Cases

13-1 California-Illini Manufacturing

The California-Illini Manufacturing Company's (CI) plant operates in the rural central valley of California. It is family-owned and run. CI's plant manager, a grandson of the founder, went to school with many of the employees. Despite this family atmosphere, CI is the largest producer of plain and hard-faced replacement tillage tools in the United States. It averages annual sales of $13 million. Farmers use tillage tools to cultivate the land. Hard-facing, the application of brazed chromium carbide to leading edges, increases a tool's durability.

THE PRODUCTION PROCESS

Historically, CI grew from the founders' original blacksmith shop, and today the production process is still relatively simple. The plant manager described the process as "You simply take a piece of metal. And then you bang, heat, and shape it until it's a finished product. It really isn't a sophisticated process. We just do it better than anyone else." The production process is like a flow following a routing from one cost center to another in a sequence of move, wait, setup, and runtime for each process. Work-in-process inventories in the move and wait stage litter the plant. Economic lot size rules determine the size of each batch while production schedules push jobs onto the floor.

THE COST SYSTEM: MEASURING PERFORMANCE

CI uses standard unit costs to measure performance and profit potential. In this cost system, each materials and labor input is given a standard usage, and production managers are evaluated on their ability to meet or improve upon these standards. Differences from the standard were called “variances.” For example, if a certain manufacturing operation required at standard 5 minutes, the operator would be expected to complete a lot of 100 parts in 500 minutes. If actually 550 minutes were required, there would be a 50 minute unfavorable variance. Also, using the operator’s wage rate, the cost of the variance could be calculated.

CI’S IMPROVEMENT STRATEGY

The depressed market in the mid-1980s caused a 1986 net loss of close to $1.8 million. Inventory turns were down to one and a half, and cash flow was poor. Facing these conditions, management adopted a new strategy stressing improvements in accounting performance and reduction of inventories. Their strategies for improvement included: increasing productivity, cost cutting (overhead control), improving technology, and increasing prices.

1. **Productivity**. Productivity improvements centered on direct labor productivity measures. Output per direct labor hour was the crucial factor. Accordingly, improving efficiency, by definition, consisted of keeping direct labor busy producing as much product as possible during regular working hours. Actions supporting this strategy were 1) reducing idle manhours between jobs, 2) increasing batch sizes to maximize runtime, and 3) reducing setup times.

   The operational control system measured the "earned labor hours" for each department daily. While the plant manager only received these reports weekly, he was still aware of the daily figures. Budget reports, including variances, while processed monthly, were often two to three weeks late! Thus, they had little direct impact on day-to-day decisions. However, the plant manager knew what the accounting reports should be like from his daily earned labor hours information.

   The short-term results of these efforts were impressive because plant efficiency measures rose about 15%. There were, however, some negative, unanticipated side effects in work-in-process levels, scheduling, and overtime.

   First, work-in-process levels increased. In order to improve efficiency measures, departments kept processing large lots regardless of current demand. Once a machine had been set up, to economically justify large batches, the rationale was to provide for both current and future inventory needs. Consequently, finished goods grew from two to six-months' supply.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Second, the large batch sizes made scheduling difficult. They reduced plant flexibility by keeping machines on single jobs for long periods. Therefore, it was difficult to adjust for normal production problems and still maintain the production schedule. Machines were not readily available for special situations and expediting.

Finally, these large batches, while increasing productivity, created the need for overtime to maintain the schedule. Overtime in the finishing department, for example, increased by 15-20%, thus raising operating expenses. The larger lots reduced the variety of products produced each production period. This increased the lead time for custom orders could get stuck behind jobs with long runtimes. Overtime, then, became necessary to expedite out-of-stock orders. These factors combined with low sales volumes to create losses and more cash flow problems.

2. **Overhead.** Overhead improvement focused on two strategies. The first was direct cost reduction. The second concentrated on reducing unit costs by increasing volume. The higher volumes allowed overhead to be absorbed over more units. However, because CI's cost structure had large fixed obligations (like union contracted pension fund contribution), potential overhead savings were minimal.

   The results of these strategies were unimpressive. The union didn't make many concessions, and few overhead savings occurred. Production volumes did increase, but the plant was producing to cover overhead rather than to satisfy immediate demand. Management hoped that increasing sales would eventually take care of the excess production. Unfortunately, this didn't happen. By 1989 inventories were 24% higher than in 1986. And, once again, there were cash flow and earnings problems.

3. **Technology.** CI considered the technology focus to be particularly troublesome. Concentrating on reducing unit costs through technology improvement often blocked out other aspects of the decision. Management's assumptions were that the savings from each decision flowed directly to the bottom line. However for CI this myopic view of unit costs encouraged mistakes.

   Management's use of robots provided a vivid example of the problems. Robots were investigated as a means of decreasing the unit costs for the application knife. The anhydrous ammonia applicator knife was popular worldwide, to revitalize the soil with ammonia fertilizer after each harvest. Although CI led the industry in product quality, it was a high-cost producer. The primary reason was determined to be hand welding, using expensive piece rates, with manual electric arc welders.

   After a unit-cost analysis, the savings in labor and applied overhead seemed to justify the introduction of welding robots (Tables 1,2,3). Subsequent price reductions increased sales from 20,000 to more than 60,000 units in the first. At the new, lower, price the company seemed to still realize savings of $1.25 per unit.

   Unfortunately, these savings were illusory. During the second year, other manufacturers became price competitive and sales volume dropped to 40,000 units; however, management still believed the robots saved the company money. At a 10% discount rate the three-year net present value was $63,730. A major problem was that labor savings disappeared as manual welders found work in other areas of the plant. In fact, the robots required additional new hires and caused increases in utilities and maintenance costs. New operating expenses were greater than the increased throughput. Thus, management was misled by its focus on standard unit costs.

4. **Selling Prices.** Unfortunately, the market for the firm's products was very competitive. Due to such macroeconomic factors as government programs and foreign grain production, the domestic market was shrinking. Internationally, CI's high unit costs made foreign markets difficult to enter. Consequently, management perceived the marketplace to be mostly out of their control. Their main focus was on improving plant performance. Nonetheless, CI still tried to increase the sales volume in domestic markets and to find new foreign markets. As for the foreign markets they experienced some success and some failures.

   In an attempt to find new international markets, the company successfully set up a working relationship with a John Deere distributor in Mexico and, unsuccessfully pursued a contract in Saudi Arabia. This failure was very revealing because Saudi Arabian soils were made to order for CI's product. The Saudi's cultivation process was particularly abrasive for tillage tools. Because of frequent breakdowns, crews with replacement parts had to constantly follow the field workers. But with CI's parts this practice wasn't necessary. Consequently, the Saudis were very enthusiastic about the company's products. Unfortunately, CI did not believe the 10% profit margins to be large enough. CI rejected the Saudi Arabia offer. This happened while at the same time the plant was having difficulty with operating expenses, overhead, and inventories. Thus, the accounting cost standards influenced market decisions as well as leading to questionable, limited improvements in manufacturing. All was not harmonious among management as well.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

During this time, marketing and production meetings were frequent. Marketing pointed out that while quality was good, prices were too high and lead times were too inaccurate. On the other hand, production complained that marketing was constantly messing up their production schedules.

Using this combination of efficiency improvement, overhead reduction, unit-cost reductions and sales margins, management proceeded, over an 18-month period, to reduce domestic volume by 11.5% and to turn away significant foreign opportunities. Overall, decisions to improve the performance of the company using standard cost measurement failed. By February 1989, operating expenses were 20% greater than the disastrous 1986 figures. During the same period, inventories increased by 24%, and net profits continued to deteriorate.

At year-end CI hired a new Production Control/Inventory Control (PCIC) manager. However, the plant manager was suspicious when the PCIC manager came to him with revised schedules. The PCIC manager suggested processing job lots of 100 to 150 part rather than the current 6,000. The plant manager questioned the PCIC manager's ability. "Clearly he isn't very knowledgeable. How can we make any money running only small lots? The setup costs will kill us!

Finally the PCIC manager gave the plant manager a copy of The Goal by E. Goldratt and J. Cox. After reading the first few pages, the plant manager recognized many similarities between his plant and the one described in this book.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

REQUIRED:

1. What is the firm's competitive strategy? Does the strategy seem appropriate?
2. What motivated the cost reduction strategy? Did the cost reduction strategy work? Why?
3. How did CI's standard cost system affect the cost reduction strategy?
4. What is the role of work-in-process in the cost reduction strategy?
5. Is the new Production control/Inventory Control (PCIC) manager on the right track with the smaller lot sizes?
6. What steps is the PCIC likely to take now?
7. What type of cost system should be used at CI?

(IMA adapted)

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

TABLE 1
IMPACT OF ROBOTICS ON STANDARD COST
ANHYDROUS AMMONIA KNIVES

Department	Material: Before	After	Labor: Before	After	Overhead: Before	After	Total: Before	After
Cold Shear	$2.000	$2.000	$0.068	$0.068	$0.238	$0.238	$2.306	$2.306
Hot Forge			$0.127	$0.127	$0.445	$0.445	$0.572	$0.572
Heat Treat			$0.025	$0.025	$0.088	$0.088	$0.113	$0.113
Shot Blast			$0.025	$0.025	$0.088	$0.088	$0.113	$0.113
Arc Weld	$6.500	$6.500	$1.380	$0.250	$4.830	$0.875	$12.710	$7.625
Paint/Pack			$0.076	$0.076	$0.266	$0.266	$0.342	$0.342
Total	$8.500	$8.500	$1.701	$0.571	$5.954	$1.999	$16.155	$11.070
Selling Price							$18.150	$14.310
Gross Margin							12.353%	29.274%
Unit Profit							$1.995	$3.241
Note – OH/DL = 3.5/1								

TABLE 2
IMPACT OF ROBOTICS ON STANDARD COST
ANHYDROUS AMMONIA KNIVES

Year	Unit Savings	Unit Sales	+(–) Profits	Present Value (10%)
1	$1.245	6,000	$ 74,700	$ 67,909
2	$1.245	4,000	49,800	41,157
3	$1.245	4,000	49,800	37,415
Total			$174,300	$146,482
Initial investment				$ (60,000)

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Net present value	$ 86,482

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

TABLE 3
IMPACT OF ROBOTICS ON STANDARD COST
ANHYDROUS AMMONIA KNIVES

Actual Results:

Year	Net Additional: Labor	Maintenance	Utilities	Total Additional: Expenses	Net Additional: Throughput	+(-) Profits	Present Value (10%)
1	$52,000	$2,000	$4,000	$ 58,000	$155,600	$97,600	$88,727
2	$92,000	$2,000	$4,000	$ 98,000	$ 39,400	($58,600)	($48,430)
3	$92,000	$2,000	$4,000	$ 98,000	$ 39,400	($58,600)	($44,027)
Total				$254,000	$234,400	($19,600)	($3,730)
Initial Investment							($60,000)
Net Present Value							($63,730)

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

13-3 Nebraska Toaster Company: Target Costing Case

Thomas W. Lin

Through market research and competitor analysis Nebraska Toaster Company has found a market for toaster oven new product that is not currently being produced by competitors. This new toaster can toast bagels or regular toast bread or grill sausages. It will be targeted for a consumer group of young family households. The customer requirements and important features to the consumer have been identified and the Nebraska Toaster Company will focus on these for the toaster oven design. The criteria are:

Toasts properly
Size
Speed of toasting
Toaster capacity
Appearance
Easy to clean

Nebraska Toaster Company wants to competitively match the price toaster oven to basic toasters; the competitive market price is $20.00. Nebraska Toaster Company wants to earn a profit of 20 % of sales price. Relevant cost information for the company follows in Table 1. Most of the life cycle activities are done inside the firm, but shipping is outsourced.

Table 1 Life Cycle and Value Chain Analysis

Value Chain	***Inside***			***Outside***			***Total***		
Life Cycle	**Target**	**Current**	**Gap**	**Target**	**Current**	**Gap**	**Target**	**Current**	**Gap**
R&D	$ 4.00 (25%)	$ 4.20	$ 0.20				$ 4.00 (25%)	$ 4.20	$0.20
Manufacturing	9.00 (56%)	12.00	3.00				9.00 (56%)	12.00	3.00
Selling	1.60 (10%)	1.80	0.20				1.60 (10%)	1.80	0.20
Shipping				$ 0.90 (6%)	$ 1.00	$ 0.10	0.90 (6%)	1.00	0.10
General Adm.	0.50 (3%)	0.70	0.20				0.50 (3%)	0.70	0.20
Total	**$ 15.10 (94%)**	**$ 18.70**	**$ 3.60**	**$ 0.90 (6%)**	**$ 1.00**	**$ 0.10**	**$16.00**	**$19.70**	**$3.70**

The toaster company through value engineering and continuous improvement plans to determine a way to reach the target cost by looking at the products life cycle and its value chain activities to determine where to reduce costs.

Step 1-- Product Functional Cost analysis

Nebraska Toaster Company plans to implement functional analysis to target areas of cost reduction. Here the company breakdowns the current $12.00 manufacturing costs (from Table 1 "Manufacturing" row and "Total

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Current" column) for the toaster oven by the components' estimated costs and functions performed. The result is in Table 2.

Table 2 Product Functional Cost Analysis

Component	Function	Current Cost	% of Cost
Heating Unit	Toast bagels or grill sausages	$2.40	20
Display Light	Indicates the process of toasting or grilling	1.60	13
Lever	Lowers bagels or sausages into toaster & initiates toasting or grilling	0.60	5
Spring Coil	Pops up bagels or sausages when toasted or grilled	0.60	5
Temperature Control Timer	Controls degree of toasting or grilling	0.60	5
Body Design	Holds bagels or sausages	5.10	43
Crumb and Grease Catcher	Catches crumbs and greases & is removable for cleaning	1.10	9
TOTAL		$12.00	100%

The Nebraska Toaster Company plans to rank the features of the new bagel toaster according to customer preferences and requirements, in Step 2.

Step 2 -- Customer Requirement Analysis

Nebraska Toaster Company selected a customer focus group to rank the six most important characteristics or requirements as shown in Table 3.

Table 3 Customer Requirement Analysis

Customer Requirements	**Customer Ranking**	**Relative Ranking**	
	Ranking is from 1-5, 5 the most important	**Raw Score**	**%**
Toasts and grills properly	5	5	28
Size	3	3	17
Speed of toasting or grilling	3	3	17
Toaster oven capacity	2	2	11
Appearance	1	1	5
Easy to clean	4	4	22
TOTAL		**18**	**100**

The customers rank the criteria -- toast or grill properly, cleaning, and size -- as the most important relative to the other customer characteristics or requirements. The next process compares the customer requirement features to the component functions.

Step 3 -- Quality Function Development Analysis

Nebraska Toaster Company engineers assessed the new toaster oven product's functional performance as shown in Table 4.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Table 4 Quality Functional Performance Assessment

Components or Functions	Heating Unit	Display Light	Lever	Spring Coil	Temp. Control & Timer	Body Design	Crumb Catcher	
Customer Requirements								**Total**
Toasts properly	50 %		20 %	20%	10%			100%
Size	50 %					50 %		100%
Speed of toasting	70 %				10 %	20 %		100%
Toaster capacity	30 %		5 %			60 %	5 %	100%
Appearance		20 %				80 %		100%
Easy to clean	50 %					45 %	5 %	100%

Required:

1. Calculate the target cost for the toaster
2. Using the information above, develop a ranking of product functions that gives the company the importance and value of each component relative to the features that create value to the customer.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Readings

13-1 Targeting Costing at a Consumer Products Company

By: Mohan Gopalakrishnan; Janet Samuels, CPA; and Dan Swenson, CMA

Does the following sound familiar? Your company has developed a new product. You determined the product cost, added a markup, and came up with a price of $5.82 per unit. Your competitors, however, sell comparable products for less than $5.00 per unit. Now managers are scrambling to cut costs while trying to determine if they should proceed with the new product or scrap it. Many companies follow the process where they develop new products, calculate prices based on cost plus a markup, and don't really scrutinize costs until it's almost too late. At this point, management has a much more difficult time delivering a profitable product. Conversely, some companies use a target-costing approach when developing new products. Target costing assumes that prices are market driven. Many describe a target cost as an allowable cost and calculate it by subtracting the desired profit margin from the product's selling price. The target cost is considered throughout the product development cycle. Companies manufacture and sell products that they can produce at or below a target cost and redesign and abandon products with costs that exceed the target cost.

While many people focus on the calculation of a target cost or "cost target," target costing is a process. It differs from cost-plus pricing in that it's a way of managing the product-development process. The target-costing process focuses on six key principles: price-led costing, customer focus, focus on design of products and processes, cross functional teams, life-cycle cost reduction, and value-chain involvement. To date, most target-costing applications in the United States have been at large companies in the transportation, heavy equipment, large appliance, automotive, and electronics industries. Competitive pressure was often the driving force behind these implementations. Target costing has been advocated as especially effective for companies with extensive supply chains that face globalization in price-aggressive marketplaces. Even though the consumer products industry doesn't have all of these characteristics, it does face extensive competitive pressures, and the principles of target costing still apply. Nevertheless, very few consumer products companies have actually implemented target costing. A large global manufacturer and supplier of personal homecare products is a notable exception. Headquartered in the southwestern U.S., this company has aggressively applied target-costing principles to introduce new products. Given the competitive nature of the consumer products industry, this company uses target costing as a cost-control tool during product and process design for its new product introductions. Target costing can be broken down into five steps, as Figure 1 shows. We will discuss how the consumer products company used each step during its product development process. Then we'll explain how it linked target costing to Stage Gate, another corporate initiative already in place, to bolster target costing's credibility and avoid the perception that it's just another flavor-of-the month improvement initiative.

Step 1: Define the New Product

To define the new product, you need to understand customer requirements and determine what features the new product will have. The product-introduction process at the consumer products company began with a new product concept. In 2002, the company was concerned about inroads that private-label products were making on the market share of liquid hand soaps. As a branded producer of liquid hand soaps, this company competes with other branded producers as well as private labels. Creating new products, including extensions of existing products, helps the company increase market share. Therefore, the company decided to launch a liquid hand soap containing Vitamin E, a new feature added to the company's existing line of hand soaps. Even though the company expects the Vitamin E product to generate relatively modest sales, it must make a profit.

Step 2: Establish A Target Selling Price

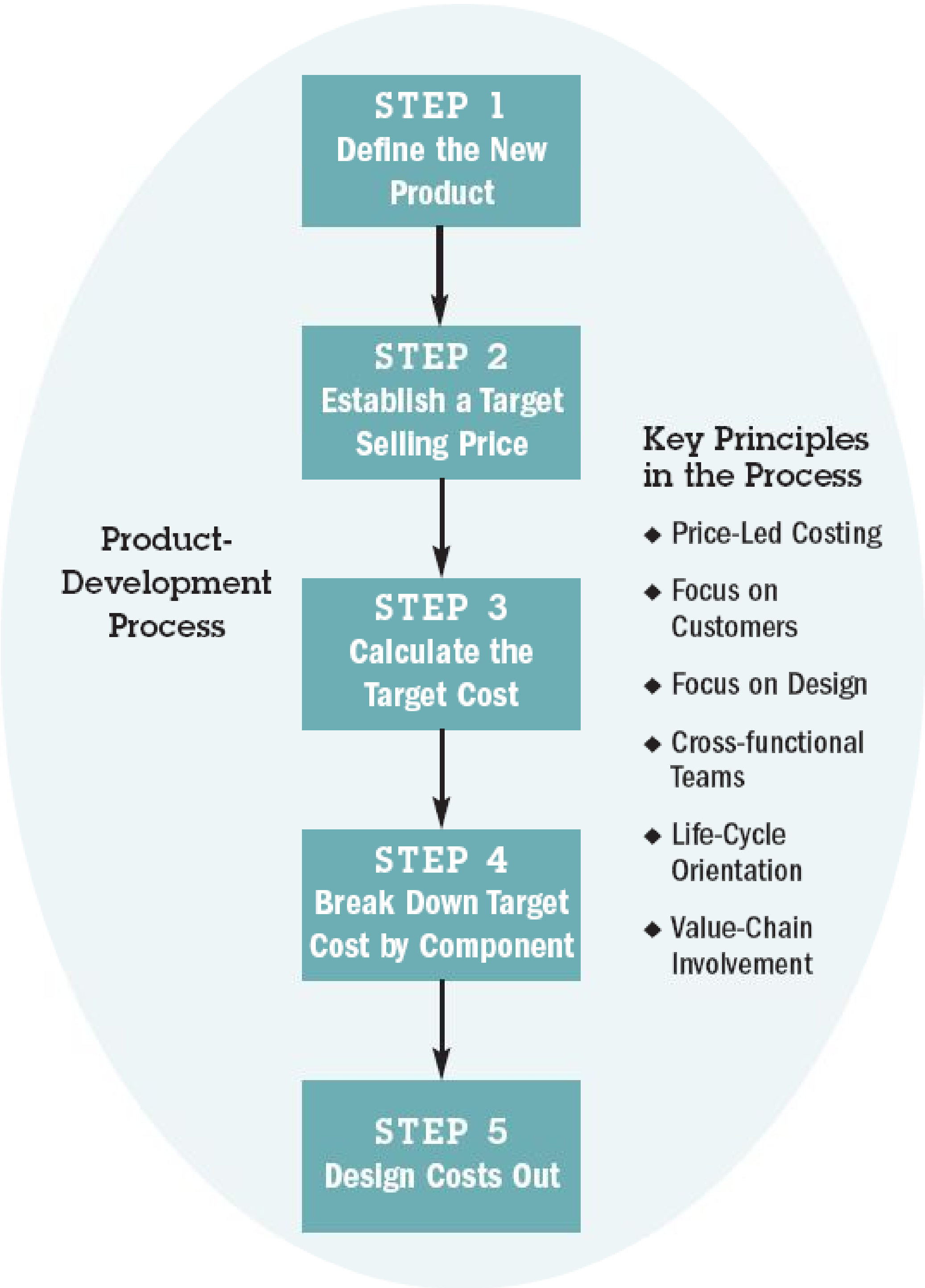
Once you define the product characteristics, pricing research begins and includes customer surveys, focus groups, and reviews of competitor pricing. For new product concepts, the consumer products company's marketing department frequently uses an Internet

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

survey to establish price points that are acceptable to consumers. For a variation of an existing product, marketing generally surveys competitor prices to support its pricing decision.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Figure 1: Steps for Target Costing



Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Table 1: New Product Target Cost

Target Selling Price	$1.52
Desired Contribution Margin (46%)	0.70
Cost Target (Variable Costs)	$0.82

Table 2: Target Cost by Component for Vitamin E Product

	PRELIMINARY COST ESTIMATES	TARGET COST	COST GAP
Formula	$0.308	$0.301	$0.007
Bottle	0.155	0.155	0.000
Pump	0.140	0.140	0.000
Label	0.060	0.060	0.000
Corrugate	0.026	0.026	0.000
Other (Pallet and Stretch-wrap)	0.002	0.002	0.000
Processing (primarily labor and overhead)	0.329	0.136	0.193
Total	$1.020	$0.820	$0.200

For the new Vitamin E soap, the company used these techniques to establish a target selling price of $1.52. (We have altered all pricing and cost information because of its proprietary nature.) In the highly competitive liquid hand soap industry, pricing is a focal point for consumer buying decisions. Within the liquid hand soap segment, retail prices are relatively consistent across products of the company and its major competitors. Consistent pricing ensures shelf space at the retailer, and the additional shelf space a new product garners improves brand awareness, which is very important for consumer-products companies.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Step 3: Calculate the Target Cost

Once you establish the target selling price, you subtract its required profit margin to determine the product's target cost. For this particular company, the required profit margin is expressed as a contribution margin, and the cost target is for variable costs only. Therefore, the company's contribution margin must be high enough to cover all of its fixed costs and still produce a profit. The fixed costs include not only fixed manufacturing costs, but also selling, general, and administrative costs. For liquid soaps, the company requires a 46% contribution margin.
After subtracting the Vitamin E product's contribution margin from its selling price, its cost target for variable manufacturing is $0.82 (see Table 1). By including only variable manufacturing in its cost targets, the company's target costing process is somewhat unusual. Unlike at Boeing, Caterpillar, and other large manufacturers, new-product-development costs are relatively low for the company's liquid soaps. Therefore, these nonrecurring fixed costs, as well as all other fixed manufacturing costs, are excluded from the cost targets for liquid soaps.

Step 4: Break Down Target Cost By Component

Next, you assign cost targets to each of the product's components. After reviewing the component costs of similar products, the company established cost targets for the variable components of the Vitamin E soap. For example, the company had recently launched Product B hand soap, which was similar to the Vitamin E soap, so its component costs served as a benchmark for the Vitamin E product. But the production requirements for the Vitamin E product were somewhat different from those for Product B, which led to a gap between Vitamin E's preliminary cost estimates and its cost target (see Table 2).
Even though the Vitamin E hand soap was above its cost target, management could have launched the new product based on its desire to keep up with the competition and maintain or build upon its current allotment of shelf space at retail outlets. Using this strategy, the company would attempt to reduce costs after introducing the product. Once they finalize the formulation, processing, and packaging decisions, however, there's little opportunity for cost reduction (see Table 3 for a description of each of these areas). Therefore, the company decided to delay introducing the Vitamin E product until it closed the gap between the preliminary cost estimate and the cost target.

Step 5: Design Costs Out

As we discussed, opportunities for cost reduction occur during the formulation, processing, and packaging of liquid hand soaps. For example, the company could change the formula to allow for less expensive ingredients, outsource processing to a third party, or negotiate with suppliers to reduce the cost of the container and pump. By reviewing the costs in Table 2, you can see that manufacturing labor and overhead account for most of the gap between the preliminary cost estimate for the Vitamin E product and its target cost.

Figure 2: New-Product-Development Process Using Stage Gate

Since labor and overhead costs occur during the processing phase of the production process, this was the area the company focused on during cost reduction efforts. The selection of a manufacturing site significantly affects labor and overhead costs, so the Vitamin E product team considered three possibilities: union plants, nonunion plants, or independent vendors or co-packers:

- **Union plants:** These are located in relatively low cost areas in the central part of the U.S. Wage rates at these locations are low, and, because of the centralized locations, transportation costs are relatively low as well. While steady-state, long production runs are very cost effective, these plants are less flexible, so changing over to new products is quite expensive.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

- **Nonunion plants:** These plants are located in parts of the country that have relatively high labor costs. They aren't centrally located, and thus have higher transportation costs, but nonunion plants offer flexibility. Work rules are less restrictive, so the plants can adapt to new products and production processes more easily. These plants can also work overtime and add or reduce production workers more easily than the unionized plants, thus allowing greater flexibility in their production schedule. Furthermore, changing over to new products at these plants is less expensive than at the union plants.

- **Co-packers:** These are independent vendors to whom production is outsourced. Early in the product-development process, the company had ruled out production at a union plant because they are better suited for large batch sizes and long production runs. Since the company is going after a niche market and never expects the Vitamin E product to be mainstream, it would be produced in relatively low volumes with variable demand. Therefore, initial plans were to produce it at a nonunion plant. Unfortunately, as Table 2 illustrates, the preliminary cost estimate for processing at a nonunion plant was $0.193 above the cost target. Upon further investigation, the high labor and overhead costs were due to the low volume and slow run rate of the new formula. Since pro producing the new product internally didn't meet the cost target, the product team requested a bid from co-packers.

Table 3: Key Management Decisions During the Development of Liquid Hand Soaps

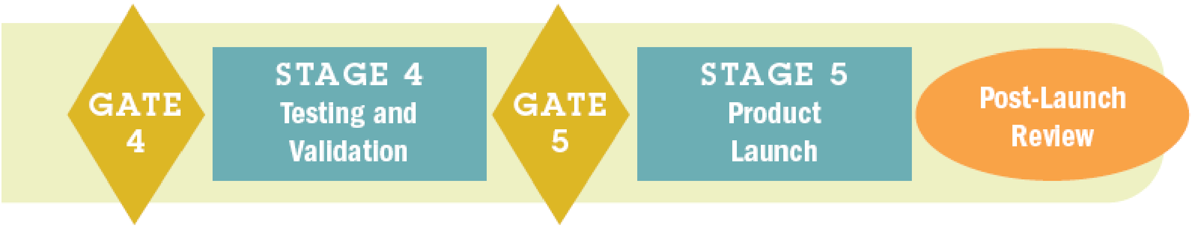
Formulation—Research and Development works with the marketing department to select new ingredients for the liquid soap. Decisions must be made with regard to selection of cleaning ingredients, antibacterial agents, dyes, and fragrances. Niche products might also contain some specialty ingredients, such as Vitamin E.

Processing—For the most part, the mixing and blending process is similar for all liquid soaps. Depending on the product's characteristics, however, steps might be taken to make the processing more efficient. For example, antifoam ingredients could be added to speed up the production process. Processing costs are also affected by production volume, batch size, flow rate, processing location, and other factors.

Packaging—For liquid hand soaps, packaging includes development of the bottle and pump container that hold the liquid soap. This step requires a cross-functional product team that includes marketing, packaging design engineers, procurement, and suppliers. The role of marketing, engineering, and suppliers is to select a design that is aesthetically pleasing yet provides the necessary functionality. Procurement's responsibilities include scheduling, and its representative must ensure that any product choices can be delivered in the right quantity and at the right time to meet production requirements.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

One co-packer submitted a bid of $0.136, which met the cost target for processing and put the total cost within $0.007 of the target. At this point, the company finalized and approved the new product.



Integrating Target Costing Into the Process

Target costing is more likely to be adopted successfully if it's fully integrated into a company's pre-existing product-development process. The consumer products company uses Stage Gate, a process for product development from a third party (see www.stage-gate.com for more information). Stage Gate represents a series of processes and software tools to support the new product-development process. Essentially, Stage Gate provides an operational roadmap for driving new product-development projects from idea to launch by dividing this process into a series of activities (stages) and decision points (gates). After idea generation, the five stages include preliminary investigation, detailed investigation, development, testing and validation, and product launch. A gate precedes each stage where a decision is made as to whether or not to proceed with product development. At each gate, or decision point, a senior leader decides to go, kill, hold, or recycle the project. Figure 2 illustrates the Stage Gate process. Stage Gate instills discipline into what can be a chaotic process by speeding up the new-product-development process and helping ensure that critical steps aren't omitted.

Using Stage Gate in the product-development process supports target costing. First, Stage Gate requires financial analysis at each gate in the process to determine whether a business case can be made to support the new product introduction. Target costing offers a methodology to support the analysis. A company establishes a hard cost target for a new product and must achieve it before target costing supports the decision to move forward with the project. Otherwise, the company should kill the product or place it on hold until they meet the cost target (as was the case with the Vitamin E product). This aspect of Stage Gate supports a key principle of target costing, namely price-led costing.

Cross-functional teaming is another important component of Stage Gate. The diagram of the Stage Gate process illustrates that there's no single R&D, production, or marketing stage; instead, each stage consists of a set of parallel activities undertaken by individuals from different functional areas working together as a team. Using cross-functional teams is also a very important component of target costing. Achieving an aggressive cost target requires cooperation among different functional areas. For example, in the case of the Vitamin E product the manufacturing department worked with procurement and outside suppliers before deciding to outsource production of the new product to co-packers.

Close the Gap

Target costing is a proactive, comprehensive, strategic cost management system for profit planning. It instills discipline by requiring that new products hit their cost targets before they are produced. This consumer products company doesn't often drop new products when they initially fail to meet a cost target. Instead, the company attempts cost reductions while holding the functionality and quality of the products at a constant level. They simply delay a new product's introduction until cost targets are achieved. For the Vitamin E soap, the product team delayed its launch until they closed the $0.193 gap between the preliminary cost estimate and the target cost for labor and overhead, which allowed them to introduce a profitable product.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

13-2: INTEGRATING ACTIVITY-BASED COSTING AND THE THEORY Of CONSTRAINTS

By Robin Cooper and Regine Slagmulder

The profitability maps created by an activity-based costing system are powerful strategic tools designed to help firms become more profitable. But they are based on "general-purpose" costs designed to focus managerial attention, not to directly support decisions. For example, while an ABC system might indicate that a particular product is highly profitable and therefore a candidate for more aggressive selling, it cannot confirm that selling more of that product will indeed lead to higher profits. To make an informed decision, a company must undertake a special study to convert the ABC resource usage analysis into a resource supply one. These special studies are not failures of the ABC approach but are outcomes of a cascading cost benefit trade-off. Sometimes, these special studies are one-time events designed to answer a specific question (such as, "Should I sell more of this product?"), while other times, they are ongoing analyses designed to fine-tune the ability of the firm to generate profits.

The conversion from resource usage to resource supply is particularly important when the proposed change in resource usage predicted by the ABC system is not mirrored by an equivalent change in resource supply The underlying cause of this difference is the way that contracts for the acquisition of resources are structured. If the contract for a resource is on an "as-needed" basis**,** then resource supply and usage will be equal and the profitability map will be decision relevant. But if the contract is written on an "in-case" basis, then resource supply and usage are not necessarily equal. Here, resource supply will remain unchanged until a capacity limit established by the contract is reached. Then resource supply will change, not by the same amount as usage but by a contractually stipulated amount. Consequently, the ABC profitability maps lose their decision relevance, and special studies are required to understand the implications of decisions that involve these resources.

There are two ways in which capacity limits can be managed. Either management accepts that a capacity limit exists and the objective is to try to maximize the revenue (and hence profit) that can be generated given the constraint, or management decides to change the level of resource supply and hence the capacity limit. When managers accept a capacity limit, they must be sensitive to bottlenecks and undertake a special study to optimize around them.

A bottleneck occurs when the demand for a resource, in a given time period, outstrips the firm's ability to deliver it. A pure ABC system is unable to acknowledge bottlenecks because it assumes that resource demand and usage always match. Consequently, a product that consumes a large quantity of the bottleneck resource is not penalized compared to a product that consumes only a small amount of that resource. This limitation of the ABC approach leads to poor decisions if the ABC profitability maps are used to manage the firm's short-term product mix when bottlenecks are present. In particular, decisions based upon an ABC analysis will not keep the bottleneck resources optimally loaded and hence will not lead to maximum profits.

To accommodate bottlenecks, the best solution is to use the theory of constraints (TOC) to identify the optimal short-term mix of products that can be manufactured. The superiority of TOC over ABC for resolving the short-term implications of bottlenecks can be demonstrated using a simple numerical example. Assume that the firm has to choose among manufacturing three products: A, B, and C. The three products consume four different resources: material, labor, machining (the current bottleneck resource), and inspection. The cost of the supplied capacity for labor is $50, for machining $20, and for inspection $50. All three products have the same selling price, but product A has the lowest ABC costs (see Table 1). Consequently, ABC favors the manufacture of product A because it has the highest reported profits.

TOC takes a different approach; it splits resources into two categories. The first category incorporates all resources that are purchased on an "as needed" basis. These are the resources that vary directly with the changes in the level of production. The other category of resources is acquired on an "in-case" basis. The costs of these resources will be incurred irrespective of the level of usage. Under TOC, the costs of these "in-case" resources are grouped into the

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

category "operating expenses" and treated as fixed costs. For the purpose of the TOC analysis relating to product mix they are essentially ignored. Thus, TOC can be viewed as an extreme form of contribution analysis.

The objective under TOC is to maximize "throughput" defined as revenues minus the cost of the "as needed" resources. In the illustrative example, the only cost that is subtracted is material. Consequently, product A has the highest unit throughput and, on the surface, is the favored product under both TOC and ABC (see Table 2). Product A, however, consumes twice as much of the bottleneck resource "machining" as products B and C. Therefore, in a given time frame, the firm can manufacture two units of product B or C for every unit of product A. Despite the fact that product A has the higher unit throughput, product C generates the highest overall throughput and hence profits (see Table 3). Thus, the correct decision is to manufacture product C, not product A. Thus, the appropriate metric for such short-term decisions is not ABC profits but the throughput per unit of the constrained (or bottleneck) resource.

Initially, there is no apparent correspondence between the ABC and TOC reported profits. Under TOC, the reported profits include a charge for all of the unused nonbottleneck resources, so product C reports the highest profits. In contrast, under ABC only the consumed resources are included, and the initial ABC profitability report indicates that manufacturing and selling two units of product B generates almost double the profit compared to manufacturing and selling a single unit of product A or two units of product C (see Table 4-ABC Profit). The ABC profits will match those reported by the TOC once the unused labor and inspection costs are taken into account (see Table 4-Net Profit).

TOC outperforms ABC when bottlenecks are present because it can better match currently available resources to outputs and thus enables higher revenues and hence profits to be generated. The drawback to the TOC approach comes from ignoring operating expenses that can be managed over the long term. To illustrate this point we revisit the example. The ABC system indicates that product C is approximately half as profitable as products A and B (see Table 1), raising the question: Should product C be discontinued? A special study indicates that the inspection resource is dedicated to the production of product C. Therefore, if product C is discontinued, the inspection costs of $50 can be avoided and the overall profits of the firm will increase. A TOC analysis between products A and B now indicates that the best solution is to manufacture two units of product B, generating an overall profit of $60 (see Table 5), which is higher than the original TOC profit of $14.

The important point is that TOC and ABC are complementary, not competing, cost management techniques. They can coexist and be used together to identify the best short-term and long-term product mixes. TOC assumes that the existing infrastructure is a given and sets out to optimize throughput and hence short-term profits. As such, it is a tactical cost management technique. Alternatively, ABC assumes that the supply of most resources can be managed over the long-term; it sets out to identify the product mix that will lead to the highest long-term profits. As such, it is a strategic cost management technique. Thus, TOC can be viewed as a formal on-going special study that is used to render the ABC profitability maps more effective for a particular class of decisions -- those associated with short-term optimization of the use of capacity.

Table 1		**Products**		
	A	**B**	**C**	**Supplied Capacity**
Revenue	$70	$70	$70	
Material	2	5	3	N/A
Labor	6	20	17	50
Machining	20	10	10	20
Inspection	0	0	20	50
Total Cost	**28**	**35**	**50**	
ABC Profit	**$42**	**$35**	**$20**	

Table 2		**Products**	
	A	**B**	**C**
Revenue	$70	$70	$70

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Material	2	5	3
Throughput	**$68**	**$65**	**$67**

Table 3		**Products**		
	A	**B**	**C**	**Supplied Capacity**
Revenue	$70	$140	$140	
Material	2	10	6	N/A
Throughput	**68**	**130**	**134**	
Labor	50	50	50	50
Machining	20	20	20	20
Inspection	50	50	50	50
Operating Expenses	120	120	120	
Net Profit	**$ (52)**	**$10**	**$14**	

Table 4		**Products**	
	A	**B**	**C**
Revenue	**$70**	**$140**	**$140**
Material	2	10	6
Labor	6	40	34
Machining	20	20	20
Inspection	0	0	40
Total Cost	**28**	**70**	**100**
ABC Profit	**42**	**70**	**40**
Unused Capacity	94	60	26
Net Profit	**$(52)**	**$10**	**$14**

Table 5		**Products**
	A	**B**
Revenue	**$70**	**$140**
Material	4	10
Throughput	**$66**	**$130**
Operating Expenses	$70	$70
Net Profit	**$(4)**	**$60**

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

13-3: IS TOC FOR YOU?

BY LINDA E. HOLMES, CMA and ANN B. HENDRICKS

Are you familiar with the Theory of Constraints (TOC)? Physicist Eliyahu M. Goldratt introduced this management technique in 1986 in the bestselling novel *The Goal*. TOC is another operation improvement technique centered on an innovative decision-making process. Just like ABM, BPR, CI, and TQM (Activity-Based Management, Business Process Reengineering, Continuous Improvement, and Total Quality Management), TOC is founded on its own philosophy and has its own buzzwords. And like the other operation improvement programs, TOC considers speed, waste reduction, capacity, direct labor use, and the like according to its own unique perspective. But its foremost appeal is its simplicity. TOC is based on three logical, straightforward premises:

1. The only reason that companies do anything is to make *money*.
2. Anything that a company does to *speed up the processes that generate money is appropriate*.
3. Each business operation is *one big process* with many subprocesses.

According to TOC, companies that keep these three things in mind will prosper.

TOC TALK

TOC's basic vocabulary emphasizes its philosophy and its three performance measures. *Throughput* equals sales revenue minus direct materials cost—it measures the speed at which the company makes money. *Inventory* is the raw materials value tied up in work in process and finished goods. Large amounts of inventory are undesirable because it means that the company has spent money for production that hasn't generated revenue yet. *Operating expenses* are all of the costs of operations other than direct materials costs. Under the Theory of Constraints, operating expenses are fixed and therefore irrelevant to any TOC decision. Of the three terms, throughput is the most important. It tells the company that it is achieving its goal of making money. Moreover, increases in throughput mean that the rate at which the company is making money is increasing.

PROCESS IMPROVEMENT PROCEDURE

According to Goldratt, there are five basic steps to operations improvement:
1. Identify the system's constraint(s), and prioritize them according to importance.
2. Exploit the system's most critical constraint.
3. Subordinate everything else to the action taken in Step 2.
4. Elevate the system's constraint(s).
5. Repeat Steps 1-4, focusing on the new constraint.
(These are paraphrased from *The Goal*, p. 307.) What these steps accomplish are incremental improvements in the operation as a whole. In Step 1, an assessment of the entire process identifies the slowest subprocess. This subprocess is called the constraint or the *bottleneck*. Identifying the constraint is very important because it sets the pace of the whole operation.

The Goal uses Boy Scouts on a hike to illustrate this concept. We learn that no matter how fast some of the boys walk, the boy who walks the slowest always sets the pace and determines when the whole troop will reach its destination. Faster boys in the front of the line will get far ahead, but faster boys at the end of the line won't be able to walk any faster than the slowest boy. Using this example, we can easily visualize the constraint in a production operation: Work in process is piled up in front of (or before) the constraint, and the processes behind (or after) the constraint sit idle waiting for something to do. In Step 2, the company determines how best to "exploit" the constraint. Exploiting means finding ways to get the maximum output possible from the constraint without overloading it and requires that the whole operation be slowed down to the pace of the constraint.

The most obvious way to exploit the constraint is by proper scheduling and control that favors the constraint's capacity. It's also important to improve quality control so that the constraint will work only on good inputs. Waste of time and effort incurred when the constraint spends its valuable time working on output that will eventually have to be scrapped or reworked should be avoided. In Step 3, the company subordinates all other operation improvement opportunities to exploiting the constraint. This may

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

cause problems with managers and workers who have their own ideas about operation improvement. Glaring problems that everyone can see and that most know how to correct will always be present in any operation, but TOC requires that all operation improvement opportunities other than those dealing with the constraint be ignored. This may be very difficult for managers and employees to accept if they don't understand what's going on. Therefore, TOC recommends that the company discuss the Theory of Constraints and its rules with all employees involved so that they will understand what is going on, support it, and be willing to help. Step 4 calls for "elevating" the constraint. This means that the company finds ways to increase the capacity of the constraint.

Ways to increase the output of the constraint include:
1. Performing regular maintenance on the constraint to prevent breakdowns.
2. Running the constraint for extra shifts.
3. Automating the constraint.

Since the constraint sets the pace, making it faster will speed up the whole operation. This increases the rate of throughput (i.e., the rate at which it generates money), which is the company's overriding objective. By now you've probably guessed that after performing Steps 1-4 the original constraint is faster and no longer the constraint. Considering the value of continuous improvement, Step 5 says to find the new constraint and start the TOC process again.

WHAT ABOUT PERFORMANCE MEASURES?

So far, we've discussed increasing speed and output and improving quality, but we haven't mentioned any of the conventional management accounting performance measures (i.e., productivity, cost per unit, etc.). TOC won't suggest using any of them, either. Moreover, according to TOC, not only are conventional management accounting performance measures unnecessary, but focusing on them can make things worse. Of course, we still need management accounting—we just have to be very careful about what we believe is important, the measures we take, and how we use them. Here are five "truths" about management accounting to think about as they relate to TOC.

Management Accounting Truth #1: Process improvements work together to speed up the whole operation. We know that in Total Quality Management and Continuous Improvement the objective is to eliminate waste and speed up every process. The Theory of Constraints takes almost the opposite view. It requires that we focus on the constraint while leaving all other people, processes, and machines alone. Consider what would happen to TOC's inventory (i.e., work in process) if a process located before the constraint were sped up. This process would produce even more work in process that the already overloaded constraint couldn't handle. Likewise, if the newly improved, more efficient process were located after the constraint, it would still be sitting idle, waiting for the constraint to send it work. *Remember, increasing the speed of nonconstraint processes will only make things worse. Extra costs will be incurred with no increase in throughput.*

Management Accounting Truth #2: You have to spend money to make money. Under other operation improvement programs like Business Process Reengineering, a company is required to make radical process changes, usually by purchasing expensive machines, equipment, and/or technology. For example, in the landmark book *Re-Engineering the Corporation*, Michael Hammer and James Champy talk about the way that IBM Credit Corporation turned its step-by-step paper-based credit approval process into a one-step computerized process. Credit approval time went from seven days to four *hours*—an amazing improvement. But TOC discourages large expenditures for process improvements. It presumes that companies are already working at capacity and that all resources are running as efficiently as possible. According to TOC, all that a company needs to do is slow things down and work to the capacity of the constraint. Expensive improvements can be made, but only on the constraint. *Remember, be very careful that all money spent on new equipment, hardware, or software goes toward maximizing the capacity of the constraint.*

Management Accounting Truth #3: Operations can be made more efficient by improving labor efficiency variances. Who doesn't believe that keeping workers busy earning their pay benefits the firm? Well, TOC, for one. Just like any other nonconstraint, fully utilized labor will produce more work in process than the constraint can handle. This causes the same problems that happen when any other nonconstraint process becomes more efficient. Think what would happen if idle workers from processes located after the constraint were moved to processes located before the constraint to keep them busy. Let the workers spend their free time on machine maintenance, on learning new skills, or just having a rest. They will be happier, and the company

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

will eventually have more money to spend. *Remember, increasing labor efficiency when labor isn't the constraint will only increase work-inprocess inventory and tie up money that could be used more effectively somewhere else.*

Management Accounting Truth #4: Large production runs are desirable because they are an efficient use of setup time and fixed costs. Moreover, large production runs reduce per-unit costs, which will increase profit. Actually, the opposite is true for TOC. Large production runs overload the constraint and increase work in process without increasing throughput. Moreover, TOC views all costs other than direct materials as irrelevant fixed costs. It doesn't matter how they are arbitrarily allocated among individual products. *Remember, making production decisions based on reducing per-unit costs works against the objectives of TOC.*

Management Accounting Truth #5: Product mix should be determined based on maximizing total contribution margin. Traditional product mix decisions consider individual product profitability measured by contribution margin per unit. This makes sense in an operation with no constraint. But in operations with a constraint it's better to select among products based on the benefit (i.e., throughput) received per unit of capacity of the constraint. This is the same analysis used in traditional management accounting when the system is bound by a scarce resource.With TOC, the constraint is the scarce resource, so the benefit obtained from it should be maximized. *Remember, wise use of time at the constraint is the thing to consider in TOC product mix decisions.* The simplicity and logic of the Theory of Constraints make it very appealing. All that it requires is a thorough knowledge and understanding of the processes that are already in place. In addition, except for slowing things down (which can have its own benefits to work atmosphere and morale on all levels), no expensive or demoralizing changes will be needed. Finally, remember, you should adapt your performance measurement to your new understanding of processes and outcomes so that you can correctly gauge your performance and make effective decisions. Our five suggestions should help.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

13-4 Environmental Considerations in Product Mix

By: Julie Lockhart, CMA, CPA, and Audrey Taylor, Ph.D., CPA

One of the primary objections to the environmental movement is that it is too costly to businesses, which could place them at an economic disadvantage, especially when competing head-on with foreign companies unhampered by similar cumbersome and costly regulations. Increasingly, companies are faced with pressures from government, stockholders, and the public to improve their environmental records while achieving profitability goals to keep Wall Street happy. Some companies are finding, however, that going beyond regulatory compliance can create value for customers and shareholders alike. With so many pressures, how can management best make profitable choices between investing scarce resources to reduce environmental waste or to increase throughput and profit?

As environmental issues increasingly influence corporate performance, they need to be institutionalized in management accounting systems. Manufacturers need information from their management accounting systems for maximizing profit, given environmental spending. A 1994 article in *Management Accounting* by Jerry Kreuze and Gale Newell supports the use of activity-based costing (ABC) in conjunction with life-cycle costing for allocating environmental costs to products to get a handle on what those costs are. (Life-cycle costing tracks costs over the entire product life cycle “from cradle to grave.”) Their article illustrates the implications on profitability analysis from using the theoretically more accurate ABC system to allocate environmental costs to products that generate those costs. The illustration, however, does not consider constraints in the production process, so the product mix decisions made from ABC information may not facilitate profit maximization goals.

COMPARISON OF ABC AND TOC

	ABC	TOC
Focus	Cost control	Profit maximization
Method(s)	Reduce activities	Maximize utilization of the constraint
	Simplify processes	Simplify control
	Reduce product offerings	Eliminate nonvalue-added activities/actions
Treatment of Capacity	Identifies unused capacity if the practical volume of the cost driver is used to calculate rates	Identifies resource usage on each resource and determines if a constraint exists
	If anticipated or normal capacity volumes are used for the cost driver rates, capacity is ignored	Focuses on the constraint, if internal, by maximizing profit over the constraint through prioritization of production given throughput/(amount needed per unit of the constraint)
Cost Behavior Assumptions	All allocated costs are variable	Most costs are fixed
Variable Cost	Unit-, Batch-, and Product-level costs are variable	Only Unit-level costs are variable
Step-Fixed Cost Behavior	As activity usage decreases, so does the cost of the activity	Step-fixed costs change only at the edges of the steps
Catalysts for Cost Control	Allocating costs is the best way to control the cost by encouraging the reduction of the cost to produce one unit	Viewing fixed costs in a lump sum and expensing the cost in its entirety is a strong motivator to control the cost
Timing of Expenses	Expense most production costs when the unit is sold	Expense most production costs in the period they are incurred
Items that Impact Income	Sales and Production levels can impact income	Sales levels impact income

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Two methods of evaluating product mix decisions given an environmental constraint include ABC and the Theory of Constraints (TOC). While ABC is important for understanding how environmental spending affects product cost, it does not necessarily help in making decisions to reduce the most environmentally damaging products from the mix. Under certain conditions, TOC may be the better choice for maximizing profit while minimizing the production of products causing the most environmental damage.

ABC, TOC, and Differing Assumptions

Both ABC and TOC appeared in literature during the decade of the 1980s. Robin Cooper and Robert S. Kaplan popularized ABC to trace costs to products based on the way each product uses resources. ABC recognizes that different products use resources based on complexity rather than volume. Cooper and Kaplan proposed using non-volume drivers to allocate batch and product-level costs to units produced. Around the same time, Eliyahu M. Goldratt promulgated TOC to prioritize scheduling of products over limited resources in order to maximize profit. Goldratt advocated eliminating all allocations of any non-volume-based costs to units. The proponents of each method believed their method ensured that profit would increase more while costs were better controlled.

Because of the juxtaposed assumptions of each method, academics and practitioners have debated their usefulness with little agreement on common ground.6 ABC assumes that costs are predominantly variable over the long run and that variability should be recognized in all decision making. Cooper and Kaplan tracked the accelerated increase in "fixed costs" over the decades in specific companies, belying their "fixed cost nature."7 They said that such a dramatic increase in so-called fixed costs was overlooked because managers assumed these costs were fixed and did not need to be monitored carefully. Only by recognizing the "true" variability of these costs would managers be encouraged to monitor and limit their proliferation.

In contrast, TOC assumes just the opposite—that most manufacturing costs are predominantly fixed, with materials being the only consistent variable cost. Researchers Eric Noreen, Debra Smith, and James T. Mackey documented the way managers controlled fixed costs in a TOC-based company.8 They theorized that TOC managers controlled fixed costs even in the face of increasing complexity because they *believed* these costs were truly fixed and should not increase. Therefore, the managers found ways to improve processes and decrease non-value-added activities so these fixed costs would stay constant. In addition, Noreen, Smith, and Mackey found that, in the face of increased complexity, ABC-based companies had increases in the Non-volume-based costs because the managers *expected* those costs to increase.

Several researchers also have argued that time is the primary difference between ABC and TOC.9 ABC views the company over a long time frame, whereas TOC looks at the short term. These researchers have proposed that TOC should be used for short-term production mix decisions where costs are predominantly fixed and that ABC should be used to determine any increases or decreases in capacity and products (as well as any other long-term decision) because, in the long term, all costs tend toward being variable.

A Different Focus

Another important difference between TOC and ABC is focus. ABC's focus is predominantly on cost, and its primary goal is to increase profit by reducing cost via the reduction of complexity. In the case of Pitney Bowes, environmental operating and product costs were reduced through the use of ABC.10 TOC, on the other hand, focuses rigidly on profit and attempts to maximize profit given a certain stable level of capacity. To aid in the focus on profit, TOC removes complexity, not from the product but from the allocation process.11 It also attaches only volume-driven costs to each unit. The assumption is that nonmaterial costs are stable when used to produce several products with shared resources.

ABC, on the other hand, seeks to remove complexity from the system by focusing on higher-volume products using fewer resources for each unit produced. What the ABC advocates have tried to deal with was the quick rise in indirect costs for both production and nonproduction tasks. In effect, ABC has tried to become a method of doing incremental analysis by highlighting resources that will need to increase in order to increase the output of complex products. The product mix that results will not necessarily reduce the production and sale of the product that pollutes the most.

*Focusing on the constraint***.** A unique attribute of the TOC method is the focus on the constraint of the system. In order to increase profit, TOC focuses on the use of limited resources and recognizes that neither unit cost nor unit-based profit is sufficient to

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

determine which products should be produced. Instead, managers should realize that every system has a constraint that limits profit. A constraint can be external, such as the lack of demand in the market for the company's products, but often the constraint is internal to the company, such as limited resources for environmental compliance.

When the constraint is an internal resource, products using limited amounts of the constrained resource or products producing higher levels of profit for each unit of the constrained resource are preferred. In cases where the constrained resource is used to reduce pollutants, TOC helps to shift the product mix to the products that pollute the least. Products requiring more resources to reduce environmental pollutants will be given lower priority in the mix unless the prices charged to consumers are sufficient to cover the extra cost of eliminating those pollutants.

Environmental Costs and Resources

Clearly, all businesses have an impact on the natural environment from the use of electricity and fuel, to paper use and waste, to the more considerable impacts of chemical-related manufacturing. Both federal and state governments regulate hazardous material inputs and waste. Perhaps the most onerous of these are the Superfund regulations created to clean up toxic waste sites and the Resource Conservation and Recovery Act (RCRA) for facilities that treat, store, and/or dispose of hazardous waste. Beyond hazardous substances, many companies have chosen to adopt "eco-efficient" policies internally, which has the dual result of saving the companies money as well as improving their reputation with certain stakeholders.

Internal environmental costs when regulations are imposed may include record keeping, reporting, labeling, emissions and effluent management, waste management, compliance, training, research and development, certification, and permitting. Typically, costs may be different depending on whether a company is a generator/user, transporter, or disposal facility for hazardous materials. Table 1 includes four categories of costs that were derived under the assumption that the company uses and generates hazardous materials.

Comparing ABC and TOC

Clean Products, Inc. manufactures four products: R, S, T, and U. Four categories of environmental costs are included in the array of manufacturing costs in the company. Because hazardous chemicals are used in the manufacture of R, S, T, and U, we have included a hazardous waste disposal fee per pound, which is assumed to be variable. Clean Products invested in a scrubber to clean emissions at the end of the process, and the company incurs environmental reporting (by product) and regulatory costs (by facility). The sales prices, materials costs, direct labor usage, and resource usage of each of the four products are listed in Table 1.

Using ABC To Determine Product Mix.
Using the demand levels in Table 1, the first step is to determine the load on each resource to see if the current demand can be filled. To test this, the capacity used by each resource needs to be calculated and compared to the capacity available for each resource. The calculations to determine the demands on each resource are listed in Table 2. As you can see from the calculation of machine hours needed on each resource, only the environmental scrubber needs more time than it has available; therefore, not all of the products can be produced. Management must determine which products to emphasize and which to defer to last.

Prioritizing Production Using ABC
ABC is highly valued because of its ability to trace the cost of activities to products. In Table 1, a list of activities and cost drivers is presented, using the cost-driver rates to attach the cost of the activity to each product. The annual amount of each driver listed in the table is its practical capacity, or the amount of the cost driver possible if 100% of the resource is used, given real-world efficiencies. For many companies, practical capacity is considered to be 85% of its theoretical or ideal capacity. By using practical capacity as the cost-driver level, several benefits occur:

- Allocated unit costs are consistent for decision making as long as costs for the resources are unchanged.
- Available capacity is highlighted on each resource.
- Unavailable capacity is highlighted on constrained resources.

Using ABC to determine the product mix choice, we calculated contributions for each product. For each product-level cost, the amount of the cost driver consumed by the product was multiplied by the rate for that particular cost driver. The resulting overhead was then traced to each product line (see Table 3). Using ABC to trace the costs to each unit, the ranking for each product by profitability from highest to

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

lowest would be S, R, T, and U. With this order of production, and given the limited time on the environmental scrubber, S, R, and T are produced to their demand levels, and the remaining time is used to make 1,000 units of U.

Table 1: Basic Product and Resource Information

Clean Products, Inc.

A. Market Information

	Products R	S	T	U
Sales Price	$175	$250	$275	$350
Demand in Units	20,000	12,000	14,000	8,000

B. Materials Information—Unit Level

Unit-Based Costs:	Price per Pound	R	S	T	U
Materials					
Material A	$10.00	$20.00	$40.00	$ 20.00	$-
Material B	$20.00	$20.00	$20.00	$ 40.00	$-
Material C	$25.00	$-	$-	$ 50.00	$150.00
Disposal of Hazardous Material	$ 7.00	$21.00	$35.00	$ 42.00	$ 42.00
Total Material		$61.00	$95.00	$152.00	$192.00

Material Pounds per Unit	R	S	T	U
Material A	2	4	2	0
Material B	1	1	2	0
Material C	0	0	2	6
Total Pounds	3	5	6	6

C. Labor and Machine Information—Unit Level

Unit-Driven Resources/Activities	Cost Driver	Annual Hours	Cost	Cost per Hour
Direct Labor	labor hours	30,000	$ 750,000	$25.00
Machine D	machine hours available	20,000	$ 250,000	$12.50
Machine E	machine hours available	30,000	$ 400,000	$13.33
Machine F	machine hours available	40,000	$ 600,000	$15.00
Environmental Scrubber	machine hours available	40,000	$1,200,000	$30.00

Labor Hours per Unit	R	S	T	U
Direct Labor Hours	0.50	0.25	0.75	0.50

Machine Hours per Unit	R	S	T	U
Machine D	0.10	0.20	0.05	1.20
Machine E	0.05	0.50	0.30	1.80
Machine F	0.20	0.40	0.05	2.80
Scrubber	0.25	0.50	2.00	1.00

D. Batch- and Product-Level Costs

Cost Type		Annual Amount Possible	Cost	Cost per Driver
Material Handling	number of production orders	2,500	$ 75,000	$ 30
Environmental Reporting	number of products	4	$150,000	$37,500

Number of Orders and Product by Product Type	R	S	T	U	Amount Needed	Excess (Deficiency) in Cost Driver
Orders	750	500	200	350	1,800	700
Products	1	1	1	1	4	0

E. Facilities-Level Costs

Cost Type	
Research and Development	$ 500,000
Plant Maintenance	$ 200,000
Buildings and Grounds	$ 625,000
Environmental Regulatory Costs	$ 250,000
TOTAL	$1,575,000

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Table 2: Utilization of Each Resource

The environmental scrubber is the constrained resource in this example.

Direct Labor Hours	R	S	T	U	Total	Excess (Deficiency) in Hours
	Total Labor Hours					
	10,000	3,000	10,500	4,000	27,500	2,500

	R	S	T	U	Hours Needed	Excess (Deficiency) in Hours
	Machine Hours per Unit					
Machine D	2,000	2,400	700	9,600	14,700	5,300
Machine E	1,000	6,000	4,200	14,400	25,600	4,400
Machine F	4,000	4,800	700	22,400	31,900	8,100
Scrubber	5,000	6,000	28,000	8,000	47,000	(7,000)

	R	S	T	U	Amount Needed	Excess (Deficiency) in Cost Driver
	Number of Orders and Product by Product Type					
Orders	750	500	200	350	1,800	700
Products	1	1	1	1	4	0

Table 3: Example of Product Ranking with ABC*

Clean Products, Inc.

	Price per Pound	R	S	T	U
Sales		$175.00	$250.00	$275.00	$350.00
Unit-Based Costs					
Materials					
A	$10	$ 20.00	$ 40.00	$ 20.00	$-
B	$20	$ 20.00	$ 20.00	$ 40.00	$-
C	$25	$-	$-	$ 50.00	$150.00
Disposal of Hazardous Material	$ 7	$ 21.00	$ 35.00	$ 42.00	$ 42.00
Direct Labor		$ 12.50	$ 6.25	$ 18.75	$ 12.50
Machine Cost					
D		$ 1.25	$ 2.50	$ 0.63	$ 15.00
E		$ 0.67	$ 6.67	$ 4.00	$ 24.00
F		$ 3.00	$ 6.00	$ 0.75	$ 42.00
Environmental Scrubber		$ 7.50	$ 15.00	$ 60.00	$ 30.00
Total Unit-Based Costs		$ 85.92	$131.42	$236.13	$315.50
Contribution Margin		$ 89.08	$118.58	$ 38.88	$ 34.50
Ranking Based on Contribution Margin		2	1	3	4
Material Handling		$ 1.13	$ 1.25	$ 0.43	$ 1.31
Environmental Reporting		$ 1.50	$ 2.50	$ 2.14	$ 3.75
Product Margin		$ 86.46	$114.83	$ 36.30	$ 29.44
Ranking Based on Product Margin		2	1	3	4
Demand in Units		20,000	12,000	14,000	8,000
Production Given Demand and Scrubber Constraints		20,000	12,000	14,000	1,000
Hours Used for the Scrubber		5,000	6,000	28,000	1,000
Hours Available in Order of Ranking		29,000	34,000	1,000	0

*Note that ABC does not rank products based on the constraint caused by the scrubber.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Table 4: Profit When ABC Is Used to Determine Product Mix

	R	S	T	U	Unused Capacity	Total
Sales	$3,500,000	$3,000,000	$3,850,000	$350,000		$10,700,000
Material	$ 800,000	$ 720,000	$1,540,000	$150,000		$ 3,210,000
Disposal of Hazardous Material	$ 420,000	$ 420,000	$ 588,000	$ 42,000		$ 1,470,000
Throughput	$2,280,000	$1,860,000	$1,722,000	$158,000		$ 6,020,000
Direct Labor Cost	$ 250,000	$ 75,000	$ 262,500	$ 12,500	$ 150,000	$ 750,000
Machine Cost						
D	$ 25,000	$ 30,000	$ 8,820	$ 15,000	$ 171,250	$ 250,000
E	$ 13,400	$ 80,040	$ 56,000	$ 24,000	$ 226,667	$ 400,000
F	$ 60,000	$ 72,000	$ 10,500	$ 42,000	$ 415,500	$ 600,000
Environmental Scrubber	$ 150,000	$ 180,000	$ 840,000	$ 30,000	$ —	$ 1,200,000
Material Handling	$ 22,600	$ 15,000	$ 6,020	$ 1,310	$ 30,150	$ 75,000
Environmental Reporting	$ 30,000	$ 30,000	$ 29,960	$ 3,750	$ 30,000	$ 150,000
Product Margin	$1,729,000	$1,377,960	$ 508,200	$ 29,440	$(1,023,567)	$ 2,595,000
Research and Development						$ 500,000
Plant Maintenance						$ 200,000
Buildings and Grounds						$ 625,000
Environmental Regulatory						$ 250,000
Operating Income						$ 1,020,000

Because of the decrease in production of U from 8,000 units to 1,000 units, fewer of the unconstrained resources are needed. Inventories in this example are assumed to be zero, so any unused capacity costs for any activity are expensed as a period cost. Based on this level of production and sales, the profit for the company is $1,020,000 (see Table 4).

Prioritizing production using TOC.
The Theory of Constraints prioritizes production based on throughput over the constrained resource. Throughput in TOC is defined as sales less the truly variable costs (usually just materials). Calculation of throughput per hour of time on the environmental scrubber is presented in Table 4. Using the throughput per scrubber hour to determine the order of production, Product R is the most profitable, followed by S, U, and T, respectively. When production follows this order, all of the units of demand for R, S, and U are produced and sold; in the remaining time, 10,500 units of T's demand can be satisfied (see Table 5). Following this plan, the profit is $1,695,000. This TOC-based profit is $675,500 greater than the ABC based profit. Again, the profit difference is due solely to the focus of TOC vs. ABC on profit maximization vs. cost control. The profit calculations and the differences in the product rankings and in the profit generated by ABC and TOC are presented in Tables 6 and 7. TOC is always the best choice given the following conditions:

1. Products use shared resources.

2. Demand for all of the products sharing those resources is greater than the capacity of at least one resource.

3. There is a commitment to maintain capacity at the current level for the immediate future.

4. There is a desire to maximize profit over the current level of resources.

5. When capacity increases are made, the constrained resource is the first resource purchased.

6. The market dictates the price of the competing products, and those prices or price and volume choices are known before production plans are solidified.

7. The creation of certain toxins is of concern to the company, and there is a desire to determine the product mix that generates the fewest toxins.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Table 5: Example of Product Ranking with TOC

Clean Products, Inc.

		R	S	T	U
Sales Price		$175.00	$250.00	$275.00	$350.00
Unit-Based Costs					
	Price per Pound				
Materials		R	S	T	U
Material A	$10	$ 20.00	$ 40.00	$ 20.00	$-
Material B	$20	$ 20.00	$ 20.00	$ 40.00	$-
Material C	$25	$-	$-	$ 50.00	$150.00
Disposal of Hazardous Material	$ 7	$ 21.00	$ 35.00	$ 42.00	$ 42.00
Total Material		$ 61.00	$ 95.00	$152.00	$192.00
Throughput		$114.00	$155.00	$123.00	$158.00
Time on the Scrubber per Unit		0.25	0.50	2.00	1.00
Throughput/Scrubber Hour		$456.00	$310.00	$ 61.50	$158.00
Ranking		1	2	4	3
Demand in Units		20,000	12,000	14,000	8,000
Production Given Demand and Scrubber Constraints		20,000	12,000	10,500	8,000
Hours Used for the Scrubber		5,000	6,000	21,000	8,000
Hours Available in Order of Ranking		35,000	29,000	0	21,000

Table 6: Profit When TOC Is Used to Determine Product Mix

	R	S	T	U	Total
Sales	$3,500,000	$3,000,000	$2,887,500	$2,800,000	$12,187,500
Material	$ 800,000	$ 720,000	$1,155,000	$1,200,000	$ 3,875,000
Disposal of Hazardous Material	$ 420,000	$ 420,000	$ 441,000	$ 336,000	$ 1,617,000
Throughput	$2,280,000	$1,860,000	$1,291,000	$1,264,000	$ 6,695,500
Direct Labor Cost					$ 750,000
Machine Cost					
D					$ 250,000
E					$ 400,000
F					$ 600,000
Environmental Scrubber					$ 1,200,000
Material Handling					$ 75,000
Environmental Reporting					$ 150,000
Research and Development					$ 500,000
Plant Maintenance					$ 200,000
Buildings and Grounds					$ 625,000
Environmental Regulatory					$ 250,000
Total Operating Expense					$ 5,000,000
Operating Income					$ 1,695,500

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.

Table 7: Product Rankings and Profit Changes Using ABC and TOC

Product	R	S	T	U
ABC Rank	2	1	3	4
TOC Rank	1	2	4	3

TOC Profit	$1,695,500
ABC Profit	$1,020,000
Profit Advantage Using TOC	$ 675,500

Possible Ramifications for "Green" Companies

By using TOC to identify the constraint and to use it so that the environmental scrubber was used most profitably, the company simultaneously chose products that used the least amount of scrubber time per unit. In effect, the TOC method fostered the selection of a theoretically cleaner product than the previous mix because it emitted fewer toxins requiring scrubber time. Product T needed two hours of scrubber time, while Product U used only one hour. In addition, the company improved its own profitability. It is also important to note that when the TOC mix is chosen, there is unmet demand (3,500 units) for Product T in the market. This means that the company has some leeway for potentially increasing the price of T to better reflect its environmental impact. This in turn could increase profits even more. If companies can reduce emissions while maximizing profit, resistance to making environmental improvements should be more tenable.

Concern Is Obligatory

Investments in environmental assets can be very expensive, but, given the current regulatory environment regarding toxic substances as well as public demand for clean products, concern over the environment is obligatory. Regardless of the motivation, companies find that they must be proactive about reducing the environmental impact of the products they produce. By adopting the TOC methodology, companies investing in environmentally sound resources can maximize their profits, given environment investments, while producing a better mix of Earth-friendly products.

Copyright © 2016 McGraw-Hill Education. All rights reserved. No reproduction or distribution without the prior written consent of McGraw-Hill Education.