institutional philosophy dictates.

Direct cost determination requires more work from the cost analyst than full costing. Actual resource consumption must be determined requiring original data collection. However, the end result is that the costs reported are limited to those actually incurred by the cost center. The remainder of this article assumes that the direct cost approach will be used and describes how these costs are determined.

Collecting Cost Information

A discussion of cost data collection must deal with the period for which costs should be collected in addition to the procedures for collecting the information. The time period covered by a cost analysis is called the time horizon.

The Time Horizon

There are three phenomena that create a problem for the cost analyst: (a) costs are continuous, (b) calendar years, fiscal years, and academic years do not always coincide, and (c) cost bubbles occur as major expenses are incurred in the development of a program. The problem created is to deter-

Life Cycle Phases \ Cost Categories	Category 1	Category 2	Category 3	Category 4 . . . n	Total Costs
Design	$	$	$	$	$ _____
Investment/ Production	$	$	$	$	$ _____
Operation	$	$	$	$	$ _____
Total Costs:	$ _____	$ _____	$ _____	$ _____	

FIGURE 2. Cost model for a single cost center.

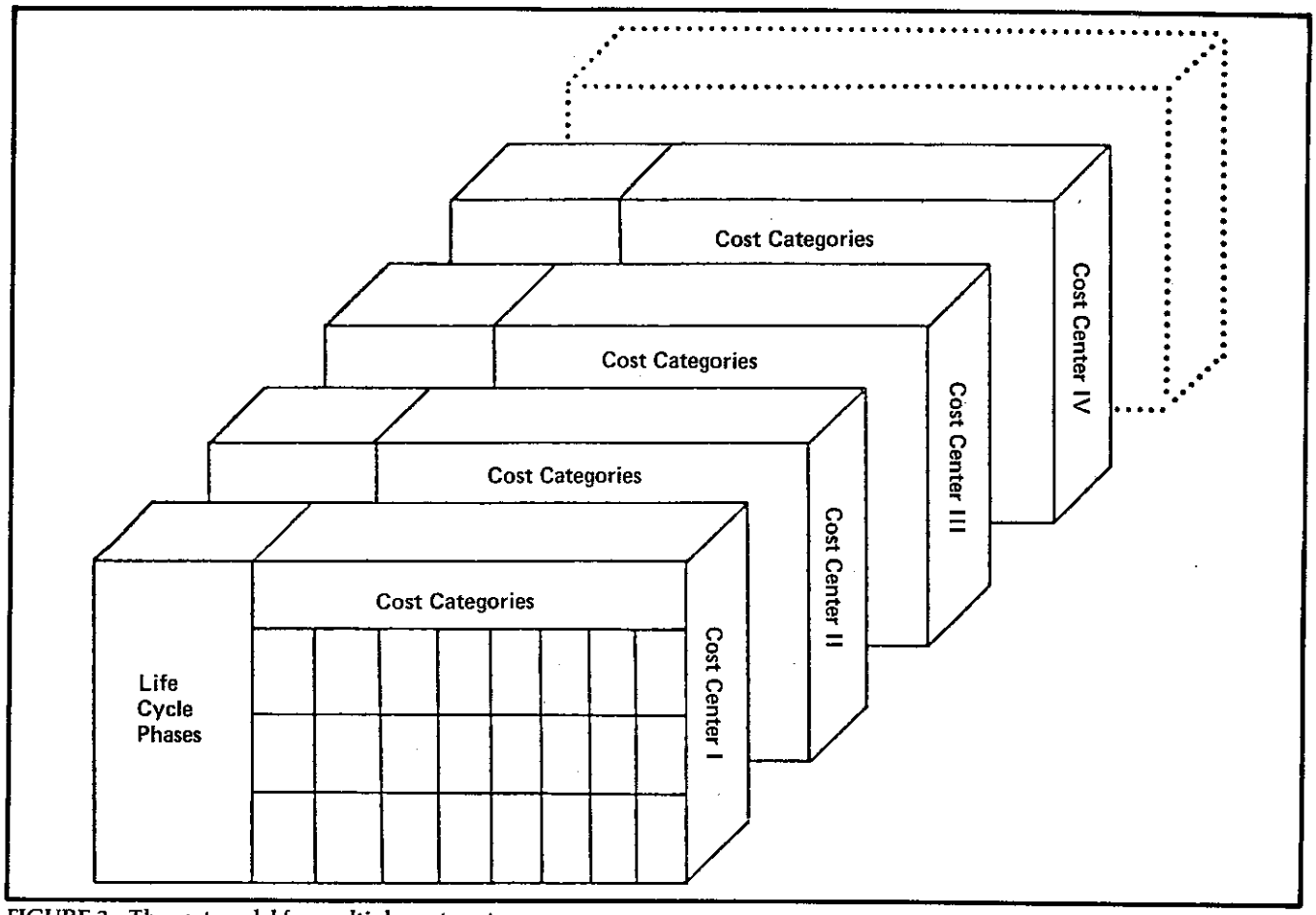

FIGURE 3. The cost model for multiple cost centers.

mine the beginning point and direction of the analysis, one of the first decisions to be made.

A cost analysis should follow the cyclic nature of the program being costed. In education, activity is determined more by the academic year than by calendar or fiscal years. Therefore, costs should be organized over an academic year by academic periods such as semesters, quarters, and summer sessions.

The time horizon should include start-up and development costs when the cost center is a newly implemented or modified program. Inclusion of start-up costs may involve an historical analysis of cost records; however, an historical analysis is not feasible if the program is more than 4 or 5 years old or if records are incomplete. If a program is well established, the time horizon may begin with the current or most recent academic period.

To summarize, the time horizon should include: (a) development and start-up costs where feasible and (b) a full academic period, preferably an academic year.

Data Collection

Four classes of information are required for the cost analysis:

1. The resources used in each cost center (e.g., a video cassette player).
2. The life cycle stage for which each resource is used.
3. The consumption pattern of the resource by cost center and—if personnel—life cycle stage[1] (e.g., a faculty member spends 30 percent of his or her time in cost center X; 25 percent of that time is for design and 75 percent is for operation).
4. The unit cost of the resources (unit costs for personnel are individual salaries and wages).

The first three types of information are collected via interviews with cost center personnel when the analyst is not intimately familiar with the cost center. The interview process is the key to functional cost analysis. Much of the data is obtained from participants rather than relying exclusively on financial records.

The fourth data set is obtained from financial records and constitutes the control feature of functional cost analysis. That is, total costs obtained via functional cost analysis will not exceed costs achieved through conventional analysis.[2] The difference between functional and conventional cost analysis lies in how costs are distributed within an institution.

Combining the four data sets permits the analyst to apportion the cost of each resource across the various cost centers. The resources may also be apportioned across life cycles within cost centers. Two examples of this process will now be provided.

Example one—hardware. The cost of hardware or any capital expense is treated differently than personnel costs

[1]Purchases of hardware and equipment are assigned to "investment" only, even though a piece of hardware may be used for design and operation. This is because the dollar amounts involved are rarely worth the effort of allocating these costs to specific life cycles.

[2]Exceptions are permitted in cases where donated services can be documented. Such donations must be clearly labeled in the report.

because individuals are paid for services as they occur, but a single payment is made for hardware prior to its use. Obviously, hardware remains useful over an extended period of time and is not consumed during its initial use. In order to reasonably spread costs over time, amortization rates are used. That is, an estimate is made of the hardware's useful life based on experience or convention (this is a personal preference; 5, 8, or 10 years are commonly selected). The original cost is then amortized over the selected period.

In Table 1 below, the pattern for use for a TV camera has been determined for a full year for the cost center of interest and for other programs. Computed costs are based on the use rates and the amortization period (10 years).

TABLE 1. Estimating the use of hardware: a TV camera.

Item	Cost base	Amortization rate/cost	Utilization Pattern		Cost	
			Cost center	Other programs	Cost center	Other programs
TV camera	$5800	$580 (10 years)	10%	90%	$58	$522

The example suggests that total use of the resource must be accounted for even though some uses are not of particular interest to the analyst.

Example two—personnel. Estimating personnel costs is more difficult than estimating hardware and other investment costs. Furthermore, personnel costs are usually more important because salaries often comprise the major portion of a project's cost. Humans may perform a variety of tasks for a number of cost centers. Thus the analyst is faced with the task of apportioning a person's time first among cost centers and then within each cost center by life cycle.

The analyst must account for 100 percent of each person's time. This is accomplished by first asking personnel to estimate the portion of time they spend on each cost center of interest and on all other professional activities which they believe are part of their job. The "all other professional activities" estimate is a single estimate. The analyst does not need to know the nature of these activities nor the time spent on each. The need is simply to account for all of an individual's time.

It is sometimes useful to have interviewees talk in terms of the hours they spend working in a typical week (the length of a work week may change with academic periods). The interviewees are then asked to estimate the number of hours they typically spend on each cost center. Regardless of which method used to obtain the data, the end result should look something like this for each academic period:

Cost center 1	15%
Cost center 2	35%
All other activities	50%
Total	100%

Having identified an individual's activity across cost centers, the next step is to identify his or her activity within each cost center. The goal is to categorize activity by life cycle stage.

The author approaches this task by asking each person to estimate the amount of time spent on clusters of activities which have common meaning to the analyst and the interviewee. This may involve some discussion to be sure that both parties agree on the terms.

To simplify the data collection process for interviewees, they are told to consider each cost center as the base (100 percent) for their estimate. This makes it unnecessary to keep a continuous series of percentages in motion during the interview. The subsequent analysis of the data will require the simple multiplication of percentages to obtain a complete picture of an individual's involvement. For example, assume the following results for a cost center for 1 academic year:

Planning the course (a design activity)	10%
Designing materials (a design activity)	25%
Teaching (an operation activity)	40%
Grading papers (an operation activity)	5%
Evaluating results (a design activity)	20%
Total	100%

If the cost center was one in which the individual spent 15 percent of his or her time, each of the above percentages would be multiplied by 15 percent. The result would be that design activities in this cost center would account for about 8 percent of the individual's total time (and, therefore, salary and fringe benefits) and operation activities would account for about 7 percent.

Accuracy and Alternative Methods

At this point the question almost certain to be raised is: How accurate are these data? The best response is: Accurate enough! In studies of health education at Case Western Reserve Medical Center, Lee and Kutina (1974) concluded that regardless of the method used to measure activities of faculty and other personnel, the relationship between major activities will remain essentially the same. It is the relationship—the proportion of time involved—that is of interest.

> "The primary benefit of using life cycles as a cost dimension is that they isolate the costs of actual instruction (operation) from start-up costs (design and investment)."

It might be a good idea to examine alternative approaches to gathering the cost data. Alternative approaches include (a) using personnel appointments or job descriptions which indicate the amount of time persons spend in various departments or functions, (b) examination of production records, (c) use of daily journals, (d) time and motion studies, and (e) load reports.

In most instances, appointment schedules do not reflect the cost centers

of interest or they are not actually followed. In academe, production records almost never exist; ditto for journals. Time and motion studies are prohibitively expensive and could result in a lynching. This leaves load reports as the most viable alternative. However, load reports require preplanning and personnel cooperation. Seldom are these prerequisites present.

Interviews seem to be most palatable to personnel. In an interview, the reporting time is scheduled and concentrated into a short session; furthermore, an interested person is present to listen and record the data. The time involved for the analyst may range from 20 minutes to 1 hour per interview, so the cost is reasonable.

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The Cost Report

The cost report should be designed for the anticipated audience and it should explain the purpose of the analysis (Lent, 1979). It should describe the program and cost centers being reported, present data in tabular and—if possible—graphic formats. Where appropriate, sources of funds (grant or institution) should be explained. In addition, the report should include observations concerning donated time and services, observations concerning nondollar expenditures (Doughty, 1979), and clear statements about what the life cycle costs mean and imply. Any technical data (e.g., lists of resources, amortization schedules, salary schedules) should be consigned to appendices if they are included at all.

The space/time limits of an article do not permit amplification of all these concerns, so only life cycle cost implications will be discussed here.

Once life cycle costs have been established, further explanation of the costs is desirable. This is particularly true if decisions are to be made about continuing the instructional program or expanding the instructional development efforts to other instructional areas. The following questions leading to productive speculation about possible future costs are but a few of those that might be asked about a particular life cycle costs.

Design costs

- Is much of the cost due to development of procedures and, therefore, representative of costs that will not be incurred in future efforts?
- Does the design cost represent the bulk of all design costs that might be required or does it represent, say, 5 percent? Is ongoing design work anticipated?
- Can developed materials be used in other settings?

Investment costs

- Do the costs represent the bulk of expenditures or will further purchases be required?
- How often will replacements be required?

" . . . functional costing is eminently practical and is a powerful tool for determining cost information."

- Can other instructional areas benefit from the purchased hardware/equipment? If so, in what ways?
- Do facility improvements account for any investment costs?
- Were outside funds used for purchases?

Operation costs

- How do these costs compare with operation costs of other courses/programs?
- Are these costs likely to increase, decrease or remain about the same?
- What are the unit (per student) costs?
- How sensitive are unit costs to changes in enrollment?

Summary

This article has focused on the basic concepts and "how to's" of functional cost analysis. It has been a brief treatment. Use of this costing approach will reveal surprising subtleties as well as concerns and issues to confront as the analysis evolves. Minor alterations in study design and procedures are required for each cost analysis. Nevertheless, functional costing is eminently practical and is a powerful tool for determining cost information. Furthermore, it is ideally suited to program evaluation and cost effectiveness studies. The same cannot be claimed for traditional, jurisdictional cost models which express costs in terms unrelated to programs.

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