HARVARD BUSINESS

What-If Analysis and Activity-Based Budgeting

Forecasting Resource Demands

Excerpted from

Time-Driven Activity-Based Costing:
A Simpler and More Powerful Path to Higher Profits

By

Robert S. Kaplan, Steven R. Anderson

Harvard Business Press
Boston, Massachusetts

ISBN-13: 978-1-4221-2227-3
2227BC

This chapter was originally published as chapter 5 of *Time-Driven Activity-Based Costing: A Simpler and More Powerful Path to Higher Profits*,
copyright 2007 Harvard Business School Publishing Corporation.

CHAPTER FIVE

WHAT-IF ANALYSIS AND ACTIVITY-BASED BUDGETING

Forecasting Resource Demands

COMPANIES REAP the full benefits from Time-Driven ABC only if they adjust the *supply* of their resources to the *demands* from products and customers. Companies can improve processes, rationalize their product mix, and modify customer ordering and delivery patterns to eliminate transactions that make excessive demands on resources. None of these actions, however, produce profit improvements by themselves. The actions free up considerable amounts of capacity throughout the enterprise. But companies capture the bottom-line benefits from their newly released capacity only if they can sell more or spend less.

If a company can increase sales when it has excess capacity, its profits will increase sharply since spending, other than on short-term variable costs (such as for direct materials), will remain flat while revenues increase, a sure path for large profit increases. But if the company, with excess capacity, does not increase its quantity of output, then it must turn to the less attractive alternative of reducing the supply of excess capacity so that it is spending less to supply resources.

Activity-based budgeting (ABB) enables companies to forecast the changes in resource demands from projected process efficiencies and changes in the volume and mix of transactions. For example, managers at Lewis-Goetz, a hose and belt fabricator in Pittsburgh, learned from the company's TDABC model that certain products were much more profitable than previously reported. They contemplated lowering prices on these products to capture additional market share, a tactic that might lead to a surge in volume and revenue. But could the company handle the increased volume with existing resources, or would bottlenecks start to appear across the enterprise? Lewis-Goetz used its TDABC model to forecast the capacity utilizations with the higher expected sales volumes.

Executives can use their Time-Driven ABC model as an analytic core to forecast the demands for resources. These forecasts give executives the information to adjust future resource supply and, therefore, the associated spending, to meet those demands. Activity-based budgeting eliminates much of the negotiations and haggling associated with the traditional line-item budgeting process. It replaces negotiations with a rigorous, defensible, and transparent analytic model in which executives authorize spending on personnel and equipment resources to bring the supply of capacity, throughout the enterprise, in line with work needed to be performed to meet sales and production forecasts.

Activity-based budgeting existed before the TDABC innovation. What is new is how much simpler and more transparent the process becomes with TDABC. The supply, cost, and consumption of resource capacity are central features of a TDABC model. It becomes a simple task to exploit the structure of a TDABC model to forecast the change in supply and cost of resources required to meet future periods' demands for work.

MAKING FIXED COSTS VARIABLE

The theory behind activity-based budgeting is straightforward. We recognize that the supply of most of a company's resources—personnel, equipment, and buildings—is committed in advance of a period, before the demand for them is known exactly. A company pays for these committed resources, whether or not they are used during the period. That is why many economists and accountants refer to them as *fixed costs.* While this name is, in a narrow sense, technically correct, it is also misleading; the term *fixed costs* has confused generations of managers and accountants. The costs are fixed only because managers do not act to change them. In this chapter, we show how to connect a company's actions on pricing, order size, and customer service to revised estimates about the demands for resources. These revised demands can reveal unused resource capacity and—should production and sales volumes be projected to increase—some shortages of resource capacity as well. The company can then act to adjust the supply of resources to meet the projected demands. It is through this adjustment of resource supply that the cost of virtually all an enterprise's resources becomes "variable" and not fixed. The only truly fixed costs, in practice, are those for which the spending or commitments have already occurred and are irreversible, such as research and development spending or commitments for pensions based on prior years of employee service.

The sequence of steps to perform what-if or activity-based budgeting is remarkably simple:

1. Build a Time-Driven ABC model based on most recent experience.
2. Calculate product, service, and customer profitability.
3. Make managerial decisions on process improvements, pricing, product and customer mix, product design, and customer relationships.
4. Forecast next period's process capabilities and the volume and mix of sales and production on the basis of the decisions taken to improve profitability.
5. Calculate the next period's demand for resource capacities to meet the sales and production forecasts.
6. Authorize spending (either increases or decreases from current period's levels) to supply the desired resource capacities in future periods.

We illustrate what-if analysis and the activity-based budgeting sequence through an extended numerical example, the Sippican Corporation.

SIPPICAN CORPORATION: A CASE STUDY

Consider the plight of the Sippican Corporation (a fictitious company), a manufacturer of hydraulic control devices—valves, pumps, and flow controllers.[1] Its recent monthly financial results reveal the severe economic impact from price cutting in pumps, one of its major product lines (figure 5-1). The company's overall gross margin of 21 percent is well below its targeted 35 percent level, and the 1.8 percent pretax return on sales is far below the targeted 15–20 percent level that the company has realized in the past. The poor financial performance has occurred despite a recent 10 percent price increase in its new flow controller product line, which met little sales resistance in the marketplace.

Sippican operates with a simple cost accounting system that directly charges each unit of product for its direct materials and labor costs. Materials cost is based on the prices paid for components under annual

FIGURE 5-1

Sippican Corporation: Monthly Operating Results

Sales	**$1,847,500**	**100%**
Direct labor expense	351,000	
Direct materials expense	458,000	
Contribution margin	$1,038,500	56
Manufacturing overhead		
Machine-related expenses	$334,800	
Setup labor	117,000	
Receiving and production control	15,600	
Engineering	78,000	
Packaging and shipping	109,200	
Total manufacturing overhead	654,600	35
Gross margin	**$383,900**	**21%**
General, selling, and administrative expenses	350,000	19
Operating income (pretax)	**$ 33,900**	**1.8%**

purchasing agreements. Labor rates, including fringe benefits, are $32.50 per hour and are charged to products on the basis of the standard run times for each product (figure 5-2).[2]

The company has only one producing department, which machines and assembles components into finished products. The cost system allocates factory overhead costs—including setup, receiving, production control, packaging, shipping, and engineering—to products as a percentage, currently 185 percent, of production-run direct labor cost. Since direct labor is recorded anyway to prepare factory payroll, allocation via direct labor cost is an inexpensive way to assign overhead costs to products. Figure 5-3 shows the standard unit costs, planned gross margins, and actual gross margins for Sippican's three product lines.

FIGURE 5-2

Standard Cost Data

Product Lines	**Valves**	**Pumps**	**Flow Controllers**
Materials per unit	4 components 2 @ $2 = $4 2 @ 6 = 12	5 components 3 @ $2 = $6 2 @ 7 = 14	10 components 4 @ $1 = $4 5 @ 2 = 10 1 @ 8 = 8
Materials cost per unit	$16	$20	$22
Direct labor per unit (hours)	0.38	0.50	0.40
Machine hours per unit	0.5	0.5	0.3
Setup hours per run	5	6	12

FIGURE 5-3

Product Profitability Analysis (Standard Costs)

	Valves	Pumps	Flow Controllers
Direct labor cost	$12.35	$16.25	$13.00
Direct materials cost	16.00	20.00	22.00
Overhead (@185% × DL$)	22.85	30.06	24.05
Standard unit costs	$51.20	$66.31	$59.05
Planned gross margin (%)	35%	35%	35%
Target selling price	$78.77	$102.02	$90.85
Actual selling price	$79.00	$70.00	$95.00
Actual gross margin	$27.80	$3.69	$35.95
Actual gross margin (%)	35%	5%	38%

Sippican's controller, Peggy Knight, realizes that overhead has been increasing significantly in recent years, particularly for setup labor, indirect labor for packaging and shipping, and process engineers. These increases were necessary to handle the small production runs and many shipments now requested by customers, and for developing the process routines used to build newly introduced flow controller models. Knight queries the manufacturing control system and collects data about the number of production runs, shipments, and distribution of engineering personnel during the past month (figure 5-4).

FIGURE 5-4

Monthly Production and Operating Statistics

	Valves	Pumps	Flow Controllers	Total
Production (units)	7,500	12,500	4,000	24,000
Materials cost per unit	$16	$20	$22	
Direct labor per unit	0.38	0.50	0.40	
Machine hours per unit	0.5	0.5	0.3	
Setup hours per run	5	6	12	
Machine hours (run time)	3,750	6,250	1,200	11,200
Production runs	20	100	225	345
Setup hours	100	600	2,700	3,400
Number of shipments	40	100	500	640
Hours of engineering work	60	240	600	900

The differences between the product lines surprise Knight. The average production run for valves is 375 units (7,500 units divided by 20, the number of production runs), while the average production run for flow controllers is less than 18 units. Also, the average valve shipment is 188 units (7,500 units divided by 40, the number of shipments), while for flow controllers it is 8 units. As Knight fears, the flow controller product line is using indirect resources disproportionately from its shares of company revenues and units sold.

Sippican has the two classic symptoms of a company desperately needing a more accurate cost system. First, the company is spending more on overhead than on either direct labor or direct materials (figure 5-3). Second, the company has considerable diversity in its product mix. Valves, a standard product that requires little technical support, are produced and shipped in large batch sizes, while flow controllers, a newer product line, are produced and shipped in small batch sizes and require extensive technical support. The combination of high spending on indirect and support resources and high variety in product and customer characteristics is an unfailing recipe for heavily distorted costs in a traditional standard cost system.

With this in mind, Knight initiates a TDABC project in the hopes that the more accurate costing of present resources will enable Sippican to project its future resource demands more effectively. Knight takes a step-by-step approach, outlined in the next sections, to develop an activity-based budgeting model for her company's situation.

ABB Step 1: Build a Time-Driven ABC model

Knight launches a project to build a Time-Driven ABC model of Sippican's manufacturing operations. She wants an accurate cost model to quantify financially the impact of each product line's use of indirect resources. The project team spends about a week in the factory and collects the following information:

1. A setup is performed whenever a batch of components must be machined in a production run. Each component in a product requires a separate production run to machine the raw material or purchased part to the specifications for the product. Because of the large number of setups, currently about 25 percent of the production employees just perform setups. Some other production workers do not operate any machines, but perform only manual

assembly work. Their assembly time per product is already included in the direct-labor-hour estimates for each product.

2. Sippican operates two 7.5-hour shifts each weekday. Each shift employs 45 production and assembly workers, plus 15 setup workers. These workers receive two 15-minute breaks each day. They also receive an average of 30 minutes per day for training and education activities, and all the workers—production, assembly, and setup—spend 30 minutes each shift for preventive maintenance and minor repair of the machines.
3. The company has 62 machines for component processing. These machines are generally available for the 6 hours per shift that production workers are actively engaged in production or setup activities on the machines. Sippican leases the machines. Machine operating expenses are about $5,400 per month; this amount includes lease payments, supplies, utilities, and maintenance and repairs.
4. The receiving and production control departments employ 4 people over the two shifts. These personnel order, process, inspect, and move each batch of components for a production run. It takes 75 minutes for all the activities required to get one batch of components ordered, received, and moved to a machine for processing. This time is independent of whether the components are for a long or a short production run, or whether the components are expensive or inexpensive.
5. The work in the packaging and shipping area has increased during the past couple of years as Sippican increased the number of customers it served. Each shipment takes 50 minutes to prepare the packages and labels, independent of the number or types of items in the shipment, plus 8 minutes per item to bubble wrap and pack in the carton, whether the item is a valve, a pump, or a flow controller. The packaging and shipping area employs 15 people in each of the two shifts (30 in total).
6. Employees in the receiving, production control, packaging, and shipping departments work a 7.5-hour shift that includes two 15-minute breaks per day, and 30 minutes, on average, for training and education.
7. Sippican employs 8 engineers for designing and developing new product varieties. The engineers' total compensation is $9,750 per month. Much of their time is spent modifying flow-control products to conform to customer requests. Engineers work 7.5-hour

shifts. After breaks, training, education, and professional activities, engineers supply about 6 hours of productive work per shift.

With this information, Knight's project team starts by estimating the capacity cost rates for each major production process: fabrication and assembly, setup, receiving and production control, packaging and shipping, and engineering. Figure 5-5 summarizes the calculations of capacity cost rates, and figure 5-6 shows the aggregate supply, cost, and utilization of Sippican's production resources.

The data reveal that the company has sensibly expanded its supply of people and equipment resources to meet the demands for work. All the resources are currently being used to near their available capacity. Sippican's low profitability cannot be attributed to excess capacity or poor capacity utilization. Its problems must lie with the existing economics of its products and processes.

ABB Step 2: Calculate product cost and profitability

The project team brings all the data together into an integrated Time-Driven ABC model that assigns production costs to the three product lines on the basis of the cost of the resources the products use. It matches these costs to revenues (figure 5-7). Valves are now seen to be even more profitable than previously thought. Pumps, while not earning the targeted 35 percent gross margin, are still strong profit contributors. Flow controllers—previously thought to be the most profitable product line—actually lose money because of the high costs for their setups, engineering support, and packaging and shipping.

FIGURE 5-5

Capacity Cost Rates for Resources

	Employed Days/ Month	Monthly Cost	Paid Hours per Day	Productive Hours per Day	Hours per Month	Cost per Hour
Production workers	20	$3,900	7.5	6	120	$32.50
Indirect workers	20	3,900	7.5	6.5	130	30.00
Engineers	20	9,750	7.5	6	120	81.25
Machines	20	5,400		12	240	22.50

FIGURE 5-6

Monthly Resource Cost and Utilization

	# Units	Monthly Cost/Unit	Total Cost	# Hours Available	# Hours Used	Capacity Used (%)
Direct labor	90	$3,900	$351,000	10,800	10,700	99
Machines	62	5,400	334,800	14,880	14,600	98
Setup	30	3,900	117,000	3,600	3,400	94
Receiving and production control	4	3,900	5,600	520	431	83
Engineers	8	9,750	78,000	960	900	94
Packing and shipping	30	3,900	117,000	3,900	3,733	96

This phase of work illustrates in more detail the fundamental TDABC concepts introduced in chapter 1. It shows how a company works from readily available data to build an accurate model of the cost of resources used by individual products or product lines. Extending the analysis in a subsequent phase would enable many of the marketing, selling, and administrative resource costs (the $350,000 "below-the-line" expenses in figure 5-1) to be driven down to individual orders and customers. Of course, the most important question comes after the model has revealed the actual profit and losses of the products. How will Sippican's management team react to the report on the actual economics of their product lines shown in figure 5-7?

WHAT-IF ANALYSIS

The TDABC model has stimulated the management team to explore several action possibilities. The team immediately notices the high cost of labor and machine time for flow controller setups. Sippican is spending more on setting up to produce flow controllers ($148,500) than it spends on materials and direct labor ($140,000) to produce the product. One possible remedy would be to impose a minimum order size for flow controllers. Managers may ask, "What if we impose a minimum acceptable order size of fifty units? How would this policy affect costs?" The answer can be easily obtained with the TDABC model.

FIGURE 5-7

Sippican Corporation Time-Driven ABC Product Cost and Profitability

	Valves	Pumps	Flow Controllers	Total	Unused Capacity	Actual
Sales revenue	**$592,500**	**$875,000**	**$380,000**	**$1,847,500**		**$1,847,500**
DL expenses	92,625	203,125	52,000	347,750	3,250	351,000
Material expenses	120,000	250,000	88,000	458,000	—	458,000
Contribution margin	379,875	421,875	240,000	1,041,750	(3,250)	1,038,500
Machine run-time	84,375	140,625	27,000	252,000	6,300	258,300
Set-up labor	3,250	19,500	87,750	110,500	6,500	117,000
Machine setup	2,250	13,500	60,750	76,500	—	76,500
Receiving and production control	750	3,750	8,438	12,938	2,663	15,600
Engineering	4,875	19,500	48,750	73,125	4,875	78,000
Package and ship	31,000	52,500	21,000	104,500	4,700	109,200
Manufacturing overhead	126,500	249,375	253,688	629,563	25,038	654,600
Total costs	$339,125	$702,500	$393,688	$1,435,313	$28,288	$1,463,600
Gross margin	**$253,375**	**$172,500**	**$(13,688)**	**$412,188**	**$(28,288)**	**$383,900**
Gross margin %	**42%**	**20%**	**–6%**	**22%**		**21%**
Selling and administrative						350,000
Operating profit						$33,900
Return on sales						1.8%

The project team could simulate the impact of producing the same quantity of flow controllers with the proposed minimum-order size constraint. If every order were for exactly 50 units, then the 4,000 total sales of flow controllers would require 80 production runs (down from the 225 actually experienced in the previous month). But some orders might be for more than 50 units. So the project team assumes 60 production runs for flow controllers, an average batch size of 67. Reducing the number of production runs from 225 to 60 yields a savings of 165 setups, whose impact can be calculated as follows:

Setup labor reduction:	165×12 hours/setup	= 1,980 hours
Machine time savings:		1,980 hours
Receiving and production control:	165×1.25 hours/setup	= 206.25 hours

The monthly capacity of each resource, from figure 5-5, is as follows:

Setup (production) workers: 120 hours

Machines: 240 hours

Indirect labor: 130 hours

If the average batch size of flow controllers increases to 67, with nothing else changing, Sippican could meet its production commitments with 165 fewer production runs, and enjoy the potential savings below:

16	fewer setup employees at $3,900 per month	$62,400
8	fewer machines at $5,400 per month	43,200
1	less receiving-and-production-control person at $3,900	3,900
	Total monthly savings	$109,500

This is a simple example of what-if analysis. Managers perform sensitivity analysis around the current operating plan to assess easily and accurately the resource and cost impact from proposed actions.

As another example of what-if analysis, the TDABC model has revealed, for the first time, the very high costs associated with setup activities. Suppose Sippican's managers explore the benefits of launching a new initiative to focus its process engineers on reducing setup times for all products. Under this scenario, the company would accept the current volume and mix of orders as given and not change any pricing or order terms with customers until it first tried to improve its own internal processes. "What if," the managers wondered, "setup times could be reduced by 40 percent across the board? What would the impact be?"

The project team can run quickly through a scenario in which setup times are reduced to the following times:

Valves: 3.0 hours

Pumps: 3.6 hours

Flow controllers: 7.2 hours

All other production and sales parameters are assumed to remain the same. Under this scenario the total setup times are the following:

	Before (Hours)	*After (Hours)*
Valves	100	60
Pumps	600	360
Flow controllers	2,700	1,620
Total setup	3,400	2,040

The setup time savings of 1,360 hours would allow Sippican to maintain the same sales and production schedule as before but with 11 fewer setup people (1,360 hours divided by 120 hours per setup employee) and 5 fewer machines (1,360 hours divided by 240 hours per machine) for a potential cost savings of $78,900 per month. Thus, Sippican can see the potential benefits and rapid payback from starting an initiative focused on setup time reduction. Since the TDABC model has already estimated the resource capacity for every category of resource, any contemplated reduction in resource demand can be immediately translated into the quantity of resources that can be saved.

These two examples of what-if analysis show how managers use their Time-Driven ABC models to explore the resource supply implications of decisions about products, customers, and operating processes. The ABC model of current operations, including resource capacities and resource demands, provides the starting point for analysis. The what-if analysis enables managers to perform simple, inexpensive studies that translate contemplated changes in product mix, processes, order parameters, and customer service into the implications for changes in resource supply and spending. The forecasted spending changes provide the fact-based benefits case for proposed changes in products, customers, and processes.

ACTIVITY-BASED BUDGETING

What-if analysis assesses the impact of incremental changes to operations and sales. It studies these effects when one or a few parameters vary at a time. The most extensive analysis occurs when the company makes comprehensive plans for changes in product mix, processes, and customer relationships. Such comprehensive planning occurs at least annually when the company conducts strategic planning and translates the updated strategy into detailed sales and operating plans for the upcoming year. Some companies now forecast and plan even more frequently as they migrate from an annual planning exercise to quarterly rolling forecasts, looking ahead five or six periods into the future.

Whether the planning is done annually or quarterly, imbedding the company's TDABC model into the process enables the forecasted sales and production plan to be translated into the specific resources that must be available to meet forecasted targets. After all, if a company forecasts a 10 percent sales increase, it must know whether such an increase can be handled with existing production and support resources, or whether bottlenecks will arise in resources already being used at or near capacity. Alternatively, if the company forecasts an 8 percent productivity improvement, management needs to know which resources presently supplied will no longer be needed if the targeted productivity gains are to be translated into actual cash savings. Otherwise, the productivity improvements just produce unused capacity in future periods. The TDABC model provides a powerful analytic tool for translating aggregate plans into detailed resource requirements.

Few of an organization's resources adjust automatically to short-run changes in operating and sales levels. Perhaps only the energy to operate machines, and the direct materials used in production, are truly short-term variable costs that fluctuate with changes in operating levels and mix. The resources that are most variable or flexible within short periods are typically the resources the organization purchases from outside suppliers. Outside suppliers include vendors from which an organization purchases materials; utility companies from which it purchases energy; manpower agencies from which it leases temporary, part-time workers; and individual labor suppliers from which it purchases labor hours as needed or pays for on a piecework basis.

Much of a company's cost base consists of organizational infrastructure, including the following:

1. Personnel—frontline and support employees, engineers, salespersons, and managers—with whom the organization has a long-term contractual commitment, either explicit or implicit
2. Equipment and facilities
3. Information systems supplying computing and telecommunications

Decisions to acquire new resources or to continue to maintain the current level of these committed resources are typically made during the budgeting process. Once the authorization to acquire and maintain organizational resources has been made, the expenses of these resources appear to be fixed and unrelated to local, short-term decisions about product mix and customer expansion or contraction. The time to make spending on these resources variable is during budgeting. A TDABC model gives managers the information they need during the budgeting process to acquire, supply, and maintain only those resources needed to perform the activities expected in upcoming periods.

Activity-based budgeting is simply Time-Driven ABC performed in reverse. A TDABC model drives costs, via time equations and capacity cost rates, from resources to orders, products, and customers on the basis of the capacity they use. In contrast, activity-based budgeting starts by forecasting the volume and mix of products, orders, services, and customers. Then it estimates the quantity of capacity that must be supplied to meet the forecasted demand, and, finally, calculates the cost—that is, the budget—authorized to supply the needed resource capacities. The process is iterative. Using the first run through the model as a basis, the company varies the assumptions, continually testing different scenarios, until it reaches a targeted profitability scenario.

ABB Step 3: Take managerial decisions on process improvements, pricing, and product and customer mix

The Sippican Corporation, after reviewing the TDABC calculations of product-line profitability, makes the following decisions to improve profitability. It plans to refocus on its core product lines of valves and pumps. It wants to increase market share in valves, which are now seen as the company's most profitable product line, by offering discounts for large orders, an action that the TDABC model has revealed to be highly profitable. In an attempt to stabilize and perhaps reverse the pricing pressure on pumps, Sippican will stop discounting small orders of pumps; it will meet price competition in this product line only for large production orders. It also plans to continue to raise prices aggressively for its flow controllers, especially for small orders, and will establish a minimum order size policy of 50 units.

For productivity improvements, Sippican will direct its engineers to launch a six sigma study of the setup process and will set a target to dramatically decrease setup times so that small-lot production will not be so costly to offer in the future. Sippican recognizes that its new policy may lead to lower sales of pumps and flow controllers, but it is prepared to make that trade-off now that it sees the full costs and losses associated with small-lot production.

ABB Step 4: Forecast the next period's process capabilities and the volume and mix of sales and production

Peggy Knight, working from the forecast for the next period, develops the specific sales and production plan shown in figure 5-8. The estimates of expected production and sales volumes and mix for an ABB model need to be more detailed than in a traditional aggregate production plan. The estimates must include the quantity of products and services that will be sold, as well as the individual customers (or customer types) expected to buy the products and services. The estimates also include details on the production and sales ordering process. For example, the budget should include the number of production runs for each product, the frequency of materials orders and receipts, the number of customer orders, and the method of shipment. Technology has made forecasting at this level of detail easier. Companies can now use their ERP systems to extract information from the order and production schedule files and the master customer and SKU files to generate typical production and customer order patterns.

Sippican's sales and production plan shows how the new focus on larger orders leads to far fewer production runs and shipments. Knight forecasts that the six sigma initiative for setup time reduction will yield 20 percent improvements next period for all three product lines. The new production plan requires more direct labor and machine hours since the

FIGURE 5-8

Forecasted Sales and Production Plan

	Valves	Pumps	Flow Controllers	Total
Price	$75	$80	$110	
Previous price	$78	$70	$90	
Sales (units)	12,000	12,000	2,500	26,500
Previous sales units	7,500	12,500	4,000	24,000
# production runs	40	40	60	140
# shipments	40	70	100	210
Total DL hours	4,800	6,000	1,000	11,800
Setup labor hours/run	4.0	4.8	9.6	
Total setup hours	160	192	576	928
Machine hours (run and setup)	6,160	6,192	1,326	13,678
Engineering hours	60	240	400	700

increased volume of valves more than compensates for the anticipated sales reductions in pumps and flow controllers caused by the elimination of price discounts and small orders.

The detailed production plan shown in Figure 5-8 is the key step for time-driven activity-based budgeting. Once such a credible production plan has been created and approved, the remaining steps to construct an activity-based budget are easy to implement.

ABB Step 5: Calculate the next period's demand for resource capacities to meet the sales and production forecasts

Working from the detailed forecast of volume and mix of products, services, and customers in the production plan, Knight can now forecast the demand for resource capacity in each production department and process. She can use modified time equations to reflect process improvements and changes, such as the reduction in setup times. The forecast of resource demands is identical to that used in calculating conventional budgets for the purchasing of materials, the utilization of machines, and the supply of direct labor. Both conventional budgeting and activity-based budgeting are based on the forecasted production mix for the upcoming year. Activity-based budgeting extends the conventional budgeting exercise by forecasting the demands for all the indirect and support processes: ordering, receiving, and handling materials; processing customer orders; handling customer complaints and requests for technical support; scheduling production; and setting up for production runs.

Figure 5-9 shows the demand for resource capacity in Sippican's various departments to meet the production plan in figure 5-8. The critical calculation, simple to perform, given all the data collected and available, appears in the third column, Estimated Resource Demand (hours). To illustrate, the demand for setup hours comes directly from the production plan in figure 5-8 and already incorporates the benefits of fewer production runs and the 20 percent forecasted reduction in setup times per run. The demand for receiving and production control capacity is calculated by multiplying the number of production runs (140) by the time required per production run (75 minutes, or 1.25 hours, per run). The demand for packaging and shipping is calculated from the simple time equation:

$$\begin{aligned}
\text{Packaging and shipping time} &= (50 \text{ minutes} \times \text{number of shipments}) \\
&\quad + (8 \text{ minutes} \times \text{number of items shipped}) \\
&= (50 \times 210) + (8 \times 26{,}500) \\
&= 222{,}500 \text{ minutes} = 3{,}708 \text{ hours}
\end{aligned}$$

FIGURE 5-9

Estimated: Resource Demands from Sales and Production Plan

Resource	Monthly Productive Hours per Unit	Estimated Resource Demand (hours)	Calculated Resource Supply	Budgeted Resource Supply	Previous Resource Supply
Labor (direct)	120	11,800	98.33	100	90
Labor (setup)	120	928	7.73	8	30
Machines	240	13,678	56.99	57	62
Labor (receiving and production control)	130	175	1.35	2	4
Labor (packing and shipping)	130	3,708	28.53	29	30
Engineers	120	700	5.83	6	8

The data for engineering hours comes from discussions with the head of engineering regarding the quantity of effort required for the six sigma initiative for setup time reduction and for supporting the three product lines at forecasted sales volumes and mix.

The activity-based budgeting team calculates the required resource supply by dividing the resource demands by the capacity of each resource unit. The capacity per resource unit has already been estimated in the original TDABC model. For example, in the Sippican Corporation, each production worker (either direct or setup) and engineer supplies 120 hours of work per month, and each machine can supply 240 hours of available time per month. Column 4 in figure 5-9, Calculated Resource Supply, shows the exact quantity of resources required to meet the next period's production and sales plan. Recognizing that most resources do not come in fractional quantities, the activity-based budgeting team (or computer program used to implement this step) rounds the actual calculated quantity to the next highest integer (column 5). The budgeted resource supply may also include some extra resource units to handle peak or surge demands or provide a buffer in case actual sales and production exceed forecasted levels. This is a judgment call that managers can make during the activity-based budgeting process. The numerical calculations reveal the minimum resource supply required—at anticipated productivity levels—to meet the production plan. Managers can adjust this figure up to provide a protective buffer, or adjust it down to be conservative in contracting with resource supply, expecting to use overtime or reductions in planned downtime (for training, education, and maintenance) to accommodate higher demands for productive work.

Companies may discover that their current resource supply is well above that anticipated for future operations. This is when companies have the opportunity to make the costs of these resources "variable," by redeploying, eliminating, or—in the case of plant, property, and equipment—selling the resources no longer needed. Alternatively, companies may learn that they cannot meet all the resource demands in their production plan with existing resources. They have three options at this point. They can acquire the resources needed to meet the production plan, they can revise the production plan downwards so that it can be fulfilled with existing resources, or they can attempt to increase the productivity of their existing resources so that the increased demand for work can be met through efficiency gains. None of these options is a trivial decision. Activity-based budgeting does not make these decisions automatically; it simply signals to managers the consequences from their new production and sales forecasts. It identifies where excess capacity or capacity shortages will exist, department by department and process by process, if no adjustments are made to current resource supply. It is up to the company's managers to make the hard decisions about changes in production and sales forecasts and how to accomplish the required resource reduction or acquisition to match the revised plans.

ABB Step 6: Authorize spending (either increases or decreases from the current period's levels) to supply the desired resource capacities in future periods

The final step is simple, once management has made the critical decisions on the quantity of resources to be supplied next period. Knight estimates the budget for resource spending when she multiplies the quantity of authorized resources by the cost per unit of each resource. The right-hand column, Budgeted, in figure 5-10 is the authorized (budgeted) quantity of each resource multiplied by its per-unit cost ("Monthly Cost/Unit" column in either figure 5-5 or figure 5-6). The remaining columns in figure 5-10 reflect the product costs associated with the sales and production plan in figure 5-8. The costs attributed to each product are based on the resource costs incurred to meet each product's forecasted production plan. The difference between the costs attributed to the products, summarized in the Total column, which represents the sum of costs attributed to the three product lines, and the budgeted cost (the Budgeted column)

FIGURE 5-10

Sippican Corporation: Projected Sales and Product Profit Analysis

	Valves	Pumps	Flow Controllers	Total	Unused Capacity	Budgeted
Sales (units)	12,000	12,000	2,500	29,500		
Sales revenue	**$900,000**	**$960,000**	**$275,000**	**$2,135,000**		**$2,135,000**
DL expenses	156,000	195,000	32,500	383,500	6,500	390,000
Material expenses	192,000	240,000	55,000	487,000	—	487,000
Contribution margin	552,000	525,000	187,500	1,264,500	(6,500)	1,258,000
Machine run-time	135,000	135,000	16,875	286,875	45	307,800
Set-up labor	5,200	6,240	18,720	30,160	1,040	31,200
Machine setup	3,600	4,320	12,960	20,880		
Receiving and production control	1,200	1,200	1,800	4,200	3,600	7,800
Engineering	4,875	19,500	32,500	56,875	1,625	58,500
Package and ship	49,000	49,750	12,500	111,250	1,850	113,100
Manufacturing overhead	198,875	216,010	95,355	510,240	8,160	$518,400
Total costs	$546,875	$651,010	$182,855	$1,380,740	$14,660	$1,395,400
Gross margin	$353,125	$308,990	$92,145	$754,260	$(14,660)	$739,600
Gross margin %	**39%**	**32%**	**34%**	**35%**		**35%**
Selling and administrative						350,000
Operating profit						380,600
Return on sales						**18%**

equals the cost of unused capacity that has been planned or authorized for the period.

The cost of planned unused capacity is not associated with any particular product line (or customer). It arises from the lumpiness with which most resources are acquired, from managers' conscious decisions to supply some buffer capacity for the period, or because managers are unable or unwilling, in the short run, to reduce available resource capacity to that required for next period's production. The column Unused Capacity shows the economics associated with decisions to supply capacity beyond the anticipated needs for the production plan.

The calculations in figures 5-9 and 5-10 illustrate the analytic approach in which budgeted (authorized) spending on resources arises endogenously, from within the model. The analytic budgeting process highlights the spending that must be incurred if the company's sales and production forecasts for the subsequent period are to be realized. For Sippican, the company is likely to be delighted with the budget forecast since it reveals the opportunity to improve gross margins to 35 percent and operating margins to 18 percent, dramatic improvements over performance in recent months. If, however, the forecasted spending and profits are not acceptable to management, then the activity-based budgeting team must go back to the drawing board; develop alternative scenarios for pricing, product and customer mix, and productivity improvements; feed the new scenarios into the TDABC resource demand model; and reestimate resource spending, margins, and profitability. The process should be iterative and even exploratory. The existence of an accurate analytic model of company operations at the core of the budgeting process enables managers to explore several scenarios for the future and then commit to resource capacities that give the best opportunities for profit enhancements for the upcoming period.

BUDGETING FOR DISCRETIONARY RESOURCES

Activity-based budgeting, as illustrated in the Sippican Company example, is most useful for resources that perform repetitive activities, especially for processes triggered by demands from orders, products, services, and customers. Managers must also budget for discretionary spending for the upcoming year. This spending includes advertising, product marketing and promotion, research and development, employee training, and general customer support. The outcomes from spending on advertising, R&D, and market promotions are, for most companies, not as predictable as the capacity acquired when they spend on operating and support people, equipment, technology, and space. The amount to spend on intangible assets can rarely be derived directly from the sales and production forecast. Authorizations to spend on branding or enhancing the image of a company or a product, on R&D, and on the improvement of employees' capabilities must still be done judiciously, through the experience and wisdom embedded in the senior management team.

SUMMARY

Activity-based budgeting, based on Time-Driven ABC models, does not solve all the problems associated with budgeting. But it can replace a great deal of the judgment, negotiation, and subjectivity currently required to implement line-item budgeting processes. It provides an analytic approach for deciding on the quantity of resources that needs to be supplied to meet future periods' forecasts of production and sales. Rather than negotiate about fixed line-item budgets, activity-based budgeting provides an objective, rigorous process to forecast the level of spending on resource capacity required to implement the company's strategic plan.

Activity-based budgeting does require the company to specify, in far greater detail than conventional methods demand, how production and sales demands will be met and the available supply, acquisition cost, and efficiency of company resources. With effective activity-based budgeting, however, managers will have much greater spending control over their cost structure, particularly over what they previously considered their fixed costs.

NOTES

1. This discussion is derived from R. S. Kaplan, "Sippican Corporation (A)," Case 9-106-060 (Boston: Harvard Business School, 2006).
2. The full compensation, including fringe benefits, for direct and indirect employees (other than engineers) is $3,900 per month. Employees work an average of twenty days per month (holidays and vacations accounted for the remaining two to three days per month).