Activity-Based Costing: A Tool for Manufacturing Excellence

ABC is a strategic weapon in the quest for competitive position.

By Peter B.B. Turney, Ph.D.

This article examines the role of activity-based costing in the achievement of manufacturing excellence. It describes manufacturing excellence and the product cost information requirements of managers who seek to achieve it. It shows how conventional product costing fails to meet these needs, and demonstrates how activity-based costing corrects these deficiencies. It explains how managers in manufacturing companies can use activity-based costing for strategic, product design, and continuous improvement purposes. Finally, the article lays to rest fears that activity-based costing may be too costly and complex to be compatible with manufacturing excellence.

Achieving and sustaining a competitive advantage via manufacturing excellence requires attention to all aspects of manufacturing performance. This attention requires that managers have information that helps them choose correct strategies, improve product design, and remove waste from operating activities.

Conventional product costing systems provide little information on these sources of competitive advantage. Schrader Bellows found that the product costs generated by their conventional system were so inaccurate they encouraged management to adopt strategies which inhibited the improvement of manufacturing.[1] Product designers at the Portable Instrument Division of Tektronix reacted to inaccurate cost information by selecting designs that increased cost without adding value to the customer.[2] The conventional system at this Division also encouraged management of the allocation and absorption of overhead rather than the elimination of waste.[3]

In contrast, activity-based costing is a costing technology that provides information for achieving excellence in manufacturing. (This technology has been named "ABC" despite the use of this term in inventory control and Pareto analysis). ABC traces costs to products according to the activities performed on them. The result is accurate cost information for three purposes: focusing manufacturing strategy, designing products to increase customer value, and continuously improving operating activities throughout the manufacturing organization.

A manufacturing company that implements a successful program of continuous improvement sees a simultaneous change in key operating characteristics.

The recent emergence of ABC is timely because rapid technological change and global competition have increased the need for accurate cost information. At the same time, declines in the cost of processing and capturing data have reduced the cost of building new systems.

What is Manufacturing Excellence?

Manufacturing excellence is the deliberate and continuous improvement of all activities within a manufacturing company with the goal of achieving a competitive advantage. This continuous improvement takes place within the framework of a competitive strategy that uses market, environment, and technical opportunities to achieve a favorable competitive position in an industry.

Manufacturing excellence requires success in three broad types of activity. First, managers must select and implement strategies based on an understanding of the relative profitability of those strategies. Second, products must be designed to profitably meet the needs of customers identified by the chosen strategies, and to facilitate excellent manufacturing. Third, managers must strive for continuous improvement in all operating activities. This continuous improvement has several objectives:

- Eliminate waste.
- Reduce leadtimes for:
  - —Customers
  - —Materials
  - —Tooling and engineering changes
  - —New product introduction.
- Increase quality.
- Reduce cost.
- Develop people: Increase skill, morale, and productivity.
- Improve continuously.[4]

A manufacturing company that implements a successful program of continuous improvement sees a simultaneous change in key operating characteristics. Cost will come down, quality will go up, and the gain in flexibility will enhance customer service. These improvements increase the odds that the company will implement its strategy successfully.

What do Managers Need from a Product Costing System to Achieve Manufacturing Excellence?

Managers need product cost information to help them achieve manufacturing excellence. They need accurate costs for strategic and product design purposes. They require information on operating activities to guide continuous improvement in these activities. This must all be provided by a system whose cost does not exceed the benefits provided.

Product costs are used by managers to make strategic and design decisions. More accurate product costs reduce the chances that incorrect decisions will be made. The cost of making incorrect decisions and the need for accurate product costs are determined by the level of competition in the firm's markets.[5]

Managers also need activity-level information from the product costing system to guide continuous improvement. Activities are processes or procedures that cause work. Activity level information allows managers to identify and eliminate waste in these processes and procedures. It also confirms progress at removing waste from operating activities.[6]

Managers who are working hard to simplify manufacturing and eliminate waste do not wish to introduce a product costing system that is excessively costly to design, implement, and run. This cost should not exceed the perceived benefits of the system. Nor must the system be more complex than is necessary to achieve the required benefits.[7]

Conventional Product Costing Systems

Conventional product costing systems assume that *individual products cause cost.* They therefore make the individual product item the focus of the cost system design. Conventional systems use cost drivers[8] that are attributes of the product item such as direct labor hours, machine hours, or material dollars.

Conventional product costing systems may report accurate product costs where overhead activity is consumed in relation to production volume. Benefits for direct employees may be related to direct labor, for example, and power costs may be related to machine hours.

Product costs may be inaccurate, however, where overhead activities are not related to volume. Volume-unrelated activities are common in many manufacturing settings, and include setups and engineering changes. There are a number of documented examples of such settings, such as in the screw machine shop of the John Deere Component Works, where conventional systems report inaccurate product costs.[9]

In manufacturing settings where volume-unrelated activities are significant, conventional product costs do little to enlighten managers' understanding of the relationship between the operating activities that generate the overhead cost and the products. In the absence of proper information, managers tend to rely on across-the-board overhead cuts to control spending.

Such well intentioned efforts are doomed to failure. They do not address the demand for overhead resources—the activities that keep people busy. Deterioration in the quality of service and pressures on an overburdened staff prompt renewed spending, and overhead creeps up again.

Conventional systems also convey messages that may encourage decisions that conflict with manufacturing excellence. A direct labor-based overhead rate, for example, may cause design engineers to believe that product design should emphasize the elimination of direct labor cost. The costing system tells them that direct labor is very expensive. Where the direct labor overhead rate is 500 percent, a design change that will remove $1 of direct labor cost from a product will result in a reported savings of $5 of overhead.[10] In reality, not only has the engineering department *not* gone away, the design change is likely to *increase* overhead due to the increased demand for engineering change-related activities.

Activity-Based Costing Systems

Underlying ABC is the assumption that *activities consume resources and products consume activities.* Activities include establishing vendor relations, purchasing, receiving, disbursing, setting up a machine, running the machine, reorganizing the production flow, redesigning the product, and taking a customer order. The performance of these activities triggers the consumption of resources that are recorded as costs in the accounts. The activities are performed in response to the need to design, produce, market, and distribute products.[11]

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Each product picks up cost in ABC according to the number of driver units consumed. If the number of times shipped is a driver, for example, a product will pick up the cost of shipping activities according to the number of times the product is shipped multiplied by the cost per shipment. This cost is divided by the number of product items to get the cost per product item (Fig. 1). This view of the economics of manufacturing is radically different from the conventional view, and may report more accurate product costs.

Consider the case of a company that produces two different products requiring different levels of attention from engineering (Fig. 2). Product A uses a lot of direct labor,

How Activity-Based Costing Works: The Shipping Example

Plant shipping cost	$100,000	
Number of shipments	1000	
Cost per shipment =	$100	
	Product A	**Product B**
Volume	1000	1000
Number of shipments	2	20
Product shipping cost	$ 200	$2000
Cost per product item	$ 0.20	$ 2.00

Fig. 1.

- **Each product consumes cost according to its specific use of the shipping activity**
- **Product A is shipped infrequently in large lots. Relatively little shipping cost is therefore traced to this product.**
- **Product B requires Just-In-Time (JIT) delivery. The higher shipping cost traced to this product reflects its frequent shipment.**
- **The cost of an individual shipment is determined by the efficiency with which this activity is performed.**
  Note: This example assumes that the resources required for each shipment of Products A and B are the same.

How ABC Can Correct the Inaccuracies of Conventional Costing

	Product C	**Product D**	**Total**
Production Volume	1000	500	
Cost per engineering change	$1000	$1000	
Number of engineering changes	2	10	
Total cost of engineering changes	$2000	$10,000	$12,000
Direct labor hours per unit	3	2	
Total direct labor hours	3000	1000	4000
Engineering change cost per direct labor hr.($12,000/4000)			$3.00
ABC overhead cost per unit (C = $2000/1000 D = $10,000/500)	$2.00	$20.00	
Conventional overhead cost per unit (C = $3.00 x 3 direct labor hours D = $3.00 x 2 direct labor hours)	$9.00	$6.00	

Fig. 2.

- **Product A requires relatively little engineering attention. It picks up a lot of engineering cost, however, under a conventional system that loads overhead onto direct labor.**
- **Product B, in contrast, requires a lot of engineering attention. It receives relatively little engineering cost in the conventional system because it uses little direct labor.**
- **ABC corrects these errors by tracing engineering costs to the two products based on a driver—engineering changes—that is chosen to reflect the consumption of engineering resources.**
  Note: This example assumes that each engineering change consumes the same amount of resources. If this assumption is not true, the design of the ABC system can be modified to reflect these differences.

but has been in production for some time and most bugs have been eliminated. Product D, however, is a new product that is designed to require less direct labor. It still has production and quality problems that require a number of engineering changes.

ABC traces the costs of engineering change activities via a cost driver, such as the number of engineering change orders, to the product that receives the benefit of this activity. Product B required 10 engineering change orders, versus two for Product A, so Product B picks up an amount of cost that reflects its use of engineering time.

Traditional product costing, however, traces engineering cost using direct labor. This volume-related driver traces an equal amount of engineering cost to each direct labor hour. Product A accounts for three labor hours per unit, versus two for product B, so product A picks up engineering cost that exceeds its actual consumption of this activity. Product B, with only two direct labor hours, receives less engineering cost than it deserves.

This miscosting—where one product picks up cost that rightly belongs to another—is known as cross-subsidy. Cross-subsidy occurs in conventional systems because volume-related cost drivers fail to trace volume-unrelated activities correctly. In contrast, ABC eliminates cross-subsidy by using volume-unrelated cost drivers, such as the number of setups, to trace the cost of volume-unrelated activities to the product.

The process of designing and implementing an ABC system yields a wealth of information on operating activities that can be used by managers to eliminate waste. This information includes an identification of activities performed in the organization, a determination of the cost of each of these activities, an identification of where in the organization the activities are performed, and the consumption of these activities by individual products.

For example, in Fig. 3 the ABC system shows that two activities are performed in the process engineering department: performing setups

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and making engineering changes to products. Each of these two activities is performed in two different departments (Departments 1 and 2). In each department the activities are consumed by products according to the demand for setups and engineering changes of each product.

Using Activity-Based Costing to Focus Manufacturing Strategy

ABC can radically change the way managers determine the mix of their product line, price the products, identify the location for sourcing components, and assess new technology. It provides a realistic economic picture of the impact of these decisions on activity consumption.

Consider the case of Schrader Bellows.[12] This manufacturer of pneumatic valves changed its product mix over time by introducing low-volume specialty products into its line. Each of these products consumed engineering, procurement, quality, setup, and other activities. Introducing one or even a handful of these products did not require the hiring of a new engineer, purchaser, inspector, or setup person. But over time, as new products were added, the demand for these activities increased to the point where new staff were required.

The introduction of these low-volume specialty products was, in part, a response to information reported by Schrader Bellows' conventional direct labor-based product costing system. This system showed that the low-volume specialty products cost about the same as the high-volume standard products. The cost system reported that they were among the most profitable products sold by the division.

A new ABC system, however, showed that these low-volume products were more costly than had been previously thought. ABC reported that their costs, in most cases, were 100 to 1000 percent greater than the previously reported standard costs. Using this information, management was able to consider a range of alternatives, such as dropping certain products, increasing their price, or changing their design, that would simplify manufacturing or compensate the company for the additional activities required by the products.

ABC Reveals Information About Operating Activities

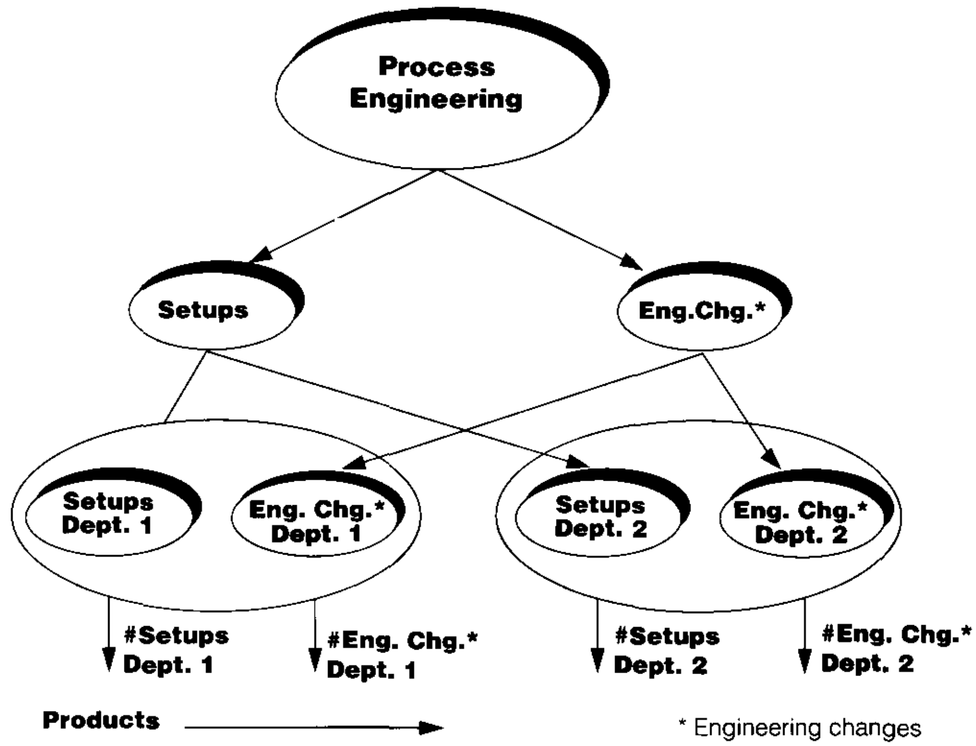

Fig. 3.
- ABC decomposes each functional area into its component activities.
- Activities are grouped together to reflect similarities of location or type.
- The consumption of the activities by the products is measured by cost drivers such as the number of setups and the number of engineering change orders.

ABC also helps management understand the impact of sourcing decisions. Sourcing decisions often focus on the elimination of direct labor that results from using outside sources but ignore the additional activities required to coordinate with the vendor. These activities may include qualifying the vendor to make the sub-assembly, shipping components to the vendor's plant, receiving and processing the completed sub-assemblies, monitoring quality and delivery, and processing purchase orders and invoices. ABC provides the insights needed to weigh the impact of these activities on the sourcing decision.

ABC also allows managers to understand the impact of new process technologies. Introducing a new technology such as surface mount equipment, improving quality to reduce inspection, and reorganizing the plant layout to create a continuous linear flow of product all have major impacts on the type of activities required and the way they are performed. ABC can model these changes accurately and provide management with the data required for an economic analysis.

The process of designing and implementing an ABC system yields a wealth of information on operating activities that can be used by managers to eliminate waste.

Using Activity-Based Costing for Product Design

Using ABC to understand the impact of alternative product designs is the key to using design as a tool of manufacturing excellence. Product design determines the activities that are consumed by the products.

ABC allows design engineers to understand the impact of different designs on product cost and flexibility. Product cost can be reduced by using designs that diminish the demand for high-cost activities. Product cost can be reduced and manufacturing flexibility improved by designing families of products that use many of the same activities.

Hewlett-Packard's Roseville Network Division, for example, developed an ABC system to guide product design.[13] An early design of the system used the number of insertions as a cost driver, but did not distinguish between axial and DIP (dual in-line processor) insertions. As a result, the design engineers did not distinguish between these two types of components on the basis of insertion cost. A study based on ABC technology, however, showed that axial insertions were about one third the cost of DIP insertions. The ABC system was modified to differentiate between axial and DIP insertions. The engineers then used this information to guide subsequent product designs.

Product XYZ Summary Bill of Activities

Activity	Cost
Receiving	$1.87
Procurement	2.19
Raw material inventory	2.99
Finished goods inventory	1.34
Engineering changes	4.75
Rework	2.88
Quality	1.34
Setup	5.21
Manufacturing-Dept. 1	4.12
Manufacturing-Dept. 2	2.02
Total Product Overhead	**$28.71**

***Fig. 4.* The summary bill of activities groups each product's activities according to meaningful economic or functional categories:**

- Activities performed in a single functional area—such as receiving—may be grouped together to show the impact of that department on the cost of each product.
- Activities may be summarized by economic types of activity that are unrelated to organizational structure. Quality-related activities, for example, may be performed in various parts of the organization. They may be summarized in the bill of activities, however, to show each product's total cost of quality.

Using Activity-Based Costing for Continuous Improvement

ABC provides critical information to support the process of continuous improvement in manufacturing. ABC maps the company's activities and describes the cost structure of the products in terms of activity consumption.

Identifying the activities that are performed in each area of the company provides management with insights into eliminating activities or improving the efficiency of activity performance. Northern Telecom, for example, used ABC to identify recommended changes in procurement activities and to monitor progress when the changes were implemented. Prior to the changes, the buyer received a weekly printout of the production plan and material requirements. The buyer visited the stockroom to compare the requirements with the quantity on hand. If there was a shortfall, the buyer called the vendor and placed an order.

After studying the cost of this procurement activity as reported by ABC, Northern Telecom replaced the above procedure with a trigger based on Kanban quantities in the assembly area. A red flag on a Kanban was the trigger for a call to the vendor to replenish the parts on the Kanban. Manufacturing proposed to track the impact of this change using ABC.

The activity-based product cost structure in ABC also provides important performance information for management. This cost structure—referred to as the bill of activities—describes each product's pattern of activity consumption. The bill may summarize activities consumed by a product into economic or functional groupings such as receiving, procurement, engineering changes, and quality (Fig. 4). The bill may also provide detailed information on the activities themselves (Fig. 5). In both cases the bill of activities is a source of information for setting manufacturing excellence targets for process and design improvement.

In the case of the screw machine shop at John Deere Component Works, for example, review of the bill of activities of screw machine parts showed that the movement of parts was a costly activity. This insight led management to move a heat treatment facility from one mile away to a site adjacent to the screwmachine manufacturing area, eliminating the cost of moving the parts.[14]

Is Activity-Based Costing Consistent with Manufacturing Excellence?

A company that implements an ABC is adding a new system that requires design, training, and maintenance resources. An important test of a new system is whether it contributes to the goals of manufacturing excellence—eliminating waste, and improving quality and flexibility. Otherwise the system adds unnecessary complexity and becomes a waste itself. Robert W. Hall made this point well in his discussion of Shigeo Shingo's seven wastes of manufacturing:

"Were he more familiar with Western manufacturing, Shingo might have added an eighth waste: unnecessary measuring, recording, and managing in an effort to deal with unnecessary complexity."[15]

It is my belief—based on the experience of managers using ABC ▷

in a variety of manufacturing situations—that a properly-designed ABC does not add unnecessary complexity. It is a tool for the reduction of waste and the improvement of manufacturing:

1. *ABC helps managers understand and eliminate waste.* ABC provides a road map to the complexity of a manufacturing organization. It describes and costs the activities being performed. It helps management understand an important source of complexity—the demands placed on the organzation by a diverse range of products. Once managers understand what is keeping the organization busy and where the demands for activities come from, they focus on eliminating both the demand for the activity and possibly the activity itself.
2. *ABC helps prevent product design and marketing from placing unreasonable demands on production.* ABC is a tool for communicating to product design and marketing the impact their decisions have on production. With the information an ABC provides, the engineers can avoid designs, such as those with a high part count, that create complexity (as measured by ABC) without adding features valued by the customer. Marketing can pick strategies that avoid product proliferation which creates complexity unjustified by added customer value.
3. *ABC system design avoids unnecessary complexity.* The cost of designing, implementing, and maintaining an ABC can be reduced by simplifying its design. The ABC designer can avoid using data that are not already available within the company. In some companies, for example, he can take advantage of data that already exist in the manufacturing data base like the number of production runs. The ABC designer can also take advantage of design rules that simplify the system without sacrificing the accuracy of product cost. For example, tasks that are performed at the same time, such as changing the tools on a machine and inspecting the first part, can be combined as one activity with one cost driver such as the number of setups.[16]
4. *The complexity of an ABC system matches the complexity of manufacturing.* A complex manufacturing organization will require a system that is sufficiently detailed to capture the patterns of activity performance and consumption. A simple manufacturing organization—such as one where products of similar design are built on a single line as a family of products and/or where manufacturing improvement programs have eliminated activities such as incoming inspection and receiving —requires a simple ABC system. In one organization that was well advanced in its manufacturing improvement program, for example, the ABC system used just two product drivers—cycle time and part numbers—to measure the consumption of activities by the products.

Product XYZ Detailed Bill of Activities

Activities	Cost	
Raw Material Inventory:		
# of raw material shipments	$1.02	
# of purchased part shipments	1.33	
# of setups	0.64	
	———	$2.99
Quality:		
# of setups	$0.88	
# of purchase orders received	0.46	
	———	$1.34

Fig. 5. **The detailed bill of activities lists the activities, and the cost of each activity, required to design, produce, and distribute a product.**

- Each activity in the bill is described by its cost driver. The cost driver measures the use of the activity by the product.
- The bill of activities shows how each product uses activities, and how much that use costs, in the manufacturing organization.
- This example bill shows three raw material inventory activities and two quality activities. A bill that lists all the activities of a product can be quite extensive if the product is complex.
- Reducing product cost requires product or process improvements that reduce the demands for activities and reduce the resources required by each activity.

Conclusion

ABC is used in a number of ways to support manufacturing excellence. ABC provides information for strategic decisions, such as product mix and sourcing decisions, that is consistent with the long-run nature of these decisions. ABC allows product designers to understand the impact of different designs on cost and flexibility and modify their designs accordingly. ABC supports the continuous improvement process by allowing management to gain new insights into activity perfor-

Using Activity-Based Costing for Behavioral Change

Some companies use ABC as a behavioral tool to focus attention on one or two critical aspects of manufacturing excellence. The Portable Instrument Division of Tektronix, for example, used ABC to drive down the part count and the number of vendors. These reductions were considered critical to accomplishing cost, quality, and flexibility goals of their manufacturing excellence program.

This division used the number of part numbers as a product driver for procurement, storage, receiving, and part data base maintenance activities. Because each part number received the same cost regardless of volume, the cost per part was much less for high-volume part numbers than for low-volume part numbers. This situation made it more expensive for the product designer to use a low-volume unique component than a high-volume common component.

The result was that the design engineers used substantially fewer unique components in their product designs. The part count for the division fell from about 6000 to 1500 in three years, while the number of vendors fell from over 1500 to less than 200 in the same time period. Procurement overhead fell, quality improved, and several products that had previously been produced on separate lines were now produced on the same line.

In another case, Zytec, a manufacturer of power supplies, used cost drivers to focus attention on the need to reduce the elapsed time from the time orders were placed for components to the time the finished product was shipped to the customer. Order leadtime for components was used as a cost driver to trace the cost of procurement activities to the product. Manufacturing cycle time was used to trace manufacturing overhead to the product. This focus on elapsed time was consistent with a manufacturing strategy that emphasized cost, quality, and flexibility—all three of which the company believed were a function of time.

mance, by focusing attention on the sources of demand for activities and by permitting management to create a behavioral incentive to improve one or more aspects of manufacturing.

ABC is a tool for managing complexity in manufacturing. ABC provides activity-based information to help managers understand and eliminate complexity. It is also a communication tool between production and marketing and product design that helps minimize product changes which create unnecessary complexity.

The benefits of ABC can be achieved without designing a system that is more complex than necessary. The ABC designer can use the rules of ABC design to simplify the system without sacrificing the accuracy of product cost. A well-designed ABC system will also have no more detail than that required by the manufacturing environment. An ABC for a simple manufacturing setting, for example, will be a simple system.

ABC . . . is also a communication tool between production and marketing and product design that helps minimize product changes which create unnecessary complexity.

The experience of the companies described in this article shows that ABC is a strategic weapon in the on-going quest for competitive position in manufacturing. For these companies, ABC is an indispensable, flexible, and cost-effective tool for manufacturing excellence that is tailored to the needs of their competitive and manufacturing conditions.

[1]Robin Cooper, "Schrader Bellows," 9-186-272 (Boston: Harvard Business School), 1986.

[2]Robin Cooper and Peter B.B. Turney, "Tektronix: The Portable Instrument Division (A), (B), and (C)," 9-188-142/3/4 (Boston: Harvard Business School), 1988.

[3]Peter B.B. Turney and Bruce Anderson, "Accounting for Continuous Improvement," *Sloan Management Review,* Winter 1989.

[4]Robert W. Hall, *Attaining Manufacturing Excellence,* (Homewood, IL: Dow-Jones Irwin, 1987), p.22.

[5]Robin Cooper, "The Rise of Activity-Based Costing—Part Two: When Do I Need an Activity-Based Cost System?" *Journal of Cost Management,* Fall 1988, Vol.2, No.3, pp.41–48.

[6]H. Thomas Johnson, "Activity-Based Information: Accounting for Competitive Excellence," *Target,* Spring 1989.

[7]Robin Cooper, "The Rise of Activity-Based Costing—Part Two: When Do I Need an Activity-Based Cost System?"

[8]In this context, a cost driver is a measure of the consumption of activities by the product.

[9]Robert S. Kaplan, "John Deere Component Works," 9-187-107/8 (Boston: Harvard Business School), 1986.

[10]Direct labor overhead rates in excess of 500 percent are not unusual in today's manufacturing environment where direct labor has declined and overhead has increased as a percent of manufacturing cost.

[11]Much of this section is based on the work of Robin Cooper. See, for example, "The Rise of Activity-Based Costing—Part One: What is an Activity-Based Cost System?" *Journal of Cost Management,* Summer 1988, Vol.2, No.2, pp.45–54.

[12]Robin Cooper, "Schrader Bellows."

[13]Robin Cooper and Peter B.B. Turney, "Hewlett Packard: The Roseville Network Division" (Boston: Harvard Business School), 1989.

[14]Robert S. Kaplan, "John Deere Component Works."

[15]Robert W. Hall, *Attaining Manufacturing Excellence,* pp. 24–25.

[16]Robin Cooper, "The Rise of Activity-Based Costing Part 3: Determining the Number and Nature of Cost Drivers," *Journal of Cost Management,* Winter 1989, Vol.2, No.4, pp.34–46.

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