1

Understanding Cost Behavior

THE ROLE OF MANAGEMENT ACCOUNTING

Management accounting information serves several major roles in organizations. It enhances decision making, guides strategy development and evaluates existing strategies, and focuses efforts related to improving organizational performance and to evaluating the contribution and performance of organizational units and members.

One of the most important types of management accounting information is cost information.[1] Organizations use information about costs to make important product feature and product mix decisions. For example, despite industry trends to increase variety and customization, Procter & Gamble announced, in 1996, that it would reduce the number of SKUs (stock-keeping units) it offered by nearly 40%. Senior managers made this decision when they understood the cost of product complexity—to themselves, to their distributors, and to their retailers—caused by producing too many versions of the same product. P&G's improved costing systems showed that the increased cost was far higher than the incremental revenues the SKUs generated and the value they created for customers.

Organizations also use cost information to develop competitive strategies. For example, by 1994 the practice of trade loading was well established in the consumer packaged goods industry. Manufacturers promoted their products heavily in certain periods, leading to a pattern of selling high volumes of product into distribution channels on a periodic basis rather than providing a continuous flow of product. With the advent of improved costing systems, organizations came to recognize the additional production costs caused by highly variable production levels and the huge inventory holding costs[2] imposed on wholesalers and retailers by trade loading. Many organizations are now trying to eliminate this practice and to move to continuous replenishment, with manufacturing decisions triggered by consumer takeaway at the retail level.[3]

As a third application, organizations use appropriate cost information to guide their operations improvement activities. Once managers see the costs associated with various organization activities, they can focus their improvement efforts on activities that are major contributors to organization cost. For example, a hospital identified the activities it undertook to provide services to patients, including all support operations, such as admitting and billing. It then identified the drivers, or causes, of those activities. Hospital personnel then tackled the job of cost reduction by focusing, improving, and eliminating high-cost activities. A major goal was to reduce the patient's time in the hospital, primarily by speeding up the scheduling and evaluation of diagnostic tests. The hospital staff developed improved procedures that eliminated some activities and made many others much less costly. The hospital example illustrates two responses to activities with high costs. A high-cost activity might prompt efforts to redesign or eliminate that activity entirely, a process called **reengineering**, or it might prompt efforts to make the activity more efficient and less costly, a process called **continuous improvement**.

Organizations also use cost information to evaluate performance. Using cost to evaluate performance has two purposes. First, an awareness of the high costs of activities often motivates the type of improvement activities illustrated by the hospital example above. Second, by tying the results of cost improvement activities to rewards, planners use cost information to motivate people to pursue organization improvement.

UNDERSTANDING COST BEHAVIOR

Costs arise from the acquisition and use of organizational resources, such as people, equipment, materials, outside services, and facilities. Organizations acquire and use resources to perform activities. When organizations use resources to perform activities, the financial system records costs.

There are two broad types of costs. The first type of cost is created when the organization acquires productive capacity. We call resources that are acquired or contracted for in advance of when the actual work is done **committed resources**. The costs associated with these resources are called **committed costs**. Most personnel costs, the costs of computing and telecommunications systems, and depreciation on the organization's buildings and equipment are examples of committed costs. The amount of resource capacity acquired determines the magnitude of a committed cost. Committed costs are unaffected by how much the organization *uses* the committed resource. Therefore, the amount of committed costs is related to the **planned level** of activities and is incurred independent of how much use is made of the committed resource during the period.

The second type of cost, which we will call **flexible costs**, arises from the use of **flexible resources**. Raw materials, electrical power consumed in a factory, labor that is acquired and paid for only in the amounts used, and fuel used in vehicles that deliver products to customers are all examples of flexible resources. The actual level of activities performed to make products and serve customers determines the quantity of flexible resources supplied and used.[4] Flexible resources do not have a capacity defined for them, because their supply, hence capacity, can be adjusted up or down to meet actual

demands. The organization pays for only the amount of flexible resources that it needs and uses.

AN EXAMPLE OF COST STRUCTURE

We illustrate these ideas of committed and flexible costs with an example. We start the example by describing how an organization initially acquires its resources. That is, we begin with an understanding of how costs arise and then estimate the resulting cost function. Management accountants typically work in the opposite direction. They observe costs and make inferences about the underlying cost structure. Chapters 3 and 4 take that path. We should understand how costs arise before learning the management accounting function of estimating a cost structure.

Consider Railstar, a railroad whose sole business is to transport passengers and freight between two cities, Rose Terrace and Whistle Stop. Railstar conducts its business from a head office complex in Rose Terrace. This head office complex contains all Railstar's administrative and marketing personnel.

The cost associated with this head office complex is about $50,000,000 per year. These costs include

1. $25,000,000 of costs relating to resources that support all Railstar's operations. The costs of these resources would be incurred even if Railstar carried no passengers or hauled no freight
2. $15,000,000 of costs relating directly to the passenger business, which, in the long run, could be eliminated if Railstar closed its passenger business
3. $10,000,000 of costs relating directly to the freight business that, in the long run, could be eliminated if Railstar closed its freight business.[5]

This cost behavior exhibits the phenomenon of increasing returns to scale. Head office costs are lower if Railstar operates both businesses than if two similar companies operate the businesses separately because separate companies would have to duplicate the $25,000,000 in head office resources for each to operate.[6]

Railstar has built and maintains a roadbed and track between the two cities. The cost of building the track was $500,000,000. Depreciation of existing track amounts to about $80,000,000 per year. Maintenance costs increase by $200 each time a locomotive travels between the two cities and by approximately $20 each time a railcar carrying either passengers or freight travels between the two cities.

Railstar has built and maintains stations in both Rose Terrace and Whistle Stop. Railstar built these stations in anticipation of annual demand for travel on the line. Stations can be built and operated in three sizes: small, medium, and large. The small size handles up to 50,000 passengers per day, medium up to 100,000 passengers per day, and large up to 200,000 passengers per day. A station's annual depreciation cost is approximately $50 per unit of daily passenger capacity.[7] Flexible station-related cost amounts are respectively $5, $3, and $2 per unit of passenger capacity for the small, medium, and large stations. Railstar has built and maintains medium-sized stations in both Rose Terrace and Whistle Stop.

Every six months Railstar personnel decide how many trains to operate each day for the upcoming six-month period. Railstar then prints the resulting passenger schedule, which is valid for the next six months. Railstar operates each train with three locomotives. Railstar leases five locomotives at a cost of $2,000,000 per locomotive per year. Operating personnel assign three locomotives to each train, which is the minimum number of locomotives required by the regulatory authority. They keep one locomotive at each station[8] to do local yardwork and to provide backup when mechanics perform routine maintenance on the running locomotives. The cost (fuel for the locomotives and crew salaries) for each trip is $10,000. Each locomotive assigned to a train provides a total capacity of 30 cars, passenger or freight. Therefore, with three locomotives, the train capacity is 90 cars.

Railstar does not own any freight cars; it hauls freight cars belonging to other railroads. Railstar leases passenger cars for six-month periods at a cost of $50,000 per car per six-month period. Each passenger car can carry 80 passengers. Railstar estimates that hauling a passenger or freight car from one city to the other increases the total of fuel, supplies, and personnel costs by about $500.

Finally, Railstar incurs costs that are directly related to the number of passengers on the train. These include baggage-handling costs and passenger service costs. These costs amount to $10 per passenger trip.

Exhibit 1-1 summarizes Railstar's cost structure.

EXHIBIT 1-1 Railstar—Illustrating the Idea of an Organization's Cost Structure

COST TYPE	COST ELEMENT	AMOUNT
Head office–related	Total all costs	$50,000,000 per year
Roadbed-related	Depreciation	$80,000,000 per year
	Maintenance	$600 per trip
	Maintenance	$20 per car per trip
Station-related	Large	
	Depreciation	$10,000,000 per year
	Other	$2 per passenger
	Medium	
	Depreciation	$5,000,000 per year
	Other	$3 per passenger
	Small	
	Depreciation	$2,500,000 per year
	Other	$5 per passenger
Train-related	Locomotive lease—provides a basic capacity of 90 cars per train—additional locomotives added at a cost of $2,000,000 per year and each provides an additional capacity of 30 cars per train	$10,000,000 per year
	Trip costs	$10,000 per trip
	Passenger car rental—car capacity is 80 passengers	$50,000 per six-month period
	Hauling cost	$500 per car per trip
	Passenger cost	$10 per passenger

Deriving the Total Cost Function

Decision makers at Railstar use cost information for many purposes. One major purpose is to identify whether the market prices that Railstar must meet[9] cover both the cost of providing that service and a reasonable return on invested capital. If they did not, Railstar would have to redouble its efforts to cut costs or decide to abandon that business.

Note that the information in Exhibit 1-1 is not in a form that can be used to compute the cost per unit of freight or passenger service, and, more important, note that many of Railstar's costs are not proportional to the number of freight or passenger service units provided.

Given the information provided we can write an equation for costs, which we can call the cost function, as follows

Total cost = head office–related costs + roadbed costs + station-related costs + train-related costs

We cannot specify this cost function in any more detail until we understand the capacity choices that Railstar personnel have made. Given that Railstar is currently operating both a passenger and a freight business, that it has built two medium-sized stations, and that it plans to operate with five locomotives, we can write the annual cost function as[10]

Total cost = \$150,000,000 + (\$100,000 * number of passenger cars rented) + (\$10,600 * number of trips) + (\$520 * number of car trips) + (\$13 * number of passengers) [1]

The cost function in equation [1] reflects choices that Railstar personnel have made about three types of committed resources:

1. The decision to be in both the freight and passenger transport businesses, reflected by the head office–related costs
2. Depreciation expenses resulting from acquiring the head office building and maintaining the rail and roadbed
3. The expenses associated with the size of station (small, medium, or large) chosen

Therefore, once Railstar personnel make commitments to acquire long-lived resources, they determine the part of the cost function that is related to committed costs. Committed costs reflect the amount of capacity acquired rather than the amount of capacity used in operations.

Committed costs arise from a decision to acquire a capacity or capability to perform work. These costs do not vary in proportion to production quantity. Once the decision has been made to acquire the resources, the costs of these resources will remain until managers eliminate those resources.

For example, if Railstar personnel decided to use small stations and to be in only the passenger business, the cost function would become, after the passage of time to allow for the adjustment of capacity resources,

Total cost = \$135,000,000 + (\$100,000 * number of passenger cars rented) + (\$10,600 * number of trips) + (\$520 * number of car trips) + (\$13 * number of passengers) [2]

Now consider the effect on the total cost shown in equation [1] when Railstar personnel fix the number of passenger cars to lease. Suppose that Railstar personnel choose to lease 60 passenger cars for the upcoming six-month period. Presumably this decision reflects estimates of the number of passengers who will want to ride the train. The total cost function becomes

$$\text{Total cost} = \$156{,}000{,}000 + (\$10{,}600 * \text{number of trips}) + (\$520 * \text{number of car trips}) + (\$13 * \text{number of passengers}) \quad [3]$$

The effect of making resource commitments by choosing capacity should now be evident. Costs that are variable or flexible before a capacity decision become committed costs after the capacity acquisition decision has been made. The subsequent level of operations will not affect those costs. For this reason, we often call these costs fixed because they are independent of the actual level of operations.

Recall that at the start of every six-month period, Railstar publishes a schedule that commits it to a specified number of trips. Suppose that Railstar decides to offer five round-trips each weekday (a total of 50) and two round trips each weekend day (a total of eight).[11] Therefore the total number of trips per week is 58 and the total trip-related costs are[12] $31,969,600 per year. The total cost function, assuming that this pattern continues for two six-month periods making up the year, becomes

$$\text{Total cost} = \$187{,}969{,}600 + (\$520 * \text{number of car trips}) + (\$13 * \text{number of passengers}) \quad [4]$$

We now have a total annual cost equation that is a function of two variables: the total number of cars and the total number of passengers that Railstar hauls during the year. We can think of each scheduled train as a group or a batch. The cost of the batch (other than the trip-related costs that Railstar committed when it chose its operating schedule) is $520 and reflects the number of cars in the trip (batch).

Suppose that, for operating reasons, Railstar makes a decision about the number of cars to put in each train for a given week on Saturday of the week preceding. Assume that Railstar is committed to hauling an average of 50 passenger cars on each weekday train and 15 passenger cars on each weekend train. The total number of weekday trips is 50 and the total number of weekend trips is eight, so the total passenger cars that will be hauled is 2,620 and the total cost commitment of this schedule is $70,844,800.[13] The total cost function, assuming that this pattern continues for two consecutive six-month periods, now becomes

$$\text{Total cost} = \$258{,}814{,}400 + (\$520 * \text{number of freight cars hauled}) + (\$13 * \text{number of passengers}) \quad [5]$$

Determining the Cost per Unit of Service Provided

From Short-Run to Long-Run Costs

Equations [1] through [5] are total cost functions. The total cost function in equation [5] is expressed in terms of Railstar's most-primitive decision variables: the units of service demanded by, and provided to, Railstar's customers. Recall that committed costs are captured by the constants in the cost functions. The committed costs reflect the many underlying decisions that Railstar personnel have made to provide a given level of capability (to

provide both passenger and freight transport service) and capacity. The variable components in the total cost functions represent the flexible costs. These terms estimate how total cost varies in proportion to the two identified activity levels: (1) number of freight cars hauled and (2) number of passengers. Therefore, we can conclude that as the number of passengers carried increases (or decreases) by one unit, the total cost will increase (or decrease) by \$13.[14] Between the times at which Railstar makes decisions to adjust capacity up or down, and assuming that operations remain within the range of capacity provided by Railstar's committed costs, the total cost will increase (decrease) by \$520 as the number of freight cars hauled increases (decreases) by one unit.

The time period of committed costs clearly varies by resource type. Railstar can adjust passenger operating costs weekly by determining the number of cars to put on each train. It can adjust passenger car expenses semiannually when it determines the number of trips and the number of passenger cars to supply. Annually, Railstar determines how much it will spend on locomotives. Over somewhat longer time periods, the company can adjust the size of its station, the size and composition of its head office, and the degree of maintenance of the rail and roadbed.

Note that the short-term variability in the cost functions (equations [1] through [5]) arises from the number of passengers carried and the number of freight cars hauled. They reflect none of the committed costs. For this reason, the coefficients (\$13 and \$520) on the flexible resource parameters do not incorporate any effects on long-run costs from decisions that require changes in the capacity being supplied, say, increasing the number of passengers by 25% or eliminating the freight hauling side of the business.

Calculating the Costs of Services

Equations [1] through [5] represent the costs of supplying resources. Understanding these costs is extremely important. Managers, in the short run, control expenses and spending by monitoring these costs closely. These costs of resource supply are also important for predicting near-term cash flows and are the basis for cash budgeting and working capital decisions. And when managers are making incremental decisions, such as whether to carry an additional passenger or small group of passengers or whether to accept a new freight order, these resource supply costs provide valuable information.

But these are not the only relevant costs for managerial decisions. Organizations that have many different types of resources and that produce and sell hundreds of products to thousands of customers often want to relate the revenues received from such sales to the costs of resources required to generate the sales. Only in this way can the organization get a signal about the relative profitability or loss of its various products and customers. Computing the cost of resources used by individual products and customers provides managers with signals about how different products and customers consume the organization's available capacity. Take Railstar, for example. First-class passengers require more car space and personnel time than do passengers traveling in tourist or coach class. When different types of passengers use capacity in different amounts, managers need a cost signal to indicate the relative cost of all the resources used by these different types. Such a cost—of resources used—can be compared with the price or revenues received to determine whether that product, class of service, or type of customer is profitable. A product is profitable when the revenues received exceed the cost of the resources used to produce and deliver the product.

An income statement for the entire organization (such as Railstar) provides an aggregate signal whether the revenues generated by operations exceed the costs of supplying all committed and flexible resources that enable operations to occur. But this aggregate signal provides little guidance about large variations in profitability among diverse products, services, and customers.

In virtually all service industries, such as Railstar, but also in an increasingly large number of manufacturing organizations, almost all expenses are determined by commitments to supply given levels of capacity, as reflected by the acquisition of committed resources. Relatively few expenses are determined by the actual quantity of work demanded or performed each day—in Railstar's case, passengers carried and freight cars hauled. Most operating expenses are determined by decisions to acquire and sustain capacity, not by what happens today or tomorrow to produce products and services for customers.

Most managers, however, want to understand the relationship between the resource capacity they supply and how the organization's diverse products and customers use that capacity. For this purpose (and for several others as well, as we will see later in the book), managers find it useful to calculate the costs of resources used by individual products and customers. This calculation requires that accountants determine, for each capacity resource, a unit cost for using that resource.

Consider one of Railstar's committed costs: the cost of a passenger car. The leasing cost of the passenger car is $50,000 for six months. How do we go about translating this cost into the cost per passenger carried? Some companies may wait to find out how many passengers were actually carried. They would divide the $50,000 cost by the actual number of passengers to calculate the actual cost per passenger. Managers advocating this approach argue that such an ex post calculation reflects actual operations. Of course, having to wait until the end of the period to calculate a cost per passenger does not make the cost very useful for decision making before the end of the period. To avoid such a wait, many companies divide the projected cost of the passenger car by the number of passengers that it expected to carry over the six-month period. Whether the cost is calculated ex ante or ex post, the per passenger cost could fluctuate quite widely every six months as the load factor, the ratio of passengers carried to capacity, varies.

Alternatively, we could relate the committed cost to the capacity supplied. In this case, we certainly know that the car capacity is 80 passengers, but what is the capacity for the six-month period? The capacity number will be 80 multiplied by the number of scheduled trips per week multiplied by the number of weeks in the six-month period. Note that, because managers can vary the intensity of usage of this type of resource (by varying the number of scheduled trips from period to period), the car lease cost per passenger can vary from one six-month period to another.[15]

For example, if we assume that Railstar intends to operate 58 trips per week, the lease cost per unit of passenger capacity is about $33.

$$\text{Cost per unit of capacity} = \frac{\$50{,}000}{58 * 26} = \$33.16$$

Does this mean that if one passenger more shows up that car lease costs will increase by $33? Of course not; car lease costs depend on the number of cars that are leased and the leasing cost per car, not on the number of passengers carried. Does it mean that if the long-run demand for passengers shifts down by one unit that the average lease cost

will fall by $33 as Railstar personnel react by leasing fewer cars? Of course not; capacity is acquired in chunks, not in individual units. Moreover, the $33 calculation reflects the assumptions made of car use. Different assumptions would result in a cost different from $33. But the calculation is a component in the total resource cost associated with carrying individual passengers. If Railstar is consistently unable to charge prices that cover the $33 per passenger cost of the railcar plus the cost of all other resources supplied to handle passenger traffic, then the company's managers are getting a signal that the economics of their passenger business does not justify a sustained presence in the marketplace.

In the case of Railstar, where a decision to acquire a supply of passenger cars is made every six months, another basis for assigning car costs arises from examining the authorization decision. At the time the decision is made about how many passenger cars to acquire, Railstar's managers have estimates about the quantity and mix of passengers it expects to carry and the prices they can expect to earn from each passenger of each type. Planners use this information to authorize the acquisition of passenger cars and to configure the cars for the anticipated mix of first-class and coach passengers.

For example, suppose that planners decide to dedicate 15 of the 60 passenger cars acquired to first-class service and configure the remaining 45 for coach service. Therefore, every six months, planners will attribute $750,000[16] of the car rental costs to first-class passenger service and $2,250,000, the balance of the car rental costs, to the coach class business.

Recall that cars configured as coach class carry 80 passengers, and assume that cars configured for first class will carry 40 passengers. Suppose that planners expect that, on average, the first-class cars will be 75% occupied and the coach class cars will be 85% occupied. Using the plan developed above to haul 2,620 cars per week, assume that 25% (15/60) of the cars are first-class and 75% are coach class. Therefore, the total capacity available for the two types of cars is

$$\text{Semiannual coach capacity available} = 2620 * 75\% * 80 * 85\% * 26 = 3{,}474{,}120 \text{ seats}$$

$$\text{Semiannual first-class capacity available} = 2620 * 25\% * 40 * 75\% * 26 = 510{,}900 \text{ seats}$$

Therefore, if car costs were assigned based on the planned level of operations, the car rental cost per passenger for each of the two services would be

$$\text{Car lease cost per coach passenger} = \frac{\$2{,}250{,}000}{3{,}474{,}120} = \$0.65$$

$$\text{Car lease cost per first-class passenger} = \frac{\$750{,}000}{510{,}900} = \$1.47$$

Note that these capacity cost per unit calculations reflect:

1. The cost of the committed capacity
2. The allocation base used to allocate capacity
3. The value or size of the allocation base

It may seem unduly complex to perform such calculations. And, in fact, for this highly simplified example in which the resources are being supplied for only one or two products (passengers: first class and coach), managers can probably get by without such a signal. With one or only a very few products, especially when the demands they make on the organization's resources are relatively homogeneous, knowledge of the total cost function (the cost of supplying resources) will likely be adequate for management's needs.

But suppose that Railstar owned or leased its own freight cars and sold freight-carrying services to shippers. Freight, unlike passengers, can be highly variable. Some shippers may wish to have Railstar carry freight that is extremely bulky (beach balls packed in mesh bags) that use up a great deal of a freight car's volume. Other shippers may contract with Railstar to transport extremely heavy products (such as steel coils) that use up a freight car's (and locomotive's) weight-carrying capacity. Still other shippers may ask Railstar to carry products that are quite difficult to handle, such as uncrated bicycles and mufflers that consume a disproportionate share of the railroad's freight sorting and handling capacity. Railstar must set prices for shippers that are competitive with other transport companies, such as trucks, airfreight, and barges. But for Railstar to remain in the freight business, it wants to know which types of freight are best for it to carry.

For this purpose, its managers want a cost signal that lets them know the cost of resources used by different types of freight (beach balls, steel coils, and uncrated bicycles and mufflers). The managers can then compare the prices it receives for different types of freight, and from different customers, with the costs of the resources it must supply to carry the freight. This information provides guidance for decisions about pricing, order acceptance, and product mix (such as whether to concentrate on compact versus bulky, heavy versus light, easy- or difficult-to-handle freight). For this purpose, managers must estimate the unit costs of its various resources, such as the cost per cubic foot of freight car space (if volume-constrained) or cost per pound of freight car (if weight-constrained) plus the cost associated with handling the freight business and specific customer-related expenses.

In summary, for many decisions, including pricing, product mix, market entry and exit, and customer service and delivery, managers need estimates that identify the costs of resources used by different products, services, and customers. This information is derived from, but also is in addition to, the information about the costs of committed resources.

Computing the Cost of Resources Used

We will start along the path of estimating the costs of resources used by product groups, such as freight and passenger services, by apportioning the committed costs in equation [3] into three groups:

1. One group for costs related to providing freight services
2. One group for costs related to providing passenger services
3. One group for costs related to providing general capacity that provides both freight and passenger services

Exhibit 1-2 summarizes this apportionment.

EXHIBIT 1-2 Railstar—Apportioning Annual Costs into Product Groups

COST TYPE	PASSENGER	FREIGHT	INDIRECT	TOTAL
Head Office–Related				
General			$25,000,000	$25,000,000
Passenger-related	$15,000,000			$15,000,000
Freight-related		$10,000,000		$10,000,000
Roadbed-Related				
Depreciation			$80,000,000	$80,000,000
Maintenance—trip			$1,809,600	$1,809,600
Maintenance—ps car	$2,724,800		$2,724,800	
Maintenance—fr car		$20 per car		$20 per car
Station-Related				
Depreciation			$10,000,000	$10,000,000
Other	$3 per passenger			$3 per passenger
Train-Related				
Locomotive lease			$10,000,000	$10,000,000
Trip costs			$30,160,000	$30,160,000
Car lease	$6,000,000			$6,000,000
Hauling cost—ps car	$68,120,000			$68,120,000
Hauling cost—fr car		$500 per car		$500 per car
Passenger cost	$10 per passenger			$10 per passenger

HANDLING INDIRECT (COMMON) COSTS

An indirect cost is the cost of capacity that provides services to more than one product. The $25,000,000 portion of head office costs, the roadbed costs, the station costs, the maintenance costs caused by the locomotives, the locomotive lease costs, and the trip costs are all examples of indirect costs in this problem. The issue that we face is how to assign these costs to the individual businesses, freight and passenger, so that we can compute unit costs for the freight and passenger businesses.

There are two broad types of indirect costs: (1) costs that are entirely independent of the level of capacity and (2) resources acquired and costs that vary somehow with the level of capacity. For example, the total expense of key administrative officers would be incurred independent of the scale or actual level of operations. We call this type of cost **business-sustaining**. Theoretically, all companies in the industry, regardless of size or complexity, should have the same level of business-sustaining expenses. We do not attempt to assign business-sustaining expenses further down the organization. The second type of indirect cost can be related to the capacity level of the organization.

As an example, suppose that $5,000,000 of the indirect head office–related costs is the minimum required to support any level of operations. These costs are business-sustaining and are not assigned to individual products. For the balance of indirect head office–related costs, $20,000,000, we need an estimate of the units of service, say 10,000,000 units, that can be handled by this supply of resources. We can calculate the cost of capacity of the headquarter's resources as $2 per unit of service.

Computing the cost of capacity used to make a product reflects the following causal chain. Most committed costs (other than sustaining costs, defined as the minimum amount

required to operate a business, facility, or product line) are incurred to supply a given quantity of to the amount of acquired capacity. This assumption enables the management accountant to calculate a cost for using the units of service provided by the capacity.

COMPUTING THE COST OF UNUSED CAPACITY

Recall that every week the planners at Railstar fix the number of passenger cars that it will put in each train for the upcoming week. There are many reasons why organizations fix, or commit, capacity ahead of time rather than supplying as flexible a capacity as possible. First, committed capacity is often in the form of buildings or factories that have to be built and whose capacity can be varied only at a great cost. Second, committed capacity is often leased from outsiders, as in the case of railcars in this example, and these outsiders, to minimize their exposure to demand uncertainty, often demand long terms for leases. Third, scheduling requirements often require that some capacity elements be put in place so that short-term scheduling can be undertaken.

Contracting in advance to acquire resources also enables the organization to make enormous savings in transactions costs and to reduce its risk. Without making commitments in advance—for equipment, for personnel, and for other resources—the organization would have to contract daily, in spot markets, for each of its resources. Equipment takes time to get into place, personnel take time to get trained and motivated to achieve organizational goals, and all the resource supply must be linked together in a highly integrated fashion to accomplish work for products and customers. It would be impossible to contract daily for most resources using forecasts for how much work is required to be accomplished that day. Also, spot market contracting would subject the company to short-term price fluctuations that it can avoid by committing to acquire a resource at a fixed price for an extended period of time.

The requirement that capacity has to be fixed before the amount needed is determined has a profound effect on costs and is the basis for differentiating between short-run costs and long-run costs. Consider the passenger railcar capacity. Recall that these passenger cars are leased on a six-month term. Railstar leased 60 of these cars for the current six-month period. Recall that a train propelled by three locomotives can pull up to 90 cars, in any combination of freight or passenger.

Suppose that, through a combination of anticipated passenger and freight traffic, Railstar plans to use the following number of passenger cars each day of the week (beginning Sunday): 10, 50, 50, 45, 50, 55, 20—during the current six-month period: an average of 40 cars per day. Recall that the total cost of leasing these cars was $3,000,000 (60 cars @ $50,000). Suppose that instead of renting for a six-month period, Railstar could lease the cars by the day. This condition amounts to a rate that reflects average use, which, in this case, would amount to $2,000,000 (40 cars @ $50,000). Therefore, Railstar has incurred additional charges of $1,000,000 because it must commit to capacity for the six-month period, and, during that time, it cannot adjust capacity for varying demand. This is a very common problem that becomes more difficult as the proportion of costs that are committed increases. Organizations with this characteristic include airlines, telecommunications companies, electrical utilities, and universities.

We can think of the excess capacity issue as follows

$$\text{Resources supplied} = \text{resources used} + \text{unused capacity}$$

In this case, on average,

$$\text{Passenger cars supplied} = \text{passenger cars used} + \text{passenger cars idle}$$
$$60 = 40 + 20$$

or, in terms of costs

$$\text{Total capacity cost} = \text{capacity cost used} + \text{cost of idle capacity}$$
$$\$3{,}000{,}000 = \$2{,}000{,}000 + \$1{,}000{,}000$$

Note that the capacity, or committed cost (on the left-hand side of the equation), is $3,000,000, which is our focus in this chapter. In Chapter 4, we will discuss activity-based costing, which works on how the cost of capacity (in this case $2,000,000) was used by individual products.

When organizations have unused capacity (of committed resources) they often attempt to get customers to shift their demand patterns. For example, an electrical utility might offer time-of-day discounts to motivate customers to move demand to an off-peak period. Airlines offer incentives to customers to travel on weekends by providing substantial discounts if the traveler stays over a Saturday night. Universities attempt to improve the use of committed resources by moving from two-semester, to three-semester, or even four-semester systems that keep the university open year-round. Railstar might respond by offering customers discounts for weekend service (freight or passenger).

The result of the excess costs attributable to idle, or unused, capacity is to increase the organization's costs. In general, the cost of idle capacity is best treated as a period-related rather than a product-related cost.[17]

COST-VOLUME-PROFIT ANALYSIS

Recall that in this chapter we have presented Railstar's cost structure as if the planners at Railstar knew it. As we will see in Chapter 4, identifying an organization's cost structure is often a difficult process requiring the application of experience and good judgment. However, once planners have identified the organization's cost structure, they can use the information to develop a financial model of the organization.[18]

To illustrate what a simple financial model of an organization might look like, let us add a few more assumptions to the data that we used to develop Railstar's cost structure. Assume that Railstar's planners expect that Railstar will sell 75% of the passenger seats it makes available and that it will haul 25 freight cars on each weekday trip and 20 freight cars on each weekend trip. Finally, assume that the price for a passenger ticket is $40 and that Railstar charges $1,000 to haul a freight car.[19]

With these assumptions, Railstar would expect to earn (lose) approximately $2,900,000 in the upcoming year,[20] as shown in Exhibit 1-3.

This projected loss would cause planners to revise their projected operating plans in order to develop a plan that is both feasible and profitable. For example, the planners might revisit their capacity-related decisions. However, for the discussion here let us assume that the major operating decisions are related to choosing the number of trips and cars to offer and taking steps to ensure that the freight business is properly priced and managed.

EXHIBIT 1-3 Railstar—Projected Financial Results

	PASSENGER	FREIGHT	COMMON	TOTAL
No. of trips each weekday				10
No. of trips each weekend day				4
No. of passenger cars on each weekday train	50			
No. of passenger cars on each weekend train	15			
Planned no. of freight cars on each weekday train		25		
Planned no. of freight cars on each weekend train		20		
No. of car trips	136,240	73,320	3,016	
Load factor	75%	100%		
Passengers carried/no. of freight cars hauled	8,174,400	73,320		
Segment margin/system profit	$128,864,000	$25,193,600		($2,912,000)
DETAILS				
Revenues	$326,976,000	$73,320,000		$400,296,000
Head office costs	15,000,000	10,000,000	25,000,000	50,000,000
Roadbed-Related Costs				
Depreciation			80,000,000	80,000,000
Maintenance	2,724,800	1,466,400	1,809,600	6,000,800
Station-Related Costs				
Depreciation			10,000,000	10,000,000
Other	24,523,200			24,523,200
Train-Related Costs				
Locomotive			10,000,000	10,000,000
Fuel and Salaries			30,160,000	30,160,000
Passenger Car Rental	6,000,000			6,000,000
Other Costs	68,120,000	36,660,000		104,780,000
Passenger Costs	81,744,000			81,744,000
Total all costs	198,112,000	48,126,400	156,969,600	403,208,000
Segment margin	128,864,000	25,193,600		
System profit				−2,912,000

To illustrate, suppose that a market analysis suggests that if the number of weekday trips were cut from 10 to 8, with the number of weekend trips remaining constant, that the proportion of seats sold would rise to 90%. Profit would increase to $3,500,000. In fact, profits are very sensitive to the proportion of seats sold; profits increase approximately $2,400,000 for each 1% increase in occupancy. This relation suggests a huge amount of operating leverage; flexible costs are low relative to committed costs. Another way of seeing this is to observe that, for the original data given in this problem, Railstar will cover its costs in the passenger business when the load factor[21] is just over 31%. Consequently, both the passenger and freight businesses must make huge contributions toward covering the costs (such as depreciation on the roadbed) that are common to both segments of Railstar's business.

It is evident in this situation that flexible cost pricing—that is, pricing designed to just recover flexible costs—in this case $13 per passenger, would be a disaster. Pricing must take place with an understanding of, and must reflect, all costs.

Planners can also use financial models to study the effects of price and volume tradeoffs. That is, how much of a volume increase is required to compensate the organization for a given price increase? For example, starting from the initial setting—when the projected loss was $2,900,000—planners might want to evaluate the effect on profits of a price decrease of $5 per ticket. Suppose that such a price decrease would cause the load factor to increase by 3% from 75% to 78%. Would this change be desirable? The effect would be to decrease profits. In fact, the load factor would have to increase to more than 92% as a result of this price increase for the price decrease to be desirable.

Planners are often interested in the level of operations that will result in zero profits. Profits are determined by the level of both products' sales in a multiproduct firm such as Railstar. Suppose we assume that there are no freight operations and that we can eliminate the $10,000,000 of head office costs that are attributable to the freight operations. If we assumed the current level of trips and passenger cars on each train, what level of occupancy would be required for Railstar to cover all its costs? Exhibit 1-4 shows that the load factor is about 85%.

EXHIBIT 1-4 Railstar—Breakeven Calculation

	PASSENGER	FREIGHT	COMMON	TOTAL
No. of trips each weekday				10
No. of trips each weekend day				4
No. of passenger cars on each weekday train	50			
No. of passenger cars on each weekend train	15			
Planned no. of freight cars on each weekday train		0		
Planned no. of freight cars on each weekend train		0		
Number of car trips	136,240	0	3,016	
Load factor	84.6%	n/a		
Passengers carried/no. of freight cars hauled	9,220,723	0		
Segment margin/system profit	$157,114,726	$0		$145,126
DETAILS				
Revenues	$368,828,928	$0		$368,828,928
Head office costs	15,000,000	0	25,000,000	40,000,000
Roadbed-Related Costs				
Depreciation			80,000,000	80,000,000
Maintenance	2,724,800	0	1,809,600	4,534,400
Station-Related Costs				
Depreciation			10,000,000	10,000,000
Other	27,662,170			27,662,170
Train-Related Costs				
Locomotive			10,000,000	10,000,000
Fuel and Salaries			30,160,000	30,160,000
Passenger Car Rental	6,000,000			6,000,000
Other Costs	68,120,000	0		68,120,000
Passenger Costs	92,207,232			92,207,232
Total all costs	211,714,202	0	156,969,600	368,683,802
Segment margin	157,114,726	0		
System profit				145,126

Of course, profit-seeking organizations are not interested in just breaking even; organizations want to earn enough to provide a return to shareholders that is consistent with the risk that they have taken investing in the firm. However, planners often use this type of analysis to estimate the level of risk that the organization faces in covering its costs.

SUMMARY

In this chapter, we described the cost structure of a simple railroad operation. We saw that the railroad's total cost is a combination of committed and flexible costs. Committed costs reflect the cost of capacity that is locked in place before any production takes place. Flexible costs are those costs that are incurred as production takes place and therefore vary with the level of production. We have also seen that there are two types of committed costs. The first type is costs that vary with increases or decreases in the capacity level. The second type is costs that are fixed and do not change as capacity levels vary. We call the latter form of committed costs business-sustaining costs, and we do not try to attribute those costs to individual units of production. However, we attribute the committed costs that vary with the level of capacity acquired to products proportional to each product's use of that capacity.

Once the organization has its capacity, and therefore its cost structure, in place, it uses that capacity to provide products to customers. Decision makers are often interested in developing a financial model of the organization that they can use to estimate the financial effects of different competitive and operating strategies. This approach provides a broad overview of the general results of different operating strategies on profits. In Chapter 4, we will describe an approach that allows decision makers to estimate costs in more detail. Planners then use these costs to evaluate process efficiency, opportunities for improvement, sourcing decisions, and abandonment decisions.

ENDNOTES

1. Other types of information that management accounting reports might convey include efficiency indicators such as yield measures (the ratio of output to input), quality measures (conformance to specification), and service measures (ability to meet customer requirements). Later chapters will discuss performance measures that are not cost-based.
2. Inventory holding costs include excess manufacturing costs caused by producing large quantities in cycles, storage and warehouse building and maintenance costs, costs related to damage and obsolescence, insurance costs, and the opportunity cost of funds tied up in inventory.
3. Organizations that moved to eliminate trade loading faced both huge skepticism and huge resistance. Therefore, the organizations that moved first to eliminate trade loading demonstrated considerable courage and confidence in the underlying cost data.
4. In this book, we will use the word *products* to refer to both physical goods, such as a box of cereal, and services, such as a phone call, a bank checking account, a medical procedure, a transport of materials or a person, and professional consulting services.
5. For example, Railstar could operate from a smaller head office complex and the people who manage the freight business would be laid off, reassigned, or not replaced when they left Railstar.
6. Total costs are $50,000,000 versus $75,000,000 if the businesses were operated separately.
7. We are assuming here no economies of scale; that is, the cost of acquiring capacity is proportional to the quantity of capacity acquired. In general, the cost of acquiring capacity increases at a decreasing rate as more capacity is acquired.
8. Note that this means that Railstar can operate only one train at a time.

9. Market prices are influenced by the cost of private automobile or bus travel or the cost of hauling goods by truck between Rose Terrace and Whistle Stop.
10. With these capacity choices, annual committed costs are: head office–related—$50,000,000; roadbed-related—$80,000,000; station-related—$10,000,000 ($5,000,000 for each station), and train-related—$10,000,000 for a total of $150,000,000. Because this is an annual cost function, we will convert costs, such as the cost of leasing passenger cars, from a half-year basis to the whole year by assuming that decisions made in the first half of the year are repeated in the second half of the year.
11. The numbers in this sentence are calculated from:
    50 = 5 round-trips * 2 trips per round-trip * 5 weekdays
    8 = 2 round-trips * 2 trips per round-trip * 2 weekend days
12. 58 trips per week * $10,600 per trip * 26 trips per six-month period = $15,984,800 trip-related costs per six-month period. However, because committed costs are expressed in terms of cost per year, we convert the trip-related costs to an annual amount by multiplying the six-month cost by 2: $15,984,800 * 2 = $31,969,600 in trip-related costs per year.
13. The calculations are: 2,620 = (50 * 50) + (15 * 8); and $70,844,800 = 2,620 * $520 * 52.
14. Note that this conclusion reflects the assumption that the station-related and train costs are flexible. If these costs were not flexible—for example, if they reflected the salaries of personnel who are hired to serve passengers—the flexible passenger-related costs would be zero. Note that the flexible passenger-related costs on an airline would reflect the cost of the meal and the cost of the fuel used to carry the passenger and the passenger's luggage, which would likely be close to zero.
15. The supply (capacity) of resources that are people-intensive are not nearly as upwardly flexible as Railstar's passenger rail cars or as machines that normally operate only one shift (out of a possible three).
16. 15 cars * $50,000 rental per car.
17. That is, in conventional practice none of this cost of idle capacity would be traced to individual products.
18. As we will see in later chapters, cost information can also be used in decision making related to process improvement, product pricing, and organization control.
19. There is a considerable simplification here. Essentially, Railstar is charging by capacity rather than by weight, although there are weight restrictions on freight cars. Also there is only one type of freight service (yard to yard) and only one type of passenger service (coach from station to station). However, the simplicity in the example allows us to make the critical points clearly.
20. The financial results discussed below were obtained with the **amach1.xls** worksheet, which is available to your instructor.
21. Load factor = capacity used/capacity available.

■ *PROBLEMS*

1-1 Computing Costs

Atlantic University has eight schools, 350 faculty members, and 20,000 students. An analysis of the university's cost structure yielded the following annual cost estimates.

The university-sustaining cost level is $20,000,000, which includes basic building costs and administrative salaries such as those of the president and the admissions officers. Committed costs at the university level increase, in the long run, by $20,000,000 for each new school added and by $1000 for each additional student enrolled.

The School of Business is a school in Atlantic University. The school-sustaining cost level is $5,000,000. The area-sustaining cost level is $50,000. Committed costs in the

School of Business increase, in the long run, by $200,000 for each faculty member added and by $500 for each unit of student capacity added. Planners at Atlantic University estimate that the total flexible costs per student amount to $600. (All the costs above are annual costs.)

Each faculty member teaches five courses and each student takes nine courses per year.

The Accounting Area in the School of Business has 30 faculty members and is offering 150 courses with, on average, 60 students in each course. Accounting students only take accounting courses.

Required

(1) What is the total annual cost per accounting student?
(2) What is the total annual cost of the accounting program?
(3) The dean of the School of Business is considering a shift in faculty workload to provide more incentive for research. The shift will result in each faculty member teaching four courses per year. The number of student course enrollments will be unchanged. How will this change affect the cost per student? How will it affect the cost of the accounting program?

1-2 Role of Cost Allocation

The Holiday Hotel provides a recreation center for the use of its guests and employees. The center also sells memberships to people in the local community. The center has squash and racket ball court facilities, showering facilities, and a room with various types of exercise equipment. The courts occupy about 70% of the facility's floor space, the showering area 10%, the exercise room 15%, and the administrative offices 5%. In the long-run the hotel could convert unused facilities to additional lodging units. The center reports the following costs for the most recent year:

1. Assigned building depreciation and staff costs: $400,000. The depreciation charges amount to $250,000; the salaries of the manager and her staff amount to $150,000. Staff costs are independent of the level of activity in the recreation center.
2. Depreciation on the exercise equipment that are added as demand grows: $200,000.
3. Maintenance and electrical charges, which are thought to vary with the number of visitors to the center: $300,000.
4. Laundry costs: $300,000, comprising $50,000 of depreciation on the machines and $250,000 of supplies costs.
5. The cost of other supplies, which are consumed equally by all visitors to the center: $200,000.

During the last year, there were 67,000 visits to the physical center. The capacity level of each of the showering, exercise, and court areas is estimated as 80,000, 40,000, and 25,000 visits per year respectively.

Required

(1) What is the cost per visit to the physical center?
(2) In the past, the costs of the physical center were charged to the various hotel departments, guest services, and outside business in the ratio 50%, 40%, and 10%. The idea of

charging back to hotel departments is to recognize that the physical center is an employee-related cost. The idea of charging back to guest services is to provide information to support the calculation of cost per guest visit at the hotel. Costs were assigned to the unit relating to memberships with the expectation of covering out-of-pocket costs under the assumption that the facility was built for the use of the employees and guests. Some of the department controllers have complained about this practice and have argued that the charges to the departments should be based on use rather than on employee numbers. Moreover, some controllers have argued that it is unfair and unreasonable to charge all visitors the same. An audit of the center's use, which is thought to reflect average long-term use, suggests that about 25,000 visits were by employees and that 80% of them only showered; the rest used the exercise and court facilities almost equally and showered. About 15,000 visits were by hotel guests, virtually all of whom showered and used the exercise room. The remaining visits were from paid members, all of whom showered, and who used the exercise and court facilities almost equally. Based on this information, how should the costs of the physical center be assigned to the various groups?

1-3 Cost Considerations in Strategic Decisions

Brantford Bat Company (BBC) manufactures popular baseball bats that are prized by professional and amateur players. The current flexible cost of manufacturing the bat is $12 per unit. The cost of operating the lathe that produces the bat is about $600,000 per year. This cost includes maintenance and physical obsolescence costs.

BBC is now evaluating the possibility of purchasing a new lathe to manufacture the bat. The new lathe replaces the mechanical patterns currently used to manufacture lathes and relies instead on direct laser sensing by a computer within the lathe to compare the current size of the wood stock being turned on the lathe with a pattern stored in the computer's memory. Although the new machine would not increase the capacity of the bat-making operation, which is 750,000 bats per year, it would reduce the flexible cost of producing the bats to $10 per unit. The cost of operating the new lathe would be about $1,400,000 per year.

If the current level of production and sales of this bat is 500,000 units, should the new lathe be purchased? Ignore the effect of income taxes in answering this question.

1-4 Cost-Volume-Profit Analysis and Pricing in the Airline Industry (Edward Deakin, Adapted)*

Trans Western Airlines is considering a proposal to initiate air service between Phoenix, Arizona, and Las Vegas, Nevada. The route would be designed primarily to serve the recreation and tourist travelers who frequently travel between the two cities. By offering low-cost tourist fares, the airline hopes to persuade persons who now travel by other modes of transportation to switch and fly Trans Western on this route.

In addition, the airline expects to attract business travelers during the hours of 7 A.M. to 6 P.M. on Mondays through Fridays. The fare price schedule, or tariff, would be designed to charge a higher fare during business-travel hours so that tourist demand

would be reduced during those hours. The company believes that a business fare of $100 one way during business hours and a fare of $60 for all other hours would equalize the passenger load during business-travel and tourist-travel hours.

To operate the route, the airline would need two 200-passenger jet aircraft. The aircraft would be leased at an annual cost of $10,000,000 each. Other committed costs for ground service would amount to $5,000,000 per year.

Operation of each aircraft requires a flight crew whose salaries are based primarily on the hours of flying time. The costs of the flight crew are approximately $800 per hour of flying time.

Fuel costs are also a function of flying time. These costs are estimated at $1,000 per hour of flying time. Flying time between Phoenix and Las Vegas is estimated at 45 minutes each way.

The flexible costs associated with processing each passenger amount to $5. This amount includes ticket processing, agent commissions, and baggage handling. Food and beverage service cost $10 per passenger and will be offered at no charge on flights during business hours. The airline expects to recover the cost of this service on non-business-hour flights through charges levied for alcoholic beverages.

Required

(1) If six business flights and four tourist flights are offered *each way* every weekday, and 12 tourist flights are offered *each way* every Saturday and Sunday, what is the average number of passengers that must be carried on each flight to break even?
(2) What is the breakeven load factor (percentage of available seats occupied) on a route?
(3) If Trans Western Airlines operates the Phoenix–Las Vegas route, its aircraft on that route will be idle between midnight and 6 A.M. The airline is considering offering a "Red Die" special, which would leave Phoenix daily at midnight and return by 6 A.M. The marketing division estimates that if the fare were no more than $40, the load factor would be 50% for each Red Die flight. Operating costs would be the same for this flight, but advertising costs of $10,000 per week would be required for promotion of the service. No food or beverage costs would be borne by the company. Management wants to know the minimum fare that would be required to break even on the Red Die special, assuming that the marketing division's passenger estimates are correct.

1-5 *Multiple-Product Cost-Volume-Profit Analysis (CMA, adapted)*

Hewtex Electronics manufactures two products, tape recorders and electronic calculators, and sells them nationally to wholesalers and retailers. The Hewtex management is very pleased with the company's performance for the current fiscal year. Projected sales through December 31, 1998, suggest that 120,000 tape recorders and 190,000 electronic calculators will be sold this year. The projected earnings statement, which follows, shows that Hewtex will not meet its earnings goal of 9% of sales after taxes.

Required

(1) Assuming that the sales mix in the planning documents is achieved, how many tape recorder and electronic calculator units would Hewtex Electronics have to sell in 1998 to break even?

HEWTEX ELECTRONICS
Projected Earnings Statement
For the Year Ended December 31, 1998

	120,000 UNITS TAPE RECORDERS		190,000 UNITS ELECTRONIC CALCULATORS		TOTAL
	Total Amount (000 omitted)	*Per Unit*	*Total Amount (000 omitted)*	*Per Unit*	*(000 omitted)*
Sales	$1,800	$15.00	$4,480	$28.00	$6,280
Flexible costs					
Materials	480	4.00	1,140	6.00	1,620
Labor	360	3.00	1,710	9.00	2,070
Other	120	1.00	570	3.00	690
Committed costs	280	2.33	1,400	7.37	1,680
Total costs	1,240	10.33	4,820	25.37	6,060
Gross margin	560	4.67	500	2.63	1,060
Facility-sustaining costs					2,000
Net income before income taxes					(940)

(2) What volume of sales is required if Hewtex Electronics is to earn a profit in 1999 equal to 9% of sales after taxes? Hewtex Electronics faces a tax rate of 42%.

(3) Hewtex Electronics now allocates committed costs based on flexible labor costs. A study has determined that committed costs are as follows: (1) supervisory costs for tape recorder production—$500,000; (2) supervisory salaries for electronic calculator production—$600,000; (3) the balance of the committed costs are proportional to the number of batches of production. Hewtex Electronics schedules tape recorders for production in batches of 1000, and electronic calculators are made in batches of 10,000. Finally, $300,000 of what was originally classified as facility-sustaining cost was actually attributable to tape recorders, and $400,000 was attributable to the electronic calculator line. Recast the original financial statements to correct the costing errors due to misclassification.