USING ACTIVITY ANALYSIS TO LOCATE PROFITABILITY DRIVERS

ABC can support a theory of constraints management process.

BY CHARLENE SPOEDE, CMA; EMERSON O. HENKE, CPA; AND MIKE UMBLE, CFPIM

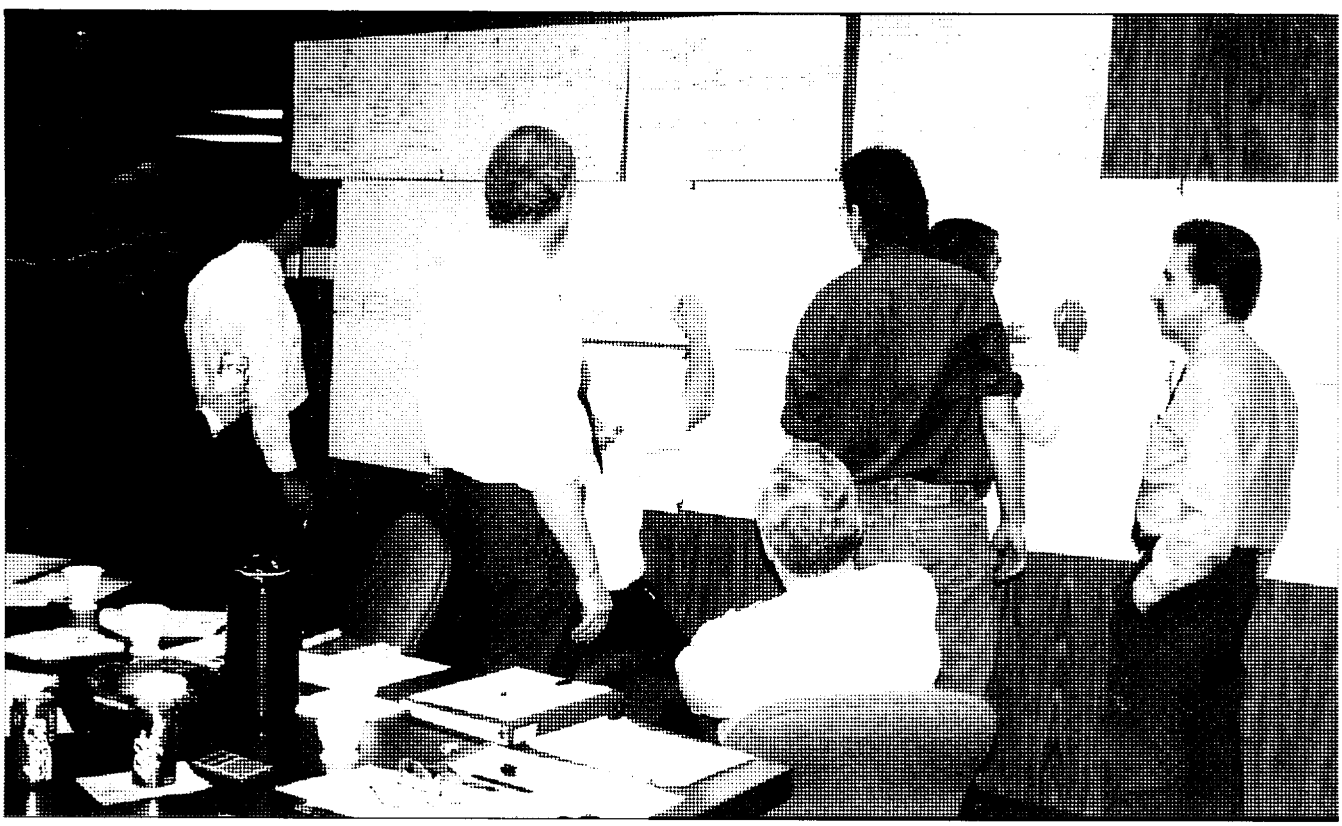
Certificate of Merit, 1992-93

If your company is simply emphasizing the mechanical implementation aspects of conventional ABC, it may fail to reap the promised benefits. The real potential of ABC is its ability to generate the data necessary to support the Theory of Constraints (TOC) management process. TOC is a proven management philosophy that provides a powerful basis for effective decision making and a process of continuous improvement.[1]

ABC APPEAL

Proponents of ABC and activity-based management (ABM) frequently mention two principal objectives: To provide detailed information that describes the range, cost, and consumption of activities throughout the organization and to provide accurate cost information to managers to improve their decisions.

In this system, accountants try to trace the cost of each activity (such as purchasing, receiving, disbursing, setups, production, engineering product and process improvement, inspections, and so on) to the product(s) benefiting from the activity. It is believed that direct tracing of incurred costs will eliminate the cross subsidies that exist



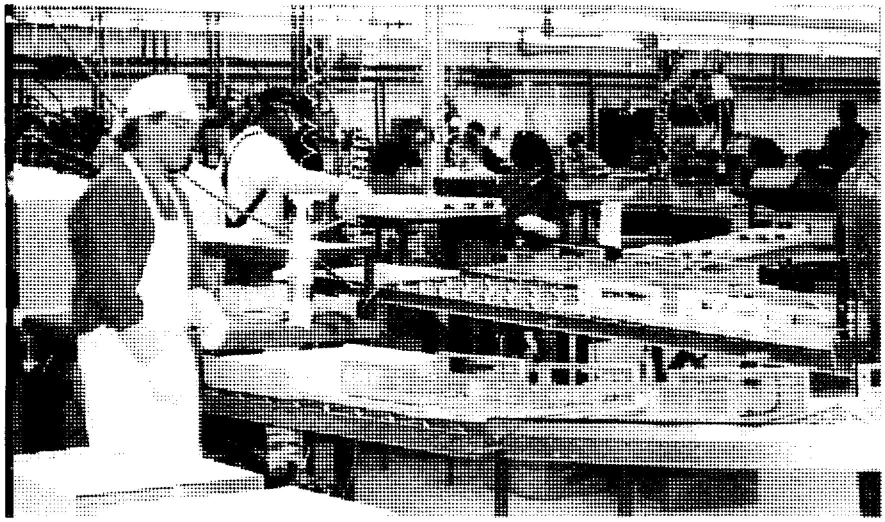
Olson Metal Products Company in Seguin, Texas, uses a process mapping technique to locate profitability drivers. L.-r.: Charlene Spoede; Vince VandeWalle, materials manager; Joe Richards, president; Pete Stahe, scheduling; Danny Beck, quality manager; John Ward, manufacturing manager; Elmer Ward, executive VP (seated).

between products in conventional cost systems. It also is believed that managers will be able to use this more accurate information to improve their decisions.

One of the best ways to illustrate the appeal of an activity-based system is to compare it with traditional approaches. A traditional cost system normally allocates overhead (indirect) costs to individual products based on some measure of product volume. Most traditional cost systems are still using direct labor hours for overhead allocations.

When a firm implements ABC, cost allocations change in the following manner. Assume that a company produces two basic products, X and Y (Table 1). Product X has unique features that require special attention for each customer and/or order. Product Y is a standard product that is sold to many customers.

The only overhead category considered in this illustration is setups. Direct labor hours are the traditional allocation base. In order to isolate the impact of volume, this example assumes that each unit of Product X or Y requires three hours of direct labor.



Olson Metal Products assembly plant during search for profitability drivers.

To allocate the setup cost element of overhead based on labor, the traditional overhead rate is calculated at $0.198 per direct labor hour. The traditional overhead cost per unit is $0.594 for Products X and Y.

The activity-based approach would estimate the cost of each setup and multiply this amount by the number of setups for each product to determine the total setup cost for each product during the period. If you divide the total setup cost for each product by the number of units of each product produced, you will determine the activity-based overhead cost per unit (Table 1 part C). The cost assigned to Product X has increased by 1,583.5%, while the cost assigned to Product Y has decreased by 15.8%. Either change can be significant in a competitive market.

Consideration of the number of setups (activities) associated with the production of each product suggests that Product Y has been "subsidizing" Product X. If a firm allocates setup costs according to setup activity, rather than in the traditional manner, the total costs of both products are changed significantly.

If this firm uses total product cost to make decisions on pricing, a traditional cost system that allocates overhead on the basis of direct labor hours would encourage them to raise the price of Product Y (to cover high production costs) and lower the price of Product X (which appears to have a high gross margin). This practice would lead to more orders for the more expensive to produce Product X. A classic case of long-term misallocation of resources and decreased profits inevitably results.

An ABC cost system appeals to ac-

TABLE 1 / SETUP COSTS

Part A: Production and cost data

	Product X	Product Y	Total
Total units produced	1,000	100,000	
Batch size	100	2,000	
Number of setups	10	50	
Cost per setup * **	$1,000	$1,000	
Total setup cost	$10,000	$50,000	$60,000
Direct labor hours per unit	3	3	
Total direct labor (DL) hours	3,000	300,000	303,000

* Setup crew expense for the period ÷ 75 (average budgeted setups per period).
** Note: One of the limitations of the ABC approach is the assumption that we can calculate things like the cost per setup. We must assume that we know (a) total setup capacity and (b) the cost of a marginal setup.

Part B: Traditional cost per unit

Traditional overhead rate for setup costs $\frac{\$60,000}{303,000}$ = $0.198 per DL hour

	Product X	Product Y
Traditional overhead per unit ($0.198 x 3 DL hours)	$0.594	$0.594

Part C: Activity-based cost per unit and percentage differences

		Product X	Product Y
Activity-based overhead per unit	$\left(\frac{\$10,000}{1,000}\right)$	$10.000	
	$\left(\frac{\$50,000}{100,000}\right)$		$0.500
Change [increase, (decrease)]		1,583.5%	(15.8%)

countants for a number of reasons. It provides for a more detailed tracking of costs incurred. Moreover, the cost of each individual activity of a company, administrative as well as manufacturing, can be allocated on some rational basis to the product that caused the activity to occur. Applied in this way, however, ABC retains a local, historical relation to total costs—focusing on allocating costs incurred to output achieved. We do not believe it provides information useful to managers for strategic and operating decisions.

FINDING THE PROFITABILITY DRIVER

The activity analysis that is required to implement activity-based cost allocation also can be used to reveal the capacity of individual resources. Isolated capacities, however, are meaningless unless associated with specific product mix.

For example, Resources A and B each may have a capacity (availability) of 40 hours (or 2,400 minutes) per week, but the output of the company is determined by the specific uses of available capacity. Suppose Product X requires 20 minutes of Resource A and 30 minutes of Resource B. Because Resource B can process only 80 units in 2,400 minutes, the system is limited to completing only 80 units each week. Resource A could produce 120 units per week, but, if it did so, 40 units would accumulate as excess work-in-process inventory each week because there would not be enough of Resource B to complete them.

In reality, companies have many different resources and products. Thus, the interaction of capacity requirements and contribution margins should be used to determine the appropriate product mix. Instead of a cost control approach, we believe a throughput-oriented management philosophy, as advocated by the Theory of Constraints, can be used best to exploit a firm's available opportunities.

Figure 1 presents a resource requirement flowchart for a simulated facility producing only Products A, D, and F. The flowchart is organized by the sequential flow of the operations required to process a product instead of the conventional departmental-workstation layout.

Thus, while the resources may be restricted to a fixed location, they can perform multiple operations on multiple products by changing their setup. For example, the two resource units labeled Resource 2 are required to do four separate operations. Such changes, however, require setup time. In the case of Resource 2, 120 minutes of setup time is required before production can begin at any operation.

Figure 1 shows a market potential (external demand) for the facility's products. Product A requires the use of one unit each of raw materials ARM and CRM. Product D requires one unit each of raw materials ARM, CRM, and

FIGURE 1 / SIM PRODUCTION FACILITY

Cash on hand	$ 2,500
Weekly expenses	$11,000

Resources Available

Setup Time	Resource Name and Identification	Number of Resources
15 min.	Resource 1	1
120 min.	Resource 2	2
60 min.	Resource 3	2
30 min.	Resource 4	2
0 min.	Resource 5	1

Adapted from seminar titled *Executive Decision Making* presented by The Avraham Y. Goldratt Institute, New Haven, Conn.(used with permission).

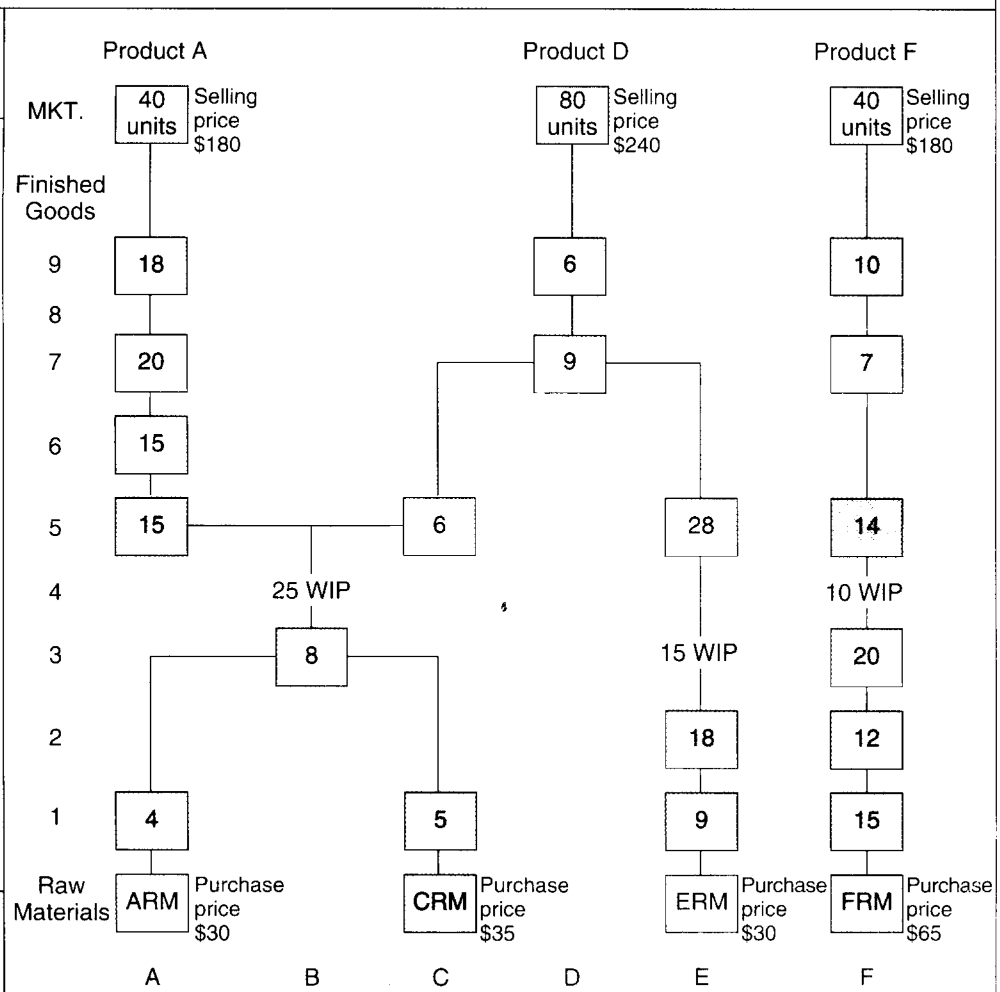


TABLE 2 / RESOURCE PRODUCTION TIMES

Finished Units	Resources									
	Resource 1		Resource 2		Resource 3		Resource 4		Resource 5	
Product A (40 units)		–0–	40(4+5+15)	960	40(15+18)	1,320	40(20)	800	40(8)	320
Product D (80 units)	80(6+28)	2,720	80(9)	720	80(9+6)	1,200	80(18)	1,440	80(8+9)	1,360
Product F (40 units)	40(14)	560	40(15)	600	40(12+10)	880	40(12+7)	760		–0–
Times required for one week of sales		3,280		2,280		3,400		3,000		1,680
Time available for 40-hour week (min.)		2,400*		4,800**		4,800**		4,800**		2,400*
Load		137%		47.5%		71%		62.5%		70%

*60 minutes x 8 hours x 5 days = 2,400 minutes ** 2,400 minutes x 2 resources of this type = 4,800 minutes

ERM. Product F requires one unit of raw material FRM. Various resources available for use in the production process are shown on the left side of Figure 1. Each resource unit is assumed to have 2,400 minutes (40 hours) of available time per week.

The simulated facility does not have finished goods inventory on hand at the beginning of the period. Because market demand consists of 40 units of A, 80 units of D, and 40 units of F, production during the period—assuming a tangible physical product is produced—can be equal to those amounts for each of the three finished products before finished goods inventory will begin accumulating.

The firm incurs weekly expenses of $11,000, payable at the end of the week. Details of capacities available and processing times required are the outputs of the first stage of an ABC cost system implementation and were determined through extensive interviews, examination of engineering standards, and analyses of historical data. The logistical flow is depicted on the right side of Figure 1. The numbers inside the shaded rectangles represent the number of minutes required by a resource to process each unit of material through each operation.

If the facility had infinite capacity, the entire market demand for Products A, D, and F could be met. But this is not the case. Table 2 derives the load as a percentage of capacity for each resource, exclusive of setup time requirements. Resource 1 would need 137% of its current capacity to produce the total units demanded. Therefore, the product mix that will maximize SIM's profit must be selected from the various possible combinations of finished units that can be produced.

Both activity-based cost systems and traditional cost systems would approach the product mix determination in a similar manner. First, the total unit cost of Products A, D, and F would be calculated. Then, using the total unit costs and the respective selling prices, the gross margins for each product would determine the relative preferences for the three products.

To demonstrate the traditional cost approach, we assume that each resource is operated by a worker who is paid $12.50 per hour, and overhead is allocated, for simplicity, on the basis of labor. The material, labor, and overhead costs for the three products under traditional costing would result in the total costs shown in Table 3, part A. The gross margin for each product is calculated in Table 3, part B. The last line of Table 3 shows that Product D is the most profitable product and, therefore, would get first production attention, Product F would be the next most preferred (profitable) product, and Product A would be the least preferred (profitable) product.

ABC requires additional information about the total weekly expenses of

TABLE 3 / TRADITIONAL COSTING

Part A: Unit Costs

	Product A	Product D	Product F
Material	$ 65.0000	$ 95.0000	$ 65.0000
Labor ($12.50 per hour)			
85 minutes	17.7083		
93 minutes		19.3750	
78 minutes			16.2500
Overhead ($21.875 per labor hour*)	30.9896	33.9062	28.4375
Total unit cost	$113.6979	$148.2812	$109.6875

$$\frac{*\$11{,}000 - [(\$12.50)(320 \text{ total labor hours})]}{320 \text{ total labor hours}} = \$21.875 \text{ per labor hour}$$

Part B: Gross Margin

	Product A	Product D	Product F
Selling price	$180.0000	$240.0000	$180.0000
Total cost	113.6979	148.2812	109.6875
Gross margin	$ 66.3021	$ 91.7188	$ 70.3125
Preference	#3	#1	#2

$11,000. Suppose a task force developed the details of resource costs shown in Table 4, part A, and resource allocations to products revealed in Table 4, part B. For simplicity, we assume that the cost driver for each resource is time spent on each unit of product.

Then these total product costs are divided by the chosen capacity (the bottom third of Table 4) to find product unit costs. Because sufficient capacity exists to produce all of Product A *or* Product D *or* Product F demanded by the market, these capacities are chosen to complete the allocation.

Note that the activity-based procedure used here does not differ conceptually from the procedures and assumptions that firms must make in real activity-based cost allocation systems.

It should be clear that the standard procedure just described implicitly assumes some specific product mix. Using the results of this analysis to select the appropriate product mix is an incongruous but accepted procedure. Table 5 shows that while the perceived gross margins of Products A and F changed significantly from those calculated using traditional cost allocation procedures, the order of product preference did not change. Using either system, if all products demanded cannot be produced due to capacity constraint(s), Product D would be produced first, then Product F, then Product A.

For the SIM facility, a sufficient amount of Resource 1 is not available to produce all units demanded. Assuming that 30 minutes of setup time will be required at C5 and E5, about 69 units of Product D can be produced. This will consume about 2,376 minutes of the total 2,400 minutes available at Resource 1. The remaining 24 minutes could be used to partially complete one unit of Product D, which would be completed for shipment the following week. Forty units of Product A also can be produced. Operating results using this product mix are shown in Table 5. The major problem is that neither the traditional method nor the activity-based method explicitly recognizes the significance of the internal constraint (Resource 1).

APPLYING TOC

The Theory of Constraints recommends that when a facility has a resource constraint, throughput (contribution margin) per unit of constraining factor can be calculated to determine the appropriate

TABLE 4 / ACTIVITY-BASED ANALYSIS

Part A: Cost Data

Resource	Labor	Overhead	Total
1	$ 500	$1,500	$ 2,000
2	1,000	1,000	2,000
3	1,000	1,800	2,800
4	1,000	2,000	3,000
5	500	700	1,200
	$4,000	$7,000	$11,000

Part B: Labor and Overhead Cost Allocations

Resource	Product A	Product D	Product F
1	– 0 –	$1,416.6667*	$ 583.3333
2	$1,000.0000**	375.0000	625.0000
3	1,320.0000**	600.0000	880.0000
4	923.0679	830.7692	1,246.1538
5	384.0000**	816.0000	– 0 –
	$3,627.0679	$4,038.4359	$3,334.4871

$* \frac{6+28}{(6+28+14)} \times \$2{,}000 = \$1{,}416.6667$ $\quad ** \frac{4+5+15}{(4+5+15+4+5+15)} \times \$2{,}000 = \$1{,}000$

Activity-Based Unit Costs – Labor and Overhead

	Product A	Product D	Product F
$\frac{\$3{,}627.0679}{40}$	$90.6767		
$\frac{\$4{,}038.4359}{80}$		$50.4804	
$\frac{\$3{,}334.4871}{40}$			$83.3622

TABLE 5 / GROSS MARGIN AND OPERATING RESULTS

	Product A	Product D	Product F
Selling price	$180.0000	$240.0000	$180.0000
Materials	(65.0000)	(95.0000)	(65.0000)
	$115.0000	$145.0000	$115.0000
Other costs	(90.6767)	(50.4804)	(80.7901)
Gross margin	$ 24.3233	$ 94.5196	$ 34.2099
Preference	#3	#1	#2

Product Mix Based on Traditional and Activity-Based Costing Procedures

(1) Product	(2) Units	(3) Selling Price Less Materials	(4) Total (2) X (3)	(5) Resource #1 Time Used
D	69	$145.00	$10,005.00	2,376 minutes
A	40	115.00	4,600.00	0
			$14,605.00	2,376 minutes
Less other manufacturing costs			11,000.00	
Net income before income taxes			$ 3,605.00	

product mix. This is the same "contribution margin per constraining factor" discussed in most cost accounting textbooks. Following the TOC approach, the key consideration in making a product mix decision is the amount of contribution margin that the firm can generate per minute of processing time consumed (Table 6).

Table 6 reveals that Product A provides the maximum contribution per unit of constraining factor (minutes of Resource 1 time available) because that product does not require any of the limiting factor, Resource 1. Thus, the first priority should be directed toward the production of the 40 units of Product A (Figure 1).

In choosing between Products D and F, the next priority should be the production of the 40 units of F that the market demands. This is because the firm will earn almost twice as much from producing and selling F ($8.21 per minute) than it would from producing and selling D ($4.26 per minute). The remaining time available from Resource 1 should be directed toward producing D. If we allow 45 minutes for setups at C5, E5, and F5, we could then produce 52 units of D as illustrated in Table 6. This product mix permits the SIM facility to maximize its net income before income taxes. Table 6 summarizes the income resulting from this optimal product mix.

The decision process described here shows how activity analysis can be used to identify the key production constraint, Resource 1. Then the Theory of Constraints philosophy should be followed and the constraint recognized as its profitability driver. Focusing on this profitability driver and selecting the best product mix increased net income before income taxes from $3,605 to $5,740, a 59% increase.

TABLE 6 / PRODUCT MIX DECISION

Contribution Margin per Minute of Constraint (Resource 1) Time

Product	Selling Price		Material Cost		Minutes of Resource 1 Time Required		Contribution Margin Per Minute
A	$180	–	$65	÷	0	=	∞
D	$240	–	$95	÷	34	=	$4.26
F	$180	–	$65	÷	14	=	$8.21

Efficient Use of Resource 1

Total machine time available 5 days X 8 hours per day X 60 minutes per hour	2,400 minutes
Time used for setups	45 minutes
Time used for F 40 units X 14 minutes	560 minutes
Time available to produce D	1,795 minutes
Time required for each unit of D = 34 minutes	

$$\frac{\text{1,795 minutes available}}{\text{34 minutes per unit}} = \underline{\underline{52.8}}\text{ units of D}$$

Operating Results – Optimal Product Mix

Product	Units	Selling Price Less Materials	Total	Resource 1 Time Used
F	40	$115.00	$ 4,600	560 minutes
D	52	$145.00	7,540	1,768 minutes
A	40	115.00	4,600	0
			$16,740	2,328 minutes
				45 minutes (setup)
Less other manufacturing costs			11,000	2,373 minutes
Net income before taxes			$ 5,740	

PRODUCT MIX DECISIONS

Activity-based analysis provides more accurate data than are provided by conventional cost allocation procedures. Such data could be useful in some limited applications. But using full unit cost data can lead to erroneous operating decisions.

The key is to use a modified activity analysis that gives recognition to resource constraints. When combined with a throughput-oriented management philosophy, activity analysis can be especially useful in product mix decisions. ■

Charlene Spoede, CMA, CPA, Ph.D., is a professor of accounting and the co-director of the Center for Manufacturing Excellence at Baylor University. She is a member of the Central Texas Chapter of the IMA, through which this article was submitted. Dr. Spoede can be reached at (817) 755-1111, ext. 4763.

Emerson O. Henke, CPA, DBA, is a professor emeritus of Baylor University and former dean of Baylor's Hankamer School of Business. Dr. Henke can be reached at (817) 755-3536.

Mike Umble, Ph.D., is a professor of management and co-director of The Center for Manufacturing Excellence at Baylor University. Dr. Umble is a Certified Quality Engineer and a Certified Fellow in Production and Inventory Management. Dr. Umble can be reached at (817) 755-1111, ext. 6239.

[1]The Theory of Constraints is introduced in Eliyahu M. Goldratt and Jeff Cox, *The Goal: A Process of Ongoing Improvement*, North River Press, Croton-on-Hudson, N.Y., 1986.

Is this article of interest to you? If so, circle appropriate number on Reader Service Card.	Yes	No
	92	93