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Which costs are pertinent to the evaluation of a new product? Using a simplified example, the author illustrates the use in management decision making of —

DIFFERENTIAL COST ANALYSIS

by Arthur Ottenstein

Worthington Corporation

COST ACCOUNTING has long been widely used in industry to provide a foundation for financial reporting and as a means of cost control. More recently, however, the liveliest management interest in this field has been focused on its use in decision making, as in determining whether to add or drop a product, expand or contract an operation, or make or buy a component.

For the most part such decisions require the use of differential cost analysis, also known as marginal or incremental cost analysis. This article reviews some of the basic principles involved and illustrates them by a simplified example.

Historically, management has utilized the data derived from costing systems to measure transactions that have already occurred, for purposes ranging from a mere compilation of costs attributable to ending inventories to highly sophisticated analyses used in controlling

expenditures, gauging operating performance, and planning future activities and undertakings.

Each of these uses has its own requirements, and it may be impractical or even impossible to accumulate under a single reporting system all of the various arrangements of information necessary for solving every question posed for solution. One system may be quite satisfactory for valuing inventory for financial statement purposes and another for yielding information on a product line basis; however, neither system may be designed to indicate differences from predetermined standards.

Management must decide, therefore, which uses have priority and which should determine the reporting system or systems to be followed. If the information generated by the existing system, when properly analyzed and interpreted, is not sufficient to aid in formulating those decisions vital to maximizing

profits, the system must be modified. It may, indeed, be necessary to maintain parallel systems.

The decision to accept or reject business at any given price level ultimately rests on an analysis of differential costs, whereby the profitability of a contemplated management decision may be determined by matching the increment or decrement in estimated future costs with changes in volume or activity. The system most readily adaptable to such analysis is one that relates prime costs (direct materials and labor) plus variable overhead to units produced, thus yielding gross profit ratios before allocation of fixed overhead.

Cost classification

There is some controversy about the exact definition of fixed costs. In general, however, it may be said that fixed costs are those that will not fluctuate with production un-

less operations during the period. They may, however, vary with changes in product mix or because of other management decisions affecting operations. Often referred to as "stand-by" costs, they represent those costs that must be incurred at zero level of production in anticipation of normal operations. Superintendents' and supervisory salaries (if such remuneration would be paid even though production had ceased, as would probably be the case if normal operations were expected within a reasonable time period), depreciation, real estate taxes, various forms of insurance, and equipment rent are examples of costs that fit this definition of fixed.

Certain costs such as direct material, direct labor, and plant utility consumption usually vary directly with production. These variable expenses, if purged of all variances from predetermined standards, when summarized and divided by equivalent production will result in a unit cost constant.

But all variable costs cannot be correlated as indicated. Many expenses will not change over a given range of output. With added production they will reach a higher plateau and remain constant, generally speaking, until a substantial increase in productivity is effected. Most forms of indirect labor fall into this category of semi-variable costs. However, some expenses that are often considered semi-variable may in reality be composed of both fixed and variable segments. An example would be machine maintenance, which, in the event of unused capacity, may contain a portion of protective maintenance on idle machinery.

These definitions have focused upon costs as related to the plant or production. Virtually all other expenses, however, such as those included in selling and general and administrative classifications are manifestations of prior management decisions and by their inherent nature contain both fixed and variable elements. It is more than likely, however, that if these costs are variable they will fluctuate with

ered fixed they may be allocated to a given time period. Perhaps management has decided to maintain a large internal sales force. Should such costs, largely fixed, be treated in internal reports of operations in the same manner as variable expenditures resulting from a decision to make extensive use of independent sales agencies paid commissions based on billings?

Thus, it is management's realistic cognizance and scientific evaluation of the nature of the company's cost structure and not merely empirical knowledge that become a basic rampart of sound decision making, whether it be related to instituting a new operating method or changing the level of production. Whenever such changes are contemplated, an analysis of all possible cost changes (differential costs) should be undertaken, as illustrated in the example that follows.

Example

The L Corporation, a chemical manufacturer, has developed through its research program a new product, X. The product, like other items previously produced, will be marketed through the company's regular sales agents. However, a sales manager and a full-time secretary will have to be employed at a minimum total annual salary of \$22,000. Advertising and promotion expenditures are expected to be approximately \$20,000. Both preliminary and secondary surveys of marketing areas have revealed that at a price of \$.80 per unit (pound), which places X in a favorable competitive position with

approximately 400,000 units can be sold during the initial year.

In addition, present plant facilities will have to be altered at an estimated cost of \$40,000 (useful life ten years). Property taxes and insurance will increase approximately \$1,000. The addition to the factory will be financed at a rate of 5 per cent. While the present staff of foremen can handle the increased output, another foreman's assistant, a maintenance worker, and an additional helper for the warehouse must be hired at a total annual cost of \$15,000. It is also anticipated that the present administrative staff can handle the additional workload by hiring an accounts receivable clerk at \$4,000 per annum. The production department has estimated that prime costs will be \$.37 a unit (direct materials \$.20, direct labor \$.17).

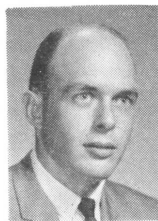
Differential costs, exclusive of variable product costs and variable selling and general and administrative expenses, may be summarized as follows:

Selling Salaries	\$22,000
Advertising and Promotion	20,000
Depreciation	4,000
Taxes and Insurance	1,000
Indirect Labor	15,000
Administrative Salaries	4,000
Interest	2,000
TOTAL	<u><u>\$68,000</u></u>

Before going any further with the analysis of the new product's prospects, let us examine L Corporation's present state of operations, particularly the method used to absorb costs into inventory.

The statement shown in Exhibit I on page 60 does not include the sales of new product X or any of the differential costs previously mentioned. It merely summarizes actual results of operations for ten months and presents a forecast for the remainder of the year, in a manner similar to that normally shown on a monthly report of operations. For purposes of the illustration, year-to-date spending and efficiency variances have been omitted.

The company has historically followed the policy of absorbing into



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Ottenstein: Differential Cost Analysis

L CORPORATION
STATEMENT OF INCOME*
YEAR ENDING 12/31/-

(10 Months Actual, 2 Months Forecast)

Sales	3,500,000 units @ \$1.086		\$3,801,000
Cost of sales			
Direct materials	3,500,000 units @ .24	\$ 840,000	
Direct labor	3,500,000 units @ .20	700,000	
Manufacturing overhead	3,500,000 units @ .325	1,137,500	
Unabsorbed manufacturing overhead			<u>379,500</u>
			<u>\$ 3,057,000</u>
Gross profit			\$ 744,000
Selling and general and administrative expenses			<u>620,000</u>
Net income before income taxes			<u>\$ 124,000</u>

*Excluding new product X

EXHIBIT 1

L CORPORATION
STATEMENT OF INCOME*
YEAR ENDING 12/31/-

(10 Months Actual, 2 Months Forecast)

Sales	3,500,000 units @ \$1.086		\$3,801,000
Variable product costs:			
Direct materials	3,500,000 units @ .24	\$840,000	
Direct labor	3,500,000 units @ .20	700,000	
Manufacturing overhead	3,500,000 units @ .10	<u>350,000</u>	
			<u>1,890,000</u>
Variable selling and general and administrative expenses	3,500,000 units @ .05		<u>175,000</u>
			<u>\$1,736,000</u>
Fixed manufacturing expenses	3,500,000 units @ .25	\$875,000	
Unabsorbed manufacturing overhead		292,000	
Fixed selling and general and administrative expenses		<u>445,000</u>	<u>1,612,000</u>
Net income before income taxes			<u>\$ 124,000</u>

*Excluding new product X

EXHIBIT 2

inventory both fixed and variable manufacturing overhead on the basis of a composite predetermined overhead rate. This rate has been set to absorb fully all overhead when the plant is operating at 80 per cent of capacity. The unfavorable volume variance (unabsorbed manufacturing overhead) has consistently been charged against current operations, since, because of the company's pricing structure, this cost could not readily be recovered for many of the products

if it were capitalized in inventory. The rate of \$.325 per unit has been computed assuming there has been no change in the amount of overhead contained in the beginning and ending inventories. Spending and efficiency variances as previously mentioned have been omitted; therefore, budgeted overhead will equal the total absorbed and unabsorbed manufacturing overhead indicated on the statement above, \$1,517,000. Dividing by the estimated unit produc-

tion of 4,667,000 units, representing annual plant output at 80 per cent of capacity, yields a composite rate of \$.325 for fixed and variable manufacturing overhead.

As a result of utilizing the data in Exhibit 1 to cost the new product X (forecasting sales of 400,000 units of X at \$.80 per unit during the initial year), management might conclude that X will not be profitable. It would appear that after providing for prime costs of \$.37 and manufacturing overhead of \$.325 (this rate will decline slightly if recomputed on the same basis as indicated previously for the additional costs and volume), the gross profit generated would be insufficient to cover differential selling and general and administrative expenses and yet provide for a sufficient return on the incremental funds invested.

Overhead rates

Upon evaluation and study of L Company's cost behavior, however, the previous income statement is reworked as shown in Exhibit 2 on this page to reflect both fixed and variable costs.

Separate overhead rates were derived as follows: The variable rate of \$.10 per unit was determined by dividing budgeted variable overhead by the estimate of actual units to be produced during the year. Total manufacturing overhead had been budgeted for \$1,517,000. Of this amount \$350,000 was said to be variable, leaving \$1,167,000 as "fixed." By dividing by 4,667,000 units (representing a full absorption rate based on 80 per cent of capacity) a rate of \$.25 per unit for applying fixed overhead was rived.

It should be noted, upon comparison of the two income statements, that net income has remained the same; so too have charges for direct materials and direct labor. However, variable selling and general and administrative expenses have been determined to be \$.05 per unit billed, and separate rates for applying fixed and variable overhead to inventory of

\$.25 and \$.10, respectively, have been provided as against a composite rate of \$.325 in the former illustration.

The use of a composite rate is adequate for financial statement and tax purposes; however, the nature and characteristics of individual overhead items are disregarded. "Capacity" costs, whereby plant and personnel have been committed to attain a given output, are treated in a similar manner to "activity" costs, which need only be incurred on a basis proportional to volume. Therefore, the composite rate, if used in differential cost analysis, will allocate costs that are unrelated to the additional volume.

Once the company's cost data are separated into fixed and variable components and all of the estimates are weighed, a statement can be prepared summarizing all cost changes effected by the manufacture of the new product X and the resultant net contribution of this product to the company's fixed costs. This statement is shown in Exhibit 3 at right.

Exhibit 3 excludes those costs attributable to prior management decisions in terms of plant, facilities, and services, which of their inherent nature are irrelevant in determining the benefit to be gained from undertaking the project. Consequently, should all the estimates and prognostications hold true, new product X would contribute \$44,000 to fixed costs during the initial year and increase net income before taxes by a like amount.

Therefore, instead of abandoning the project as would have been the case had a composite overhead rate been used to absorb costs into inventory, the company initiated further study along several avenues of approach.

Exhibit 3 indicates that out of every \$1.00 of sales \$.65 will cover variable costs and the remainder of \$.35 will be available to offset all other expenses. Dividing the increase in fixed costs of \$68,000 by 35 per cent yields the minimum sales dollars necessary to break even on the contemplated project — \$194,000. By dividing total esti-

L CORPORATION			
DIFFERENTIAL COST ANALYSIS			
NEW PRODUCT X			
YEAR ENDING 12/31/—			
Sales	400,000 units @ \$.80		\$320,000
Differential costs			
Direct material	400,000 units @ \$.20	\$80,000	
Direct labor	400,000 units @ .17	68,000	
Variable manufacturing overhead*	400,000 units @ .10	40,000	
Variable selling and general and administrative expenses*	400,000 units @ .05	20,000	208,000
			\$112,000
Fixed manufacturing overhead			
Indirect labor		\$15,000	
Depreciation		4,000	
Taxes and insurance		1,000	\$20,000
Fixed selling and general and administration expenses			
Selling salaries		\$22,000	
Advertising and promotion		20,000	
Administrative salaries		4,000	
Interest expense		2,000	\$48,000
Net contribution to fixed costs (before income taxes)			\$ 44,000

*For purposes of the illustration the same rates for variable manufacturing overhead and variable selling and general and administrative expenses were used for the new product X as were previously determined for the company's regular operations. However, for any substantial change in productivity such rates may vary, depending upon the nature of the items included in these categories. It is, therefore, incumbent upon management to restudy the various accounts and determine any applicable rate change.

EXHIBIT 3

imated sales of \$320,000 into that portion of sales exceeding the breakeven point, \$126,000, it can be determined that the marketing surveys can go awry by some 39 per cent without resulting in a loss situation.

It is interesting to note that if variable selling and general and administrative expenses were treated as fixed, the gross margin would be 41 per cent and the breakeven point increased to \$215,000.

Further refinement of the analysis may be accomplished through the use of present value techniques that recognize the time value of money. The net cash inflows for each year may be discounted at the company's investment opportunity rate as set forth by management and equated against cash outflows for the required investment, discounted in a similar manner. The

resultant ratio will indicate whether or not the required rate of return can be expected to be achieved.

The principles and techniques of differential cost analysis have numerous and varied practical applications. They are, however, supplements to long-term policies which of necessity are formulated to recover all costs plus a reasonable profit. When applied to decision making, whether it be in relation to pricing a new product or eliminating an old one, they are techniques for measuring alternatives and, as such, exclude those factors that bear little or no relationship to the profitability of a particular decision. However, such analysis might never be initiated or its benefits realized without an awareness of which costs react to volume and which costs remain relatively unchanged within a given operating framework.