Chapter 2

Analyzing Cost-Volume-Profit Relationships

After studying this chapter, you should be able to:

1. Understand the key factors involved in cost-volume-profit (C-V-P) analysis and why it is such an important tool in management decision making.

2. Explain and analyze the basic cost behavior patterns—variable, fixed, stepped, and mixed.

3. Analyze mixed costs using the scattergraph and high-low methods.

4. Perform C-V-P analyses, and describe the effects potential changes in C-V-P variables have on company profitability.

5. Visualize C-V-P relationships using graphs.

6. Identify the limiting assumptions of C-V-P analysis, and explain the issues of quality and time relative to C-V-P analysis decisions.

7. Analyze mixed costs using the least squares method.

8. Explain the effects of sales mix on profitability.

9. Describe how fixed and variable costs differ in manufacturing, service, merchandising, and e-commerce organizations, and illustrate these differences with the operating leverage concept.
If you’ve ever watched an international-caliber soccer match, you know that goals are scarce. Each goal requires extensive work, patient play, and many attempts. This same approach seems to apply to the business of professional soccer in the United States where MAJOR LEAGUE SOCCER (MLS) completed its seventh season in the United States in 2002. The year 2002 was a banner year for U.S. soccer with the men’s national soccer team reaching new heights by finally cracking the Top 10 of the FIFA World Rankings and competing in the quarterfinals of the World Cup in Korea/Japan (after taking last place at the previous World Cup tournament). This followed on the momentum generated by the U.S. women’s team, which won the World Cup in 1999 and placed third in the world in 2003. Nevertheless, MLS has so far been unable to score financially in America where sports fans continue to prefer attending basketball, football, and even baseball games to watching the most popular sport in the world in 2003. Nevertheless, MLS has so far been unable to score financially in America where sports fans continue to prefer attending basketball, football, and even baseball games to watching the most popular sport in the (rest of the) world.

Professional soccer has been launched several times in the United States amid much fanfare, but so far each attempt has failed. The last failure, that of the NORTH AMERICAN SOCCER LEAGUE (NASL)—which brought Pelé, Cruyff, Best, and Beckenbauer to the United States in the early 1970s—was especially painful because, with the big names, professional soccer looked so promising. One of the major reasons previous efforts failed is that fixed costs were too high for the small number of fans and meager TV revenues. Each attempt ended up with the team owners losing money. To better manage player salaries, which are a significant part of the fixed costs of running a soccer team, the MLS set up an unusual single-entity structure in 1996, under which the league owns all the teams as well as all player contracts, and investors buy operating rights rather than setting up franchises. The purpose of this structure is to control player salaries and other fixed costs. This approach has successfully kept players’ salaries low; so low in fact that a number of players have filed class action lawsuits arguing the MLS structure is holding down salaries in violation of U.S. antitrust laws.

Despite these efforts to contain the fixed cost of players’ salaries, MLS teams continue to lose millions of dollars, largely due to their inability to generate enough revenue from ticket sales alone to cover another significant fixed cost, the cost of the leases on the stadiums in which they play their games. And while the cost of these lease payments is high, the larger problem is that soccer teams forced to rent their facilities are only able to keep the revenue from ticket sales and are generally cut off from the all-important ancillary revenue that accompanies each game—revenue from concessions, parking, merchandise, stadium signage and naming rights, and luxury boxes.

The situation faced currently by Nick Sakiewicz, general manager of the METROSTARS in New Jersey, is pretty typical of the rest of the league. New Jersey has long been a hotbed of soccer in America, from producing three of the greatest American players of all-time (Tab Ramos, John Harkes, and Tony Meola) to being home to the winningest high school soccer coach in U.S. history (Gene Chyzowych of Columbia High School). Nonetheless, the MetroStars can’t seem to break even financially. Part of this shortfall stems from the $1.5 million annual rent the MetroStars must pay to use Giants Stadium at the Meadowlands. Worse, the Meadowlands stadium is also used by two NFL teams (the GIANTS and the JETS), the New Jersey State Fair, and multiple concerts, which means that the MetroStars can only play one or two home games each month in June and July. With most of the home games being played in April and May, average attendance is not as high as it could be (attendance in 2002 averaged just 19,000 per game). Hence, the team loses millions of dollars every year.

General Manager Nick Sakiewicz is convinced that a new stadium is crucial to the MetroStars’ financial success. At an estimated cost of $152 million, Sakiewicz wants to build a roofed, 25,000-seat stadium in Harrison City (also in New Jersey) to be located in a vast complex that would include residential housing, retail space, and a shopping center. And although he believes that more people would buy a ticket to come see the MetroStars play in their own stadium, what makes the construction proposal most attractive is the ancillary revenue that would finally belong to the team because it would own the stadium. It is estimated that a crowd of 20,000 can generate an extra $100,000 in profit from concessions, parking, and so forth. Sakiewicz believes strongly that those kinds of numbers will move his soccer team beyond the break-even point and into profitability.¹

In the previous chapter, we discussed different ways to categorize costs, and we briefly illustrated how you can use these cost categories to make management decisions. We also emphasized the fact that management accounting is defined as all accounting information that is useful in planning, controlling, and evaluating an organization. Some costs, such as direct materials and direct labor costs in a manufacturing firm, increase in direct proportion to the number of products or services produced. These are called variable costs. Other costs, such as factory rent, remain the same no matter what the level of production is. These are called fixed costs. We used these definitions of variable costs and fixed costs in the previous chapter to introduce you to cost-volume-profit (C-V-P) analysis, a critical tool in the management process. C-V-P analysis is used to make important planning decisions concerning appropriate levels of production and spending. C-V-P analysis allows a manager to answer the very important question: How much do I need to sell in order to earn a profit?

In this chapter, you will further explore the C-V-P analysis tool to analyze relationships between variable costs, fixed costs, and revenues. You will learn that successful managers must think carefully about cost behavior—how costs change in relation to changes in activity levels, such as the number of patients in a hospital or the pounds of ore processed in a copper smelter. An understanding of how costs behave in relation to levels of activity helps managers predict the effects of their plans on future performance. In addition, because the C-V-P analysis technique is applicable to all types of firms, we will discuss the behavior of costs in manufacturing, merchandising, service, and e-commerce firms.

You will also use the knowledge of cost behavior patterns to analyze the kinds of problems facing organizations such as the MetroStars’ lack of profitability as described in the opening scenario. As you work through this chapter making calculations that will determine how profits will change in relation to changes in sales volume, fixed costs, and variable costs, be sure to think about how these calculations reflect the process of managing actual organizations. For instance, because of decreased air travel in the wake of the 9/11 attacks, the airline industry has struggled to be profitable in light of the heavy fixed costs of owning and operating commercial aircraft. Many owners of retail outlets in a mall breathe a sigh of relief each month on the day when enough profit has been generated to allow them to pay the monthly fixed cost of the lease payment to the mall. The owner of a baseball team will look out over a half-filled stadium on game day and worry that the ticket sales may not have been enough to cover the costs of paying the players and running the stadium. Every business owner must carefully plan how he or she is going to generate enough money to cover the fixed costs of the business. Those who have a clear idea of exactly how many airline seats, or pairs of pants, or hot dogs must be sold to break even will be in a better position to create and maintain profitability in the organization.

We believe that the best way to appreciate the importance of good management information is to begin by using that data to make significant management planning decisions. Accordingly, this chapter will give you lots of opportunities to practice. Also note that although we will focus primarily on examining the financial implications of cost-volume-profit analysis decisions, we will also pay attention to the effects these decisions have on quality and time issues as well.

Understanding Why C-V-P Analysis Is Important

1. Understand the key factors involved in cost-volume-profit (C-V-P) analysis and why it is such an important tool in management decision making.

Management must make many critical operating decisions that affect a firm’s profitability. With respect to planning, management is often interested in the impact a particular action will have on profitability. C-V-P analysis can help managers assess that impact. The following are examples of questions that can be answered with C-V-P analysis:

- When planning whether or not to open a scuba shop in the mall, how many customers will need to be served each month in order to break even and be able to pay the monthly store rental fee?
• How will the profits of a bookstore be affected if the store raises its prices by 10%, resulting in a reduction of 2% in the number of books sold?
• How many carpets must a fledgling entrepreneur clean in a month in order to generate a net profit of $3,000 each month?
• By how much will the profits of a discount electronics store change if a $100,000 advertising campaign increases the number of computers sold by 13%?
• How will the profits of a fast-food restaurant change if the restaurant stops selling milk shakes and instead focuses on raising the volume of soft drink sales by 25%?

It should be clear to you from these examples that C-V-P analysis involves studying the interrelationships among revenues, costs, levels of activity, and profits. However, quality of products and services and speed of production and delivery must also be considered as managers use C-V-P analysis to determine product prices, the mix of products, market strategy, appropriate sales commissions, advertising budgets, production schedules, and a host of other important planning decisions. Although C-V-P analysis is most useful for planning, it can also be used to assist with controlling decisions (e.g., are the costs too high for the level of sales?) and evaluating decisions (e.g., should we reward employees for holding costs down or be concerned that sales growth has slowed?). In fact, a lot of what is done in management accounting involves some aspect of C-V-P analysis because of the tremendous potential it has to help management increase the profitability and effectiveness of an organization. For this reason, as you use this chapter to learn the mechanics of C-V-P analysis, be sure to see how important it is to be able to understand and manage costs. As you study C-V-P analysis, you will gain a better understanding of basic cost behavior patterns. And once you understand these cost behavior patterns and how to work with them, you can use them to make effective planning, controlling, and evaluating decisions.

**TO SUMMARIZE:** C-V-P analysis is a very important concept in management accounting. Key factors involved in C-V-P analysis include (1) the revenues derived from the sales prices charged for goods and services, (2) the fixed and variable costs, (3) the sales volume, (4) the mix of products, (5) the speed and quality of production, and (6) the resulting profits. Understanding the interrelationships of the key variables in C-V-P analysis can assist you in planning and in making critical control and evaluation decisions.

**Basic Cost Behavior Patterns**

The two basic cost behavior patterns—variable and fixed—were introduced in the previous chapter. Other cost behavior patterns, such as mixed costs, are variations of these two. Mixed costs exhibit characteristics of both variable and fixed costs. In this section, we will review both variable and fixed costs and examine the reality of how these costs often look in many organizations. We will also introduce stepped costs and mixed costs.

A quick example of what we’re talking about may be helpful before we dive into all the details of working with cost behavior. A cost may be classified as either fixed or variable by the way it reacts to changes in level of activity. Think of a doughnut shop such as KRISPY KREME or WINCHELL’S. Activity in the shop may be measured in terms of the volume of doughnuts sold, the number of customers served, the number of hours the shop is open, the number of employees, or the total square feet of the serving area, and so forth. Get the point? There are a lot of ways to measure activity in this organization. There are also a lot of different kinds of costs. The first task is to identify the costs and activities where we intend to focus our management effort. Let’s say that we are initially interested in understanding how the number of doughnuts sold impacts costs and profits. Which costs will change, and which costs will not change, as we expect to sell more or less doughnuts? This is the starting point of C-V-P analysis. It seems logical that as more doughnuts are sold, the cost of doughnut ingredients will increase. This is a variable cost. On the other hand, we probably wouldn’t expect the cost of property taxes to...
increase as more doughnuts are sold. This is a fixed cost. However, there are costs that have both variable and fixed components. For instance, the electricity costs to run the doughnut shop will increase as we sell more doughnuts because of the cost of the power to make the additional doughnuts. However, even if we don’t sell any doughnuts, we will have to pay the utility costs of just keeping the shop open. Utility costs are a mixed cost. The cost of a supervisor’s salary isn’t normally going to increase as we sell more doughnuts until we have so many customers that we need to hire an additional supervisor to help with the higher volume. At this point, the fixed cost of salaries will jump to a new level. This is an example of a stepped cost.

Overall, once we have defined the activity, measurements of changes in activity level can be used to determine cost behavior patterns.

**Measuring Level of Activity**

Before we can manage an organization, we need to identify exactly what it is that we intend to manage. In other words, what is the activity upon which we intend to focus our planning, controlling, and evaluating efforts? In the doughnut shop example, it makes sense for management to focus on increasing the number of doughnuts sold; management efforts can reasonably be expected to influence the number of doughnuts sold. Activity is often measured in terms of output, input, or a combination of the two. Some of the most common activity bases used are number of units sold and number of units produced in manufacturing firms, number of units sold in merchandising firms, and number of contract hours paid for or billed in service firms. We will generally use production volume or sales volume as the activity basis in this chapter to demonstrate the use of C-V-P analysis.

Note that just because a cost doesn’t vary with a particular activity base (e.g., total units sold) does not mean it could never be considered as a variable cost. For example, the total cost of wages for a doughnut shop may not vary with the amount of sales volume (the clerks get paid the same whether they sell a lot of doughnuts or just a few), but total wages would vary based on the number of hours per week that the store is open. So, if another type of activity other than sales volume is more relevant in determining changes in the variable costs being planned, the C-V-P analysis should be based on that activity. It all comes down to an issue of “focus.” Where do you believe you can best focus your management attention in order to plan for and control costs and profits—on store hours, doughnuts sold, or customers served? There is some subjectivity in this focus decision. Nevertheless, managers must be careful to understand the various activity bases within their company so that they can properly plan for and control costs. We will discuss a number of alternative activity bases in a later chapter on managing inventory.

Manufacturing and merchandising companies with a single product generally measure volume of activity in terms of output, for example, number of cars, television sets, or desks produced. However, many companies produce or sell several different products (refrigerators, toasters, and irons, for example), and a simple total of all the products manufactured or sold during a given period may not provide a good measure of activity. This is particularly true for manufacturing firms. For example, **GENERAL ELECTRIC** manufactures a wide variety of products, ranging from light bulbs to locomotives. It obviously takes more effort (and consequently costs more) to produce a locomotive than a light bulb; accordingly, it wouldn’t make any sense to state that total production for a given day was 1,000,001—1,000,000 light bulbs and 1 locomotive. In multiproduct situations, these manufacturing firms usually use input measures, such as direct labor hours worked, machine time used, or the time needed to set up a job, as the activity base. Such specific input measures are often more useful than general output measures.

**Variable Costs**

Total **variable costs** change in direct proportion to changes in activity level. Examples are costs of direct materials, which vary proportionately with the number of units produced, and sales commissions, which vary proportionately with the sales volume. For instance, as an automobile manufacturer, you might define the activity of focus as the number of cars produced. If engines, tires, axles, and steering wheels are purchased from suppliers, the related costs would be variable because the total cost of steering wheels, for example, would vary proportionately.
with the number of cars produced. If no cars are produced, there are no steering wheel costs; if 1,000 cars are manufactured during a period, the total cost for steering wheels and other purchased parts is 1,000 times the unit cost of each item. As more cars are produced, the total cost of each item increases. The unit cost, however, remains constant. For example, if an auto company pays $150 per steering wheel, the total cost of steering wheels for 200 cars is $30,000; for 500 cars, it is $75,000. At both levels of activity, however, the unit cost is still $150. This relationship between variable costs and level of activity is shown graphically in Exhibit 1, which relates the number of cars produced to the total cost of the steering wheels used in production.

In addition to sales commissions and materials, many other costs (such as labor) have a variable cost behavior pattern. For example, if it takes four hours of labor to assemble a frame and each hour costs $25, a unit labor cost of $100 per frame is a variable cost; the total labor cost would be $100 times the number of frames produced.

Curvilinear Variable Costs
Our definition of the variable cost behavior pattern specifies that variable costs have a linear relationship to the level of activity; that is, when the level of activity increases, total variable costs rise at a directly proportional rate. For example, if the level of activity doubles, the total variable costs will also double; this is a called a linear relationship. The reality is that, in practice, a truly linear relationship usually does not exist. Overall, many variable costs are actually curvilinear costs when considered over many activity levels. That is, these curvilinear costs actually vary at increasing or decreasing rates across large changes in the activity level. To illustrate, think about a manufacturer that makes a very specialized “premium natural” ice cream that is handmade. Now consider Exhibit 2. The top diagram is a graph that shows the cost of raw materials (for example, milk, sugar, and other ingredients) purchased from suppliers to make ice cream. Because the ice cream maker gets a bigger price discount as it purchases higher volumes of raw materials, the variable cost of these materials is not linear but curvilinear. That is, the cost increases at a decreasing rate.

On the other hand, the direct labor costs to produce ice cream that become more costly as production increases (bottom graph in Exhibit 2) represent costs with diseconomies of scale.
probably have to increase the wages she offers in order to attract more employees. As a result, the direct labor cost of each gallon of ice cream will increase as planned production volumes go up because the wage rate of the workers goes up. Thus, this curvilinear variable cost increases
Relevant Range and the Linearity of Variable Costs

While this is never exactly true, it is usually safe to assume that variable costs are approximately linear within a certain range of production, called the relevant range. To illustrate the relevant range concept, let’s return to our ice cream manufacturing business. Realistically, the production manager does not expect to vary weekly production volume outside the range of 3,000 to 5,000 gallons of ice cream. As displayed in Exhibit 2 for both milk material cost and direct labor cost, a linear segment within the relevant range of weekly production can effectively approximate the curvilinear cost relationship of producing between 3,000 and 5,000 gallons of ice cream. By assuming a linear (rather than a curvilinear) relationship, the variable costs of milk and direct labor are estimated at $1.55 and $1.20, respectively, per gallon of ice cream using the costs in the midpoint of the relevant range (weekly production of 4,000 gallons of ice cream).

Relevant range is an important concept. If activity increases or decreases significantly, cost relationships will probably change. If production volume soars, for example, such factors as overtime work and bulk-purchase discounts may cause direct labor and materials costs per unit to change. That is why we say that the definition of variable costs—costs that are constant per unit of activity—is applicable only within relevant ranges. The important point to remember is that whenever we define a particular variable cost, we are assuming that the cost is within the relevant range of activity.

Fixed Costs

Fixed costs remain constant in total, regardless of activity level, at least within the relevant range of activity. Examples include property taxes, insurance, executives’ salaries, plant depreciation, and rent. Because total fixed costs remain constant as activity increases, the fixed cost per unit (total fixed cost / level of activity) decreases. Similarly, as the level of activity decreases, the fixed cost per unit increases. This is in contrast to variable costs, where the costs per unit are assumed to remain constant through changes in the level of activity within the relevant range.

Before we go any further, it is a good idea for us to remind ourselves why identifying fixed and variable costs is important. Remember that this chapter is about managing the relationships among costs, volume, and profit. In the previous chapter, we briefly introduced the concept of C-V-P and break-even analysis. In the C-V-P formula below (which we introduced in the previous chapter), you can see that calculating what a company needs to do to “break even” and start making a profit requires a clear measure of total fixed costs and variable costs per unit:

\[
\text{Total fixed costs} + \text{(Sales price per unit} - \text{Variable cost per unit)} = \text{Break-even sales (in units)}
\]

In an actual company, the fixed and variable costs are very challenging to identify. That is why it is important that you understand the nature of cost behavior and how to classify costs as either fixed or variable. Once we’ve completed our discussion of cost behavior, we’ll be ready to spend some time on this very useful C-V-P formula later in this chapter.
Stepped Fixed Costs

Let’s continue with our example of the ice cream manufacturer. The top graph in Exhibit 3 shows the relationship between the production line supervisor cost and the total number of gallons of ice cream produced. In this case, until weekly ice cream production reaches 1,000 gallons a week, the manufacturing manager is able to oversee all line workers. At 1,000 gallons a week production, however, the manager expects to hire a production line supervisor at $500 per week to provide more supervision of the workers. Further, the manager expects that she’ll need to hire an additional supervisor each time weekly production is increased another 2,000 gallons. Although the production line supervisor cost is changing as the scale of ice cream production changes, we still consider this cost to be fixed within the relevant range. Hence, as shown in the top graph in Exhibit 3, within a relevant range of activity of between 3,000 and 5,000 gallons of ice cream, the total fixed manufacturing supervisor cost of $1,000 does not change. On the other hand, the per-unit supervisor cost will drop considerably as production increases. For example, when the fixed supervisor cost is $1,000 and 3,000 gallons of ice cream are being produced, the supervisor cost per gallon of ice cream is $0.33 ($1,000 ÷ 3,000 gallons). With production of 4,000 gallons, however, this fixed cost is only $0.25 ($1,000 ÷ 4,000 gallons) per gallon.

As you can see in Exhibit 3, the fixed cost of the production line supervision “steps up” as the volume of ice cream production increases. Stepped costs are costs that change in total in a stair-step fashion with changes in volume of activity. Another example of a stepped cost might be the labor charges for the maintenance of the tools and machinery in a small manufacturing plant. One maintenance worker can handle the upkeep of all the equipment during normal

Fixed Costs Are Shifting

Over the past few decades, fixed costs have increased as a percentage of total costs for many manufacturing companies, primarily due to the increase in factory automation. As a machine replaces each manual job, costs change from variable labor costs to fixed depreciation or rental charges. It is important to note that many service companies have much higher ratios of fixed-to-variable costs than do manufacturing companies. The costs of providing services in companies such as banks, consulting agencies, and airlines typically do not vary much depending on the volume of banking transactions, consulting hours, or passengers carried. Perhaps more significantly, e-commerce organizations often have even fewer variable costs than service organizations do! Once the technology has been put in place to run an e-commerce business, there is typically very little additional cost of technology based on usage (within the relevant range). Personnel costs in e-commerce organizations, such as engineering personnel, marketing teams, and executive personnel, also do not change much based on the volume of customer use of the organization’s technology.

As fixed costs in manufacturing organizations increase, and the economy continues to shift more and more to service and e-commerce organizations, this fixed cost emphasis has a significant effect on the decision-making process. When costs are fixed, management’s ability to influence costs with activity-level decisions is limited. With variable costs, management has more flexibility to change activity levels and thereby increase or decrease total operating cost structures. This trend of replacing variable costs with fixed costs has an important impact on the cost structure of an organization that is captured in the concept of operating leverage, which is discussed in the expanded material section of this chapter.

FYI:

Have you ever wondered why you always wait so long and why there are so many patients at one time in a dentist’s office? Think about the nature of the dentist’s costs. Most costs are fixed—dentists’ salaries, rent or depreciation, and so forth. When costs are mostly fixed, seeing a high volume of patients is important to cover the fixed costs. Then, once fixed costs are covered, almost all additional patient revenue becomes profit. Thus, by squeezing in only a few additional patients, dentists can increase their profits substantially.

stepped costs Costs that change in total in a stair-step fashion (in large amounts) with changes in volume of activity.
Mixed Costs

Mixed costs, like curvilinear costs and stepped costs, are variations of the basic fixed and variable cost behavior patterns. Specifically, mixed costs are costs that contain both variable and fixed components. An example is rent that is based on a fixed fee plus a percentage of total sales. Thus, the rental terms for an automobile dealer’s showroom might include a flat payment of $4,000 per month plus 1% of each month’s sales. The 1% of sales is the variable portion, and the $4,000 is the fixed cost. The total rent, therefore, would be considered a mixed cost and could be diagrammed as shown in Exhibit 4. As this exhibit shows, the cost of renting the showroom increases as sales increase. The total rent is $4,000 when there are no sales; $6,000 when sales are $200,000 [$4,000 + (0.01 × $200,000)]; and $8,000 when sales are $400,000 [$4,000 + (0.01 × $400,000)]. This increase is directly due to the variable cost element, which increases in total as activity level (car sales) increases.

One of the important challenges in using C-V-P analysis in the planning process is the need to effectively separate mixed costs into their fixed and variable cost components. Over
T O  S U M M A R I Z E : Cost behavior is the way a cost changes in response to changes in activity level. There are two basic cost behavior patterns, variable and fixed. Total variable costs change in direct proportion to changes in the level of activity over the relevant range; therefore, variable costs are constant per unit over this range. In analyzing variable costs, we generally assume a linear relationship between total costs and the level of activity within the relevant range; outside of this range, variable costs are usually curvilinear. On the other hand, total fixed costs do not change over the relevant range; therefore, fixed costs decrease per unit as the level of activity increases within the relevant range. Stepped costs increase with the level of activity but not smoothly. If the steps are wide in relation to the relevant range, these costs can be treated as fixed; if the steps are narrow, they can be treated as variable. Mixed costs have both a fixed and a variable component. An increase in a mixed cost with a rising level of activity is due entirely to the variable cost element.

Analysis of Mixed Costs

3 Analyze mixed costs using the scattergraph and high-low methods.

With an understanding of the different types of cost behavior, we can discuss how to identify and separate mixed costs into variable and fixed components. This separation is essential because we have to clearly classify all costs as fixed or variable before doing C-V-P analysis. When it comes to mixed costs, remember that the fixed portion represents the cost necessary to maintain a service (such as a telephone) or a facility (such as a building), and the variable portion covers actual use. Recall the example of the automobile showroom’s rental cost, part of which was a flat monthly fee and part a percentage of sales. Other common mixed costs are such overhead costs as electricity and repairs.

The most accurate way to separate the actual fixed and variable components of mixed costs is to analyze each invoice. An electricity bill, for example, may include a flat monthly service charge that would be classified as a fixed cost. Additional variable costs are those
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based on the amount of electricity actually used during the month. This approach could be very time consuming, however, and may not be cost effective (that is, it would cost more to do the analysis than the detailed information is worth). An alternative approach is to analyze the historical trend in past costs as the level of activity has changed as the basis for classifying costs as fixed or variable. There are several methods of doing this. In this section, we will introduce you to two methods: the scattergraph method and the high-low method. In the expanded material, we introduce least squares analysis, a more sophisticated method for analyzing mixed costs.

The Scattergraph, or Visual-Fit, Method

Probably the simplest method of separating mixed costs into their variable and fixed components is the scattergraph (or visual-fit) method. Essentially, we’re talking here about simply looking at a trend of mixed cost points over time and learning how to “see” the fixed and variable cost components. To do this, the total mixed cost for each level of activity is plotted on a graph, and a straight line (called the regression line) is visually fitted through the points. The idea is to position the line through the set of plotted data points in a way that minimizes the average distance between all the data points and the fitted regression line. With the regression line inserted into the graph, the fixed portion of the mixed cost is estimated to be the amount on the cost (vertical) axis at the point where it is intercepted by the regression line. The variable cost per unit (referred to as the variable cost rate) is equal to the slope of the regression line, which is simply the change in cost divided by the change in activity.

To illustrate the scattergraph method, let’s use the example of electricity costs for an automobile manufacturer. In the analysis and calculations that follow, all costs are assumed to fall within the relevant range of activity. In this example, we use direct labor hours as a measure of the activity level.

Exhibit 5 shows a scattergraph on which electricity costs and direct labor hours have been plotted. The regression line has been visually fitted to minimize the distance between data points. It appears that the total fixed portion of electricity cost is about $40,000 per month, which is where the regression line intersects the cost axis. The variable cost rate is approximately $4.29 per direct labor hour, which is the slope of the regression line. To calculate the slope, we use the following formula and the data points of zero and 7,000 direct labor hours, respectively.

\[
\text{Variable cost rate} = \frac{\text{Change in (electricity) cost}}{\text{Change in activity (direct labor hours)}}
\]

\[
X = \frac{70,000 - 40,000}{7,000 - 0} = \frac{30,000}{7,000} = 4.29 \text{ (rounded)}
\]

Obviously, the scattergraph method has some limitations as a cost estimation tool. Perhaps the most critical limitation is that how the user fits the regression line through the data points is entirely subjective. Consider Exhibit 5 once more. If you were the one fitting the regression line to these data points, would you have set the line exactly where it is in this graph? Hopefully, your line would have been quite close to the current line. Still, it probably wouldn’t have been exactly the same, resulting in some small differences in your own estimations of fixed and variable costs. Hence, the scattergraph method is a classic “quick and dirty” management accounting technique. Yet, although the scattergraph

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scattergraph (visual-fit) method

A method of segregating the fixed and variable components of a mixed cost by plotting on a graph total costs at several activity levels and drawing a regression line through the points.

regression line

On a scattergraph, the straight line that most closely expresses the relationship between the variables.

variable cost rate

The change in cost divided by the change in activity; the slope of the regression line.

Caution

When making these cost graphs, remember that the dollars go on the vertical axis and the level of activity goes on the horizontal axis.

Caution

Once the regression line has been fitted through the data points, the scattergraph method does not depend any longer on the data points to estimate fixed and variable costs. Cost estimations are entirely based on points along the regression line. For instance, notice that in this case we used the points 0 and 7,000 along the visually fitted regression line. However, we could have used any two points on the regression line (such as 2,000 direct labor hours and 10,000 direct labor hours) to calculate the variable costs per direct labor hour.
Exhibit 5: Total Electricity Costs

<table>
<thead>
<tr>
<th>Direct Labor Hours Worked</th>
<th>Total Electricity Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>7,000</td>
</tr>
<tr>
<td></td>
<td>$70,000</td>
</tr>
<tr>
<td>February</td>
<td>6,000</td>
</tr>
<tr>
<td></td>
<td>60,000</td>
</tr>
<tr>
<td>March</td>
<td>12,000</td>
</tr>
<tr>
<td></td>
<td>100,000</td>
</tr>
<tr>
<td>April</td>
<td>6,600</td>
</tr>
<tr>
<td></td>
<td>80,000</td>
</tr>
<tr>
<td>May</td>
<td>18,000</td>
</tr>
<tr>
<td></td>
<td>120,000</td>
</tr>
<tr>
<td>June</td>
<td>14,000</td>
</tr>
<tr>
<td></td>
<td>110,000</td>
</tr>
</tbody>
</table>

Although these two columns of figures do not visually show trends as clearly as the scattergraph does, they do suggest that as the activity level (direct labor hours) increases, total electricity costs
increase. Given this relationship, the high-low method can be used to determine the fixed and variable portions of the electricity cost as follows:

1. Identify the highest and lowest activity levels (18,000 hours in May and 6,000 hours in February). As you can see, these two months also represent the highest and lowest levels of electricity costs, or $120,000 and $60,000, respectively (although this may not always be the case).

2. Determine the differences between the high and low points.

<table>
<thead>
<tr>
<th>Total Electricity Cost</th>
<th>Direct Labor Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>High point (May)</td>
<td>$120,000</td>
</tr>
<tr>
<td>Low point (February)</td>
<td>60,000</td>
</tr>
<tr>
<td>Difference</td>
<td>$60,000</td>
</tr>
</tbody>
</table>

3. Calculate the variable cost rate (variable cost per unit). The formula is the same as the one used to compute the slope of the regression line in the scattergraph method. The results are different, of course, because the scattergraph method is based on a regression line that is plotted, as much as possible, using all the data points, whereas the high-low method uses only the highest and lowest data points.

\[
\text{Variable cost rate} = \frac{\text{Change in costs}}{\text{Change in activity}}
\]

\[
= \frac{60,000}{12,000}
\]

\[
= \$5 \text{ per direct labor hour}
\]

4. Determine fixed costs based on the variable cost rate ($5 in this case). The formula for this computation is:

\[
\text{Fixed costs} = \text{Total costs} - \text{Variable costs}
\]

At the high level of activity, the calculation is as follows:

\[
X = 120,000 - (18,000 \times 5)
\]

\[
X = 120,000 - 90,000
\]

\[
X = 30,000
\]

You get the same result if you calculate fixed costs at the low level of activity as follows:

\[
X = 60,000 - (6,000 \times 5)
\]

\[
X = 60,000 - 30,000
\]

\[
X = 30,000
\]

In summary, using the high-low method of analyzing mixed costs, the variable portion of the total electricity cost is estimated to be $5 per direct labor hour, and the fixed portion is $30,000 per month. This means that $30,000 appears to be the amount the company pays each month just to have electricity available, and $5 is the average additional electricity cost for each hour of direct labor worked.
**A Comparison of the Scattergraph and High-Low Methods**

As we have illustrated, the scattergraph and high-low methods may produce different results.

<table>
<thead>
<tr>
<th>Method</th>
<th>Variable Cost Rate</th>
<th>Fixed Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scattergraph</td>
<td>$4.29</td>
<td>$40,000</td>
</tr>
<tr>
<td>High-low</td>
<td>5.00</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Both methods are useful for a quick approximation. The scattergraph method takes all the data into account. Therefore, this method tends to be more accurate, although it is somewhat subjective and inconsistent because different people might draw the line through the points differently. On the other hand, anyone using the high-low method will consistently get the same results. However, because only two data points are used, the high-low method may not be representative of the costs incurred at all levels of activity. It is important that you realize that the math used in the high-low method essentially plots the regression line through the two most extreme points in a scattergraph. To understand what we mean, look at the scattergraph of the electricity cost data in Exhibit 5. Notice that the low point lies below the scattergraph regression line and the high point lies above the scattergraph regression line. Now, if you were to draw a straight line through the high and low points, that line would not be the same line created using the scattergraph (visual-fit) method, and may not necessarily represent all six data points plotted. Nevertheless, you can use either method or both methods to predict future costs. If, for example, management wants to know how much electricity will cost next month with 10,000 direct labor hours budgeted, the following calculations would be made:

<table>
<thead>
<tr>
<th>Method</th>
<th>Formula</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scattergraph</td>
<td>$40,000 + 10,000($4.29)</td>
<td>$82,900</td>
</tr>
<tr>
<td>High-low</td>
<td>$30,000 + 10,000($5.00)</td>
<td>$80,000</td>
</tr>
</tbody>
</table>

As you can see, the total estimated costs resulting from these two methods, in this case, are reasonably close to each other (although this may not necessarily be the case with sets of actual cost and activity data in some real-life companies).

**TO SUMMARIZE:** Two common techniques for analyzing mixed costs are the scattergraph and high-low methods. The scattergraph method involves visually fitting a straight line (the regression line) through data points plotted on a graph, then noting where the line intercepts the cost axis (the fixed cost) and calculating the slope of the line (the variable cost rate). With the high-low method, the high and the low levels of activity are used to calculate first the variable cost rate and then the fixed cost component.
Methods of C-V-P Analysis

Now that you have a better understanding of cost behaviors and can separate mixed costs into their fixed and variable cost elements, you are ready to use your knowledge of cost behaviors to make planning decisions. The previous chapter provided a quick introduction to C-V-P analysis in the process of planning and analyzing decisions to prioritize Kevlar versus Teflon products at DUPONT. However, in order to effectively use this valuable tool, we need a more detailed discussion and lots of practice.

If you haven’t done so already, now is a good time to think of an actual business organization that is familiar to you, perhaps one by which you’ve been employed or are now employed. Think about the product or service this organization creates and the costs and processes it uses. Now, as you study the C-V-P analysis method below, be sure to consider how this tool

Managing an Airline in the Post-9/11 Economy Is Not Easy. Prior to the terrorist tragedies in 2001, CONTINENTAL AIRLINES was posting an incredible string of consecutive profitable quarters. Since filing for bankruptcy protection in 1995, Continental reported 24 straight quarters of profit, even when most of the other major U.S. airlines reported losses. This all changed, of course, on September 11, 2001. Since then, Continental, the fifth largest airline in the United States, has struggled very hard just to stay alive. Both 2001 and 2002 resulted in significant operating losses for Continental, as was the case with many of its competitors. Continental, however, appears to be weathering the storm better than most other airlines. In 2002, three of the top seven U.S.-based international carriers filed bankruptcy. By the end of the first quarter in 2003, TWA no longer existed, and UNITED and US AIRWAYS were still struggling in bankruptcy. In contrast, Continental Airlines again earned a coveted spot on Fortune’s list of the 100 Best Companies to Work For—the only airline to do so and the fifth consecutive year for it to make the list. More importantly, in March 2002, Continental posted its first profitable month since 9/11, and Gordon Bethune, chairman and CEO, predicted that his company would be able to break even in 2004. This progress is significant in that the Air Transport Association (ATA) forecasts that the overall airline industry will lose $7 billion in 2003.

How has Continental’s management team carried this company through a disastrous period of time for the airline industry? For one thing, Continental Airlines’ management carefully analyzed its costs, divided those costs into fixed and variable components, and made several decisions to reduce fixed costs. For example, Continental grounded planes and slashed excess capacity. The airline eliminated 12,000 jobs in 2002 and planned to cut another 1,200 jobs, including 25% of top management, in 2003. All of this helped reduce Continental’s jet cost per available seat mile by 3.8%, which is a significant percentage in an industry defined by extremely thin profit margins.

With better control of its fixed costs, Continental Airlines is again becoming profitable, and becoming profitable more quickly than most of its competitors. Because of these cut costs, Continental Airlines’ passengers pay lower fares than on other airlines and receive better service. These lower fares and better service enable Continental to fill more seats than its competitors. Because its costs are low, it is profitable. Fixed costs are now a smaller percentage of total costs at Continental Airlines than at almost all other airlines.

would be used in your own organization to plan and manage costs and activities in order to obtain desired results.

**Contribution Margin**

In order to effectively use C-V-P analysis, we first need to spend some time working with the concept of contribution margin. **Contribution margin** is equal to sales revenue less variable costs; it is the amount of revenue that remains to cover fixed costs and provide a profit for an organization. For example, the contribution margin from the sale of one order of French fries by a fast-food restaurant is the selling price less the variables costs (potatoes, salt, container, cooking oil, wages of the cook) of producing the fries. Any contribution margin generated by the sale of an order of French fries can be used to pay the fixed costs of the fast-food outlet, such as the monthly rent, the insurance, the supervisor’s salary, and so forth. Contribution margin is one of the most important management accounting concepts you will learn because many operating decisions are made on the basis of how contribution margin will be affected. A company may decide, for example, to advertise one product more than others because that product has a higher contribution margin.

**The Contribution Margin Income Statement**

To illustrate the concept of contribution margin, let’s use the following format of a contribution margin income statement. The statement data for Jewels Corporation, a producer of high-quality baseball gloves, follow.

<table>
<thead>
<tr>
<th>Jewels Corporation</th>
<th>Contribution Margin Income Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>For the Month Ended November 30, 2006</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td>Sales revenue (1,000 gloves)</td>
<td>$200,000</td>
</tr>
<tr>
<td>Less variable costs</td>
<td>$110,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 90,000</td>
</tr>
<tr>
<td>Less fixed costs</td>
<td>$ 63,000</td>
</tr>
<tr>
<td>Profit*</td>
<td>$ 27,000</td>
</tr>
</tbody>
</table>

*In this chapter, “profit” means pretax income; the terms income and profit are interchangeable.

As this income statement shows, for internal decision-making purposes, Jewels Corporation computes its contribution margin on a per-unit (glove) and total-dollar basis. During November, Jewels’ **per-unit contribution margin** is $90; the total contribution margin at a sales volume of 1,000 baseball gloves is $90,000.

The per-unit contribution margin tells us that $90 is available from each glove sold to cover fixed costs and provide a profit. By showing the $63,000 of fixed costs separately, this income statement also tells us that Jewels must generate sufficient contribution margin to cover these costs before a profit can be earned. With $200,000 of sales revenue, the contribution margin ($90,000) is sufficient to cover the fixed costs and provide a profit of $27,000.

2 In this example, we assume that there is only one model of baseball glove, which sells for $200.
This type of contribution margin income statement is particularly useful as a planning tool. The statement helps a company to project profits at any level of activity within the relevant range. For example, if Jewels Corporation forecasts sales of 1,200 baseball gloves next month, the company can prepare a forecasted (or pro-forma) income statement (in contribution margin format) as follows:

**Jewels Corporation**  
**Pro-Forma Contribution Margin Income Statement**  
**For the Month Ended December 31, 2006**

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
<th>Per Unit</th>
<th>Ratio (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue (1,200 gloves × $200)</td>
<td>$240,000</td>
<td>$200</td>
<td>100%</td>
</tr>
<tr>
<td>Less variable costs (1,200 gloves × $110)</td>
<td>132,000</td>
<td>$110</td>
<td>55</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$108,000</td>
<td>$90</td>
<td>45%</td>
</tr>
<tr>
<td>Less fixed costs</td>
<td>63,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>$ 45,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notice that with an increase in sales of 200 baseball gloves, the contribution margin increases $18,000 ($108,000 − $90,000). You can confirm this by multiplying the per-unit contribution margin by the increase in volume ($90 per unit × 200 gloves = $18,000). Because we assume that the increase in volume is still within the relevant range of activity (which is a very important assumption!), the fixed costs remain at $63,000, and profit increases by the $18,000 increase in contribution margin. The critical thing you should see here is that once the fixed costs are covered, each subsequent dollar in contribution margin goes straight to profit!

In other words, when Jewels Corporation hits its break-even point (which is the point where all fixed costs are covered), each additional glove sold will generate $90 in profit.

Notice the importance of accurately determining cost behavior when forecasting profit levels. If one ignores cost behavior, then the $27,000 profit generated by November sales of 1,000 gloves may lead to the conclusion that each glove creates $27 ($27,000 profit/1,000 gloves) in profit. With this incorrect information, the forecasted level of profit for December sales of 1,200 gloves is $32,400 ($27 per glove × 1,200 gloves). This forecast differs significantly from the $45,000 profit forecast above that stems from a correct consideration of the behavior (fixed or variable) of Jewels Corporation’s costs.

### The Contribution Margin Ratio

Knowing the contribution margin ratio, which is the percentage of sales revenue left after variable costs are deducted, will help you compare the profitability of various products. For example, if product A has a 60% contribution margin ratio and the contribution margin ratio of product B is only 20%, the company should emphasize product A, assuming that other factors are equal. As a concrete example, in a supermarket the prepared foods (baked goods, squeezed juices, ready-to-eat barbecued chicken) have high contribution margin ratios whereas the staples such as milk and eggs have lower contribution margin ratios.

To illustrate the calculation of contribution margin ratios, let’s look again at the initial Jewels Corporation example. The ratio is computed as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
<th>Per Unit</th>
<th>Ratio (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue (1,000 gloves)</td>
<td>$200,000</td>
<td>$200</td>
<td>100%</td>
</tr>
<tr>
<td>Less variable costs</td>
<td>110,000</td>
<td>$110</td>
<td>55</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 90,000</td>
<td>$ 90</td>
<td>45%</td>
</tr>
<tr>
<td>Less fixed costs</td>
<td>63,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>$ 27,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The contribution margin ratio is 45% of sales revenue ($90 \div $200), which means that for every $1.00 increase in sales revenue, the contribution margin increases by $0.45 (45% of $1.00). If fixed costs are already covered, profit will also increase by $0.45 for every $1.00 increase in sales. As you can see, there is another ratio presented in these calculations—the variable cost ratio. These two ratios are complements of each other. Hence, the variable cost ratio ($110 \div $200 = 55\%) plus the contribution margin ratio (45\%) will always equal 100\%. This is important because whether we’re describing contribution margin ratios or variable cost ratios, we are really talking about the same basic issue—the relationship of variable costs to sales revenue.

With contribution margin or variable cost ratios, it is easy to analyze the impact of changes in sales on the contribution margin. For example, if you estimate that Jewels’ sales will increase by $20,000, you can apply the contribution margin ratio of 45\% or the variable cost ratio of 55\% and estimate that the contribution margin will increase by $9,000, which is equal to $20,000 \times 0.45 or $20,000 \times (1 - 0.55). The higher the contribution margin ratio, the larger the share of each additional dollar of sales that goes toward covering fixed costs and increasing profit.

The C-V-P Equation

As you can see, contribution margin calculations will be very useful to you when analyzing cost-volume-profit relationships in the management planning process. Doing C-V-P analysis using contribution margin calculations is a straightforward process. C-V-P analysis does require some simple algebra; here is where you reap the benefits of paying attention during your eighth grade math class.

We began this chapter with the assumption that all costs can be described as either fixed or variable. To highlight the important idea that C-V-P analysis depends on dividing costs into fixed and variable behavior patterns, we will develop the C-V-P equation as follows:

1. Because all costs can be classified as either variable or fixed, we can express the calculation of profit with the following basic formula:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = \text{Profit}
\]

2. We can specify the formula more precisely by expressing the equation in units:

\[
(Sales \ price \times Units) - (Variable \ cost \times Units) - \text{Fixed costs} = \text{Profit}
\]

3. Or, we can express the equation using ratios:

\[
\text{Sales revenue} - (Variable \ cost \ ratio \times Sales \ revenue) - \text{Fixed costs} = \text{Profit}
\]

These equations are quick and useful methods for examining the financial aspects of C-V-P analysis problems. To illustrate, see if you can use the C-V-P equation based on units and the data from the Jewels Corporation example to determine profit assuming that sales of 1,200 baseball gloves are expected.

\[
(Sales \ price \times Units) - (Variable \ cost \times Units) - \text{Fixed costs} = \text{Profit}
\]

\[
($200 \times 1,200) - ($110 \times 1,200) - $63,000 = \text{Profit}
\]

\[
$240,000 - $132,000 - $63,000 = \text{Profit}
\]

\[
$45,000 = \text{Profit}
\]

Alternatively, you could calculate Jewels’ profits using the equation based on ratios.

\[3\text{ Granted, fixed and variable costs often get “mixed together” and can be difficult (and sometimes impossible) to separate. The fact that C-V-P analysis is based on an assumption that all costs can be divided clearly into fixed and variable is one of the limitations of this technique.}\]
Sales revenue – (Variable cost ratio × Sales revenue) – Fixed costs = Profit

$240,000 – ([$110 ÷ $200] × $240,000) – $63,000 = Profit

$240,000 – (0.55 × $240,000) – $63,000 = Profit

$240,000 – $132,000 – $63,000 = Profit

$45,000 = Profit

Note that we calculated the same profit of $45,000 using both formula approaches. This result is no surprise because these are simply alternative routes to the same destination. Both methods are commonly used in business, depending on the data available for the analysis. So, although there may appear to be many alternative ways to write the C-V-P formula, there is really only one formula, and it is not hard to remember:

Sales revenue – Variable costs – Fixed costs = Profit

Once you understand this fact, C-V-P analysis using the equation approach is basic math; you merely insert the known elements into the formula and solve for the one unknown element.

**Break-Even Point**

In many cases, as a manager you will want to know how many units need to be sold to break even. The break-even point is defined as the volume of activity at which total revenues equal total costs, or where profit is zero. The break-even point may also be thought of as the volume of activity at which the contribution margin equals the fixed costs.

Although the goal of business planning is to make a profit, not just to break even, knowing the break-even point can be useful in assessing the risk of selling a new product, setting sales goals and commission rates, deciding on marketing and advertising strategies, and other similar operating decisions. Because the break-even point is, by definition, that activity level at which no profit or loss is earned, the basic C-V-P equation can be modified to calculate the break-even point as follows:

Sales revenue – Variable costs – Fixed costs = $0

As you can see, to compute the break-even point, all that you need to do is simply set income equal to zero and then solve for the unknown—such as the number of units to be sold or the total revenues to be achieved.

Let’s again use the Jewels Corporation example. How many units must Jewels sell to break even? (Note that we will use “X” to represent the unknown element, in this case, the number of baseball gloves.)

(Sales price × Units) – (Variable cost × Units) – Fixed costs = $0

(Sales price × X) – (Variable cost × X) – Fixed costs = $0

$200X − $110X − $63,000 = $0

$90X = $63,000

X = $63,000 ÷ $90 = 700 units (baseball gloves)

In this case, if Jewels sells 700 baseball gloves, the company will generate enough revenues to cover its variable and fixed costs, earning zero profit [($200 × 700) − ($110 × 700) − $63,000 = $0]. Once you understand the basic C-V-P formula, you just set it up and solve for whatever unknown you’re interested in planning. Think you’ve got it? Then try this one as a check on yourself: Assuming that Jewels can sell only 600 baseball gloves, what price per glove would the company have to use in order to break even?

4 (Sales price × Units) – (Variable cost × Units) – Fixed costs = $0

[X × Units] – (Variable cost × Units) – Fixed costs = $0

[X × 600] − ($110 × 600) − $63,000 = $0

600X − $66,000 − $63,000 = $0

600X = $129,000

X = $215 (new baseball glove price)
Determining Sales Volume to Achieve Target Income

Another way we can use C-V-P analysis in the planning process is to determine what level of activity is necessary to reach a target level of income. Instead of setting profit at $0 to do a break-even analysis, we can just as easily set income in the formula at the targeted level and then use the formula to plan or predict what fixed costs, variable costs, sales prices, and sales volumes are needed to achieve the target level of income. Target income is usually defined as the amount of income that will enable management to reach its objectives—paying dividends, meeting analysts’ predictions, purchasing a new plant and equipment, or paying off existing loans. Target income can be expressed as either a percentage of revenues or as a fixed amount.

To illustrate target income, suppose that we want to know how many baseball gloves must be sold by Jewels Corporation to achieve a target income of $36,000, assuming no changes in per-unit variable costs or total fixed costs. The calculation is as follows:

\[
\text{Sales price \times Units} - (\text{Variable cost \times Units}) - \text{Fixed costs} = \text{Target income}
\]

\[
$200X - $110X - $63,000 = $36,000
\]

\[
$90X = $99,000
\]

\[
X = 1,100 \text{ units (baseball gloves)}
\]

Thus, we can see that if Jewels sells 1,100 baseball gloves at a contribution margin of $90 each, and assuming that fixed costs are $63,000, the company will earn a pretax profit of $36,000 [($90 \times 1,100) - $63,000 = $36,000].

A fixed dollar amount of income, such as the $36,000 that would be earned by selling 1,100 baseball gloves, is probably the most typical way of expressing a target income goal for many companies. However, because investors often evaluate companies partially on the basis of the return on sales revenue (or simply “return on sales”), management may want to state its goal as a percentage return as opposed to a fixed amount of income. For example, if Jewels Corporation set a target income of a 20% return on sales, the computation would be:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = 0.20 \times \text{Sales revenue}
\]

\[
$200X - $110X - $63,000 = 0.20($200X)
\]

\[
$200X - $110X - $63,000 = $40X
\]

\[
$200X - $110X - $40X = $63,000
\]

\[
$50X = $63,000
\]

\[
X = $63,000 \div $50 = 1,260 \text{ gloves}
\]

As we can see in this calculation, Jewels Corporation can earn a 20% return on sales by selling 1,260 baseball gloves.

Short-Cut Formulas for C-V-P Analysis

Notice that in the C-V-P analysis examples that we’ve worked through so far, the basic C-V-P equation remains constant. That’s what makes this formula so powerful. Once you’re comfortable with it, you can use it to manage any number of factors in planning for profits. However, you may remember from your brief introduction to C-V-P analysis in the previous chapter and from our C-V-P formula example on page 49 that we calculated break-even sales in units directly using the following formula.

\[
\frac{\text{Total fixed costs}}{(\text{Sales price per unit} - \text{Variable cost per unit})} = \text{Break-even sales (in units)}
\]

This formula is a “short-cut” version of the C-V-P formulas above. You can see that it is simply the last step in the C-V-P calculation above for Jewels’ break-even point of 700 baseball gloves. So, if you understand the basic C-V-P equation, you can simply skip to the last step of the calculation. There are short cuts for computing the level of sales for both break-even volume and target income volume. The short-cut formula for both the break-even volume and the target income volume in units is:
Note that if you use this formula to determine the break-even volume, then you will assume that target income is $0, giving you:

\[
\text{Fixed costs + Target income} \\
\text{Contribution margin per unit}^5
\]

Plugging in the numbers for Jewels Corporation, the results are the same as shown earlier. As you can see, the short-cut calculation for both the break-even volume and the target income volume is really the same formula. For target sales:

\[
\frac{63,000 + 36,000}{90} = 1,100 \text{ units}
\]

For the break-even volume:

\[
\frac{63,000 + 0}{90} = 700 \text{ units}
\]

Always remember, though, that short cuts are useful, but they should not be applied until you fully understand the basic C-V-P relationships. In addition, managing some aspects of the C-V-P relationships can be tricky when you use short cuts. So if you ever get confused in solving a C-V-P analysis problem, just put the problem back in the original C-V-P equation:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = \text{Target income}
\]

### Computation in Dollar Amounts versus Units

Before we finish with C-V-P equations, you should note that a variable cost ratio is sometimes used instead of a per-unit variable cost. In such cases, the basic C-V-P equation is modified as follows:

\[
\text{Sales revenue} - (\text{Variable cost ratio} \times \text{Sales}) - \text{Fixed costs} = \text{Profit}
\]

Because the variable costs are stated as a percentage of sales dollars rather than on a per-unit basis, this approach expresses activity in terms of sales dollars, not units. This is still the same basic C-V-P equation, but setting up the equation using the variable cost ratio will result in a break-even point in dollars instead of units. For example, the break-even point for Jewels Corporation would then be expressed as $140,000 in sales revenue ($200 per unit x 700 units) instead of 700 units as previously illustrated. This may be verified using the preceding equation and a 55% variable cost ratio as follows:

\[
\text{Sales revenue} - (0.55)\text{Sales revenue} - 63,000 = 0 \\
(0.45)\text{Sales revenue} = 63,000 \\
\text{Sales revenue} = 140,000
\]

The short-cut formula for break-even volume and target income volume in sales dollars is:

\[
\frac{\text{Fixed costs} + \text{Target income}}{\text{Contribution margin ratio}}
\]

(Remember the following: Contribution margin ratio = 1 - Variable cost ratio.)

---

5 Remember that per-unit contribution margin is the sales price per unit less the variable cost per unit.
Measuring the Effect of Potential Changes in C-V-P Variables

The basic techniques of C-V-P analysis that you have worked with in this chapter are used almost daily by organizations in the management processes of planning, controlling, and evaluating. As a result of understanding C-V-P analysis, you will be adept at evaluating the effects on profitability of the following common changes in C-V-P variables: (1) the amount of fixed costs, (2) the variable cost rate, (3) the sales price, (4) the sales volume or the number of units sold, and (5) combinations of these variables.

Changes in Fixed Costs

Many factors, such as an increase in property taxes or an increase in management’s salaries, for example, will cause an increase in fixed costs. (Recall also from the opening scenario for this chapter that building a new facility such as a stadium can also increase fixed costs.) If all other factors remain constant, an increase in fixed costs always increases the number of units needed to break even. Obviously, the number of units needed to reach a target income will also increase. To illustrate, let’s return again to the Jewels Corporation and

Caution

If you want to use C-V-P analysis to calculate the necessary sales volume in terms of dollars, the per-unit variable cost is not used. Rather, use the variable cost ratio times sales to determine total variable costs. Many students make the mistake of multiplying the per-unit variable cost times sales instead of the variable cost ratio times sales to get total variable costs.

Business Environment

IBM Gets on the Internet Wave

In 1998, if you wanted an IBM desktop personal computer (PC), you had to walk into a store to make the purchase. In hindsight, this was a strange way to sell computers for a company that believed itself to be at the forefront of the e-business revolution. And in hindsight, this sales approach, being both slow and expensive, clearly didn’t work. The PC division for IBM lost $986 million in 1998 and was bracing itself for similar losses in 1999. Market analysts were pushing IBM to sell its PC division based in Research Triangle Park in North Carolina. Finally, in the last quarter of 1999, IBM officials announced that it would yank its entire line of home desktop PCs from retail stores in the United States and sell the machines almost exclusively over the Internet. IBM also launched a $20 million advertising campaign (TV and direct mail flyers) to back up the move.

IBM’s decision to sell over the Internet was driven largely by cut-throat pricing of components and systems by its major competitors and suppliers, the overhead costs of selling through dealers, and the inability to distinguish its product from dozens of competitor PCs sitting next to it on the retail shelf. In 2000, IBM followed the Internet decision by cutting $1.1 billion in annual manufacturing and distribution expenses. These cost savings were achieved largely by three means. First, IBM changed the way the PCs are built and redesigned the PC product to use as many industry standard parts as possible. Second, by building PCs to order (i.e., only building PCs when an order was placed), IBM was able to significantly reduce the amount of inventory it had to keep on hand. Third, IBM told its suppliers that it wanted 95% of its components ready on demand in well-stocked mini-warehouses near IBM manufacturing facilities. “The whole object is to not own the parts for very long,” said Adalio Sanchez, general manager of manufacturing and operations for the PC division.

The change to IBM’s PC business started to pay off as costs were reduced and shipments increased using the new ShopIBM Web site. Losses in the PC division were cut to $360 million in 1999 and $148 million in 2000. In 2001, after four straight years of losing money, the PC division was back in the black with a pretax profit of $99 million by the middle of the year. In a business today where prices on desktop PCs are typically in the $800 range, if IBM is $10 or $20 higher than the price of a DELL or COMPAG PC, it can lose the sale. Clearly, controlling costs and managing sales is becoming more and more important in the very competitive PC market.

assume that we need to analyze the effect on profits if fixed costs increase from $63,000 to $81,000. How many more baseball gloves must be sold to maintain Jewels’ income goal of $36,000?

\[
\begin{align*}
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} &= \text{Target income} \\
200X - 110X - 81,000 &= 36,000 \\
90X &= 117,000 \\
X &= 1,300 \\
\end{align*}
\]

Because of the added fixed costs, Jewels must now sell 1,300 baseball gloves, instead of 1,100, to earn a target income of $36,000. The computations are quite simple. In fact, you may have found them unnecessary, realizing that if fixed costs increase by $18,000 ($81,000 − $63,000), and if the unit contribution margin remains $90 per glove, 200 additional gloves ($18,000 ÷ $90) will have to be sold in order to reach the $36,000 target income (1,100 + 200 = 1,300 gloves).

**Changes in the Variable Cost Rate**

Like an increase in fixed costs, an increase in the variable cost rate also increases the number of units needed to break even or to reach target income levels, when all other factors remain constant. Suppose that the variable cost rate increased from $110 per baseball glove to $130 per glove because of higher wages for factory personnel, increased costs of direct materials, or other factors. How does this cost increase affect the number of gloves needed to reach the target income, assuming that fixed costs are again $63,000?

\[
\begin{align*}
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} &= \text{Target income} \\
200X - 130X - 63,000 &= 36,000 \\
70X &= 99,000 \\
X &= 1,415 \\
\end{align*}
\]

*Technically, if the C-V-P analysis results in a fractional answer, you should always round the answer up to the next digit. In this case, if you round the calculated answer of 1,414.29 to 1,414 gloves, you won’t quite achieve the target income of $36,000.

The increase in the variable cost rate reduces the unit contribution margin (from $90 to $70), which means that more gloves must be sold to maintain the same target income. With a unit contribution margin of $90, the company would make a $36,000 target income by selling 1,100 baseball gloves; with a unit contribution margin of only $70, an additional 315 (1,415 − 1,100) gloves must be sold to earn at least a $36,000 target income.

**Changes in Sales Price**

If all other variables remain constant, an increase in the sales price decreases the sales volume needed to reach a target income. This is because an increase in sales price increases the contribution margin per baseball glove, thereby decreasing the number of gloves that must be sold to earn the same amount of target income.

To illustrate, assume that the demand for baseball gloves is overwhelming and that Jewels cannot produce gloves fast enough. Hence, we make a decision to increase the price from $200 to $230 per glove. As a result of the price increase, the number of gloves that must be sold to reach the target income of $36,000 decreases:

\[
\begin{align*}
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} &= \text{Target income} \\
230X - 110X - 63,000 &= 36,000 \\
120X &= 99,000 \\
X &= 825 \\
\end{align*}
\]

With the sales price increase of $30 per glove, the contribution margin also increases $30 per glove to $120; and with a $120 contribution margin per glove, only 825 gloves need to be sold to reach the $36,000 target income. Obviously, a decrease in the sales price would have the opposite effect; it would increase the number of units needed to reach the target income.
Changes in Sales Volume
As you have seen, the sales volume (the number of gloves to be sold) for the target income has varied with each change in one of the other variables. When other variables remain constant, an increase in the sales volume will result in an increase in income. Very simply, the more gloves sold, the higher the income (as long as the contribution margin is positive!). The degree of change in profits resulting from volume change depends on the size of the unit contribution margin. To be specific, the change in income will be equal to the change in sales volume units multiplied by the contribution margin per unit. So, when the unit contribution margin is high, a slight change in volume results in a dramatic change in profit. With a lower unit contribution margin, the change in profit is less.

Simultaneous Changes in Several Variables
Thus far, we have examined changes in only one variable at a time. However, in your work in actual business organizations, you will find that individual changes are quite rare. More often, a decision will affect several variables, all at the same time. For example, should Jewels Corporation increase fixed advertising costs by $20,000 and reduce the sales price by 10% if the result would be to increase sales volume by 500 units? The impact on the target income from these proposed changes is as follows:

<table>
<thead>
<tr>
<th>Initial Data</th>
<th>Proposed Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales price per glove</td>
<td>$200</td>
</tr>
<tr>
<td>Variable costs per glove</td>
<td>$110</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$63,000</td>
</tr>
<tr>
<td>Target income</td>
<td>$36,000</td>
</tr>
<tr>
<td>Sales volume</td>
<td>1,100 gloves</td>
</tr>
</tbody>
</table>

Computations and Result:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = \text{Target income}
\]
\[
(180 \times 1,600) - (110 \times 1,600) - 83,000 = X
\]
\[
288,000 - 176,000 - 83,000 = X
\]
\[
29,000 = X \text{ (target income)}
\]

The analysis shows that target income would drop by $7,000 ($36,000 − $29,000) as a result of these changes. So, our decision should be to not implement the proposed changes.

Consider another possible decision: Should Jewels automate part of its production, thereby reducing (by $10) variable costs to $100 per unit and increasing (by $5,000) fixed costs to $68,000? The computation is as follows:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = \text{Target income}
\]
\[
(200 \times 1,100) - (100 \times 1,100) - 68,000 = X
\]
\[
220,000 - 110,000 - 68,000 = X
\]
\[
42,000 = X \text{ (target income)}
\]

This analysis shows that implementing these proposed changes would be beneficial because they would increase target income by $6,000 ($42,000 − $36,000). Obviously, this is true only if the assumptions can be relied on—that is, if fixed costs will rise by no more than $5,000 and unit variable costs will decrease by a full $10.

Consider another example. Suppose Jewels Corporation could use part of the excess capacity of its operating facilities to make baseball bats. These bats would sell for $90 per unit, increase fixed costs by $40,000, and have a variable cost per unit of $45. Jewels wants to add this new product line only if it can increase income by $25,000. How many baseball bats must Jewels sell to reach this target income? The computation follows:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = \text{Target income}
\]
\[
(90 \times X) - (45 \times X) - 40,000 = 25,000
\]
\[
45X - 45X - 40,000 = 25,000
\]
\[
25,000 = X \text{ (target income)}
\]
Sales revenue – Variable costs – Fixed costs = Target income
$90X – $45X – $40,000 = $25,000
$45X = $65,000
X = 1,445 baseball bats (rounded up)

Now that we have completed the C-V-P calculations, we must determine whether the company can produce and sell 1,445 baseball bats. If that sales goal seems attainable, the facilities should be used to make the bats. Don’t forget that making C-V-P calculations is the easy part of managing an organization. It takes an excellent manager to successfully implement the results of a C-V-P analysis into a real business process.

Breaking Even in the Hotel Industry
An international hotel chain undertook a project to increase the effectiveness of decision making of its properties in Europe, the Middle East, and Africa. In 1996, company executives wanted to improve the financial planning and control decisions of the hotel management teams. The Europe, Middle East, Africa division was responsible at that time for approximately 240 hotels. Essentially, the executives aimed to encourage a greater use of basic managerial accounting techniques such as budgeting models and C-V-P analysis in order to improve the profitability of individual hotels.

It was clear to the company that understanding how hotel costs behaved is absolutely key to making good decisions that affect market share analysis, annual budget preparation and monitoring of results, sales volume and business mix decisions, pricing policies, and cost management. In order to identify the fixed and variable costs in the hotels, the company first worked with individual hotel management teams within its organization who were intimately familiar with how costs behaved based on changes in sales volumes (i.e., hotel rooms rented). Initially, the company had these individuals determine from their own experience which costs were fixed, variable, or semi-variable (i.e., mixed) costs with respect to changes in sales volume. Scattergraph and statistical analyses were then used to estimate the fixed and variable proportions of the mixed costs—again related to sales volume—and allocate these costs to the main fixed and variable groups.

Computer spreadsheets were then used to assess key “what if” questions. For instance, “What is the likely effect on profit of a 3% shortfall in room revenue?” . . . or . . . “How will profit change if a 5% growth in total sales volume occurs?” This alerts managers to the critical areas of profitability and indicates which revenue and cost areas require greater attention for a given decision. It also enables management to gain an overall indication of “profit stability” or “profit instability” in relation to changes in revenue and cost of particular hotel properties. Knowledge of break-even levels and profit-and-loss implications of different business scenarios are relevant if managers are to make informed decisions which ensure survival, optimize profits, and limit risk, giving rise to a feeling of “being more in control” when making decisions.

In 1995, the year before the new management focus on C-V-P analysis commenced, the average operating profit margin in the Europe, Middle East, Africa division was 35%. In 1998, the average operating profit margin was 39%. Although the hotel executives do not believe that the new focus on C-V-P tools is the only reason for this improvement, it has played a positive role in significantly adding to shareholder value.

**TO SUMMARIZE**: The contribution margin is sales revenue less variable costs and is the amount of revenue left to cover fixed costs and provide a profit. The contribution margin can be expressed in total dollars, on a per-unit basis, or on a percentage basis. Because fixed costs remain constant within a relevant range, once fixed costs have been covered, income increases by the amount of the per-unit contribution margin for every additional unit sold. This relationship is used in C-V-P analysis. The basic C-V-P equation is:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = \text{Target income}
\]

Using this equation, you as a manager can work to plan, control, and evaluate the costs, prices, and sales output of the organization. The effects of changes in costs, prices, and volume on profitability may be determined by C-V-P analysis. Changes in individual variables or simultaneous changes in several variables can be analyzed with this technique.

---

**Using Graphs to “See” C-V-P Relationships**

5 Visualize C-V-P relationships using graphs.

Earlier in this chapter, we talked about using scattergraph methods as a way to analyze cost behavior. Recall that once we have plotted the history of costs on a graph and visually fitted a regression line through the data, we can then essentially “see” how the cost can be separated into its fixed and variable cost components. Now, by simply adding a line to the cost chart to represent revenue, we can graphically work with cost-volume-profit relationships. In fact, using graphs may be the most effective way to manage and communicate C-V-P information. This graphical approach allows you to visually examine cost and revenue data over a range of activity rather than at a single volume. Sometimes, though, reading precise information from a graph can be difficult. Hence, when analyzing specific proposals in the future, you will typically combine the C-V-P equations discussed in the preceding section with the graphs discussed in this section.

On a C-V-P graph, volume or activity level usually is shown on the horizontal axis, and total dollars of sales and costs are shown on the vertical axis. Lines are then drawn to represent total fixed costs, total costs, and total revenues. Exhibit 6 shows a C-V-P graph for Jewels Corporation.

Remember that fixed and variable cost relationships are valid only for the relevant range of activity (the screened area on the graph in Exhibit 6). In this case, fixed costs are $63,000, and variable costs are $110 per glove over the range of activity between 400 and 1,200 gloves sold. Total costs are $118,000 at 500 gloves [($63,000 + ($110 × 500 gloves)], $129,000 at 600 gloves [($63,000 + ($110 × 600 gloves)], and so on. Similarly, total revenues are $100,000 at 500 gloves ($200 × 500 gloves), $120,000 at 600 gloves, and so forth. The break-even point, the point at which total revenues equal total costs, is 700 gloves, or $140,000 in sales.

As shown in Exhibit 7, we can use the graphic format to isolate such items of interest as total variable costs, total fixed costs, the area in which losses occur, the area in which profits will be realized, and the break-even point. Because C-V-P graphs illustrate a wide range of activity, this tool can help in quickly determining approximately how much profit or loss will be realized at various levels of sales.

**The Profit Graph**

With a few adjustments to a standard C-V-P graph, we can create what is called a profit graph, which plots only profits and losses and omits costs and revenues. A profit graph is another useful way to visualize how decisions regarding costs and revenues will impact profit. Exhibit 8 shows a profit graph for Jewels Corporation based on the same underlying data used in Exhibit 6.
Notice that, though the horizontal axis of the profit graph is the same as those of the previous graphs, the vertical axis represents only profits and losses. As long as the contribution margin is positive, the maximum amount of losses that can occur is at a zero level of sales. With no sales, total losses will be the amount of the fixed costs. With the axes properly labeled, we can draw the profit line as follows:

1. Locate the loss for zero sales volume on the vertical axis. This is the total fixed cost, or negative $63,000 in this case.
2. Locate the profit or loss at another sales volume. For example, at sales of 700 gloves, profits are zero \[ \frac{140,000 - (63,000 + 77,000)}{140,000 - (63,000 + 77,000)} \] , or at sales of 1,000 gloves, profits are $27,000 \[ \frac{200,000 - (63,000 + 110,000)}{200,000 - (63,000 + 110,000)} \].
3. After the two profit or loss points have been identified, draw a line through them back to the vertical axis.

Because of how simple it is to create, the profit graph is widely used for comparing competing projects. It has the disadvantage, however, of not showing specifically how revenues and costs vary with changes in sales volume.

**A Comparison of C-V-P Graphs with C-V-P Equations**

C-V-P graphs are very useful in understanding contribution margin income statements and C-V-P equations. To illustrate this point, let's again explore the question of what volume of
Exhibit 7: Cost-Volume-Profit Graphs

Exhibit 8: Profit Graph for Jewels Corporation
activity. Jewels Corporation needs to reach a target income of $36,000. This was illustrated earlier with the equation approach, but it is repeated here to show that the graph approach will produce the same quantitative results. As you can see in Exhibit 9, Jewels Corporation must sell 1,100 baseball gloves to reach a target income of $36,000.

**Exhibit 9: Comparison of C-V-P Equation with C-V-P Graph**

**C-V-P Equation**

\[
\text{(Sales price \times Units)} - \text{(Variable costs \times Units)} - \text{Fixed costs} = \text{Profit}
\]

\[
\begin{align*}
200X - 110X - 63,000 &= 36,000 \\
90X &= 99,000 \\
X &= 1,100 \text{ gloves}
\end{align*}
\]
TO SUMMARIZE: The financial effects on cost-volume-profit decisions can be examined by using either equations or graphs. These methods of analysis can be used to calculate the break-even point, which occurs at the point where total revenues equal total fixed costs plus total variable costs. These methods can also be used to project a target profit level, with profit being equal to the excess of revenues over total costs. The graphic approaches are useful because they highlight cost-volume-profit relationships over wide ranges of activity. The most common graphic approach involves plotting fixed costs as a horizontal line with variable costs representing the distance between the fixed costs and total costs line. A profit graph, which shows only profit or loss and volume, is much simpler, but it does not show how costs vary with changes in sales volume. Regardless of the approach, all variations of C-V-P analysis are based on the same calculations and on the same underlying concept of fixed and variable costs.

Limiting Assumptions of C-V-P Analysis

6 Identify the limiting assumptions of C-V-P analysis, and explain the issues of quality and time relative to C-V-P analysis decisions.

C-V-P analysis is an extremely useful tool to assist in making short-term operating decisions. However, C-V-P analysis has some limiting assumptions that must not be overlooked.

The first key assumption underlying C-V-P analysis is that the behavior of revenues and costs is linear throughout the relevant range. This means that C-V-P analysis is valid only for a relevant range.

A second assumption is that all costs, including mixed costs, can be accurately divided into fixed and variable categories. As we have seen in this chapter, some costs have characteristics of both fixed and variable costs. These costs sometimes are not easily classified into their fixed and variable components, which limits the accuracy of C-V-P analysis.

For companies with more than one product, a third major assumption in C-V-P analysis is required—that the mix of a company’s products does not change over the relevant range. The sales mix is the proportion of the total units sold (or the total dollar sales) represented by each of a company’s products. Sales mix will be discussed in the expanded material section of this chapter.

In addition to these three key assumptions, there are other limiting assumptions implicit in C-V-P analysis. For example, C-V-P analysis assumes that efficiency and productivity are held constant, that the prices of materials and other product components are constant, and that revenues and costs can be analyzed using a single activity base, such as volume. A related and very significant assumption, and one that clearly is not always valid, is that volume is the only, or even the primary, driver of costs. As discussed below, delivery time and quality can also impact costs.

Because of the limiting assumptions just described, a manager must use reasonable caution when making decisions using C-V-P analysis. Nevertheless, C-V-P analysis does provide a good model for predicting future operating results when specific relationships are defined and recognized.

Issues of Quality and Time

The emphasis in this chapter has been primarily on costs and profits and how they change when changes in variable costs, fixed costs, sales prices, and sales volume are made. Remember, however, that financial results are just one of several elements of performance that a manager must consider. Good managers are equally interested in how these changes will affect the quality of goods and services produced and sold and the speed at which products and services can be delivered to customers. If, for example, reducing fixed costs means that goods will be produced more slowly or that the quality of manufactured products will be reduced, then a decision to reduce fixed costs may be a poor one. On the other hand, if a company can automate a function using robotics instead of high-cost workers, for example, it may be possible to simultaneously reduce total costs, increase quality and consistency, and improve speed of production. To determine whether quality and speed of production are good or bad, a management team may
need to compare its results with those of other firms, a process called *benchmarking*, which will be introduced in a later chapter.

**TO SUMMARIZE:** C-V-P analysis is based on three critical and limiting assumptions: (1) that the behavior of revenues and costs is linear throughout the relevant range, (2) that all costs can be categorized as either fixed or variable, and (3) that the sales mix does not change. When considering how changes in variable costs, fixed costs, sales prices, sales volume, and sales mix will affect profits, it is important to also consider how these changes will affect the quality of goods and services and the speed at which products and services can be delivered to customers. Decisions that increase quality, reduce costs, and speed up production are valuable changes and should be made; decisions that have a negative effect on one or more of these variables must be carefully analyzed and trade-offs considered.

Thus far, we have covered various types of costs, simple methods of analyzing mixed costs, and the basics of C-V-P analysis. In this expanded section, we cover an additional, more advanced method of analyzing mixed costs—least squares analysis. We also cover the effect of the sales mix on profitability and use the concept of operating leverage to explore differences in cost structures among manufacturing, merchandising, service, and e-commerce organizations.

### Analysis of Mixed Costs—The Least Squares Method

Analyzing mixed costs using the least squares method.

**least squares method** A method of segregating the fixed and variable portions of a mixed cost; the regression line, a line of averages, is statistically fitted through all cost points.

Earlier, we described two common methods for analyzing mixed costs: the scattergraph and high-low methods. These methods are relatively easy to use and provide useful estimates of the fixed and variable components of mixed costs. A more sophisticated method for analyzing mixed costs is the **least squares method**, which is the most accurate method of using a specific set of data to determine the fixed and variable portions of a mixed cost. Like the scattergraph, the least squares method fits a straight line through all points on a graph. However, instead of visually fitting the regression line through the cost points, it uses statistical analysis to guarantee that the line is the best possible fit for the applicable costs. As a result, the least squares method provides a better analysis because it isn’t based on a subjective regression line like scattergraphs and because it uses all the cost data points rather than just the high and low data points as with the high-low method.

The formula for the least squares method is based on the equation for a straight line:

$$Y = a + bX$$

You probably recognize this classic equation from previous math classes you may have had. When this equation is used to do cost analysis, $Y$ represents the total predicted cost; $a$ represents the intercept and the fixed cost (if in the relevant range); $b$ represents the variable cost rate or the slope of the line; and $X$ represents the activity level being considered. Using cost and activity level data, this method involves the use of simultaneous equations to find the values of $a$ and $b$. Once computed, these values can be combined with the projected activity level $X$ to predict or estimate the total future cost $Y$. For example, if the values of $a$ and $b$ are computed to be $200$ and $5$, respectively, then for an estimated activity level of 100 direct labor hours, we can predict that:

$$Y \text{ (total predicted cost) } = 200 + 5 \times 100 \text{ hours}$$

$$Y = 200 + 500$$

$$Y = 700$$
You should understand that the regression line is basically a line of averages. Therefore, the actual total cost for 100 direct labor hours might be somewhat different from the predicted cost of $700. The method of least squares, however, attempts to minimize the differences between predicted and actual costs. Once a regression line has been fitted to historical data, the fixed and variable costs represented by the line can be used to predict the level of future costs.

Calculating the estimates of \( a \) (the intercept, or the total fixed cost) and \( b \) (the slope, or variable cost rate) requires solving the following two simultaneous equations:

1. \( \Sigma XY = a\Sigma X + b\Sigma X^2 \)
2. \( \Sigma Y = na + b\Sigma X \)

where
- \( a \) = fixed cost
- \( b \) = variable cost rate
- \( n \) = number of observations
- \( \Sigma \) = summation sign (which means the sum of all historical data indicated by the sign)
- \( X \) = activity level, or independent variable
- \( Y \) = total (predicted) mixed cost, or dependent variable

Actually, solving these equations is easy with a calculator or computer, but difficult and tedious by hand. Initially solving these equations by hand may be useful to you in learning exactly how these equations work. However, as a manager working with cost estimations, you are going to have computers available to analyze large amounts of data very quickly. Hence, we will focus on describing and interpreting the typical output from a computerized application of least squares analysis. We will leave it to math classes to illustrate the manual calculations of the least squares method.

To illustrate the concept of least squares, let’s return once more to the electricity cost data used earlier in this chapter to work with the scattergraph and high-low methods. Note that the historical data that we are using for this example are given for only six months; thus, the resulting regression equation will likely be less accurate than it would be with more data (say, 12 or 18 months of data).

<table>
<thead>
<tr>
<th>Month</th>
<th>Direct Labor Hours Worked</th>
<th>Total Electricity Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>7,000</td>
<td>$ 70,000</td>
</tr>
<tr>
<td>February</td>
<td>6,000</td>
<td>60,000</td>
</tr>
<tr>
<td>March</td>
<td>12,000</td>
<td>100,000</td>
</tr>
<tr>
<td>April</td>
<td>6,600</td>
<td>80,000</td>
</tr>
<tr>
<td>May</td>
<td>18,000</td>
<td>120,000</td>
</tr>
<tr>
<td>June</td>
<td>14,000</td>
<td>110,000</td>
</tr>
</tbody>
</table>

Using these data, the following output, shown in Exhibit 10, can be generated in just a matter of minutes using the “data analysis” tool in Excel®, a Microsoft database software program.\(^6\) Now compare the least squares output with the results from our earlier work using the scattergraph and high-low methods:

<table>
<thead>
<tr>
<th></th>
<th>Fixed Costs</th>
<th>Variable Cost per Direct Labor Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scattergraph method</td>
<td>$40,000 per month</td>
<td>$4.29 per direct labor hour</td>
</tr>
<tr>
<td>High-low method</td>
<td>30,000 per month</td>
<td>5.00 per direct labor hour</td>
</tr>
<tr>
<td>Least squares analysis</td>
<td>40,402 per month</td>
<td>4.68 per direct labor hour</td>
</tr>
</tbody>
</table>

\(^6\) There are literally hundreds of software programs that can be used to run regressions or least squares analysis.
Exhibit 10: Output of Least Squares Analysis Application

<table>
<thead>
<tr>
<th>Month</th>
<th>Hours</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>7,000</td>
<td>$70,000</td>
</tr>
<tr>
<td>February</td>
<td>6,000</td>
<td>60,000</td>
</tr>
<tr>
<td>March</td>
<td>12,000</td>
<td>100,000</td>
</tr>
<tr>
<td>April</td>
<td>6,800</td>
<td>80,000</td>
</tr>
<tr>
<td>May</td>
<td>18,000</td>
<td>120,000</td>
</tr>
<tr>
<td>June</td>
<td>14,000</td>
<td>110,000</td>
</tr>
</tbody>
</table>

Summary Output

Regression Statistics

- Multiple R: 0.962
- R square: 0.926
- Adjusted R square: 0.907
- Standard error: 7207.705
- Observations: 6

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>$40,402.03</td>
<td>$7,613.10</td>
<td>5.31</td>
<td>$19,264.63</td>
<td>$61,539.43</td>
</tr>
<tr>
<td>Hours</td>
<td>$4.68</td>
<td>$0.66</td>
<td>7.05</td>
<td>$2.84</td>
<td>$6.52</td>
</tr>
</tbody>
</table>
You can see that the least squares analysis results in fixed costs estimated at $40,402 and the variable cost rate estimated to be $4.68 per direct labor hour. As you can see, the results are more similar to the results of the scattergraph method than to the results of the high-low method. Why do you think this is the case? The reason is that both the scattergraph and least squares methods are essentially using all of the historical data while the high-low method uses only two data points (February and May).

We won’t take time in this chapter to understand all of the output shown in Exhibit 10; what is most important is that you know three things: (1) the coefficient of the intercept, (2) the coefficient of the direct labor hours, and (3) the R square summary statistic. The coefficient of the intercept, or $40,402.03 in this case, is the estimate of total fixed costs. The coefficient of the direct labor hours, or $4.68 in this case, is the estimate of the variable electricity cost per direct labor hour. The R square ($R^2$) is a descriptive statistic that provides information about how well the regression line fits the data; in other words, R square can be interpreted as the fraction of the variability in the data that is explained by the computed regression statistics. For now, remember that a higher $R^2$ is better, and an $R^2$ of 1.0 represents a perfect fit (meaning all data points were exactly on the regression line). In this case, an $R^2$ of 0.926 is very high and suggests that the computed regression statistics explain most of the variability in the data.7

FYI:
An $R^2$ of more than 0.9 is actually not very common in practice. It is often quite rare to identify a single cost driver that explains most of the variance of important costs in an organization. Typically, organizations find that there are many things that affect a particular cost (e.g., headcount, floor space, operating hours, etc.), which requires that cost analysis be based on multiple cost drivers. The least squares analysis method we have discussed here is also known as simple or single linear regression. Multiple linear regression, a technique you may have learned about in a statistics class, uses a similar approach to identify the impact of several activities on changes in a specific cost.

TO SUMMARIZE: A more sophisticated technique for analyzing mixed costs is the least squares method. The least squares method is essentially equivalent to simple regression analysis, using the equation for a straight line ($Y = a + bX$) and simultaneous equations to calculate the fixed and variable portions of a mixed cost. Even though the least squares method is more mathematically correct than the scattergraph or high-low methods, it still should be used with caution in analyzing mixed costs. Least squares results can be quickly calculated using computer programs such as Microsoft’s Excel®.

Sales Mix

8 Explain the effects of sales mix on profitability.

Sales mix The relative proportion of total units sold (or total sales dollars) that is represented by each of a company’s products.

Earlier in this chapter, we described some important limiting assumptions of C-V-P analysis. As a manager using C-V-P, you need to be aware of what this tool can and cannot do. One important issue is that C-V-P analysis must be adjusted when a company starts changing the mix of products that it sells. Sales mix is the proportion of the total units represented by each of a company’s products. To keep our discussions simple, in previous sections of the chapter we used examples of companies with only one product. Many companies have more than one product, however, so you need to understand how sales mix issues are resolved. To illustrate how a change in sales mix can affect a company’s C-V-P relationships, let’s assume that Multi-Product, Inc., sells three different products. Following are the monthly revenues and costs for each type of product:

<table>
<thead>
<tr>
<th>Product</th>
<th>Amount</th>
<th>Percent</th>
<th>Amount</th>
<th>Percent</th>
<th>Amount</th>
<th>Percent</th>
<th>Amount</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product A</td>
<td>$25,000</td>
<td>100%</td>
<td>$45,000</td>
<td>100.00%</td>
<td>$30,000</td>
<td>100%</td>
<td>$100,000</td>
<td>100%</td>
</tr>
<tr>
<td>Less variable costs</td>
<td>20,000</td>
<td>80%</td>
<td>30,000</td>
<td>66.67%</td>
<td>21,000</td>
<td>70%</td>
<td>71,000</td>
<td>71%</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$ 5,000</td>
<td>20%</td>
<td>$15,000</td>
<td>33.33%</td>
<td>$ 9,000</td>
<td>30%</td>
<td>$ 29,000</td>
<td>29%</td>
</tr>
<tr>
<td>Sales mix</td>
<td>25%</td>
<td>45%</td>
<td>30%</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7 The adjusted $R^2$ of 0.907 is a more conservative estimate of the variance explained in the data and is preferred to the $R^2$ statistic in some circumstances.
Total sales are $100,000, which in this example includes $25,000 in sales of Product A, $45,000 of Product B, and $30,000 of Product C. Therefore, the sales mix is 25% Product A ($25,000 ÷ $100,000), 45% Product B ($45,000 ÷ $100,000), and 30% Product C ($30,000 ÷ $100,000). With this sales mix, the average variable cost ratio is 71%, which is determined by dividing total variable costs of $71,000 by total sales of $100,000. If Multi-Product, Inc., had fixed costs of $17,400 and desired a target income of $40,000, the necessary sales volume (in dollars) would be:

\[
\text{Sales revenue} - (0.71)\text{Sales revenue} = $40,000 \\
(0.29)\text{Sales revenue} = $57,400 \\
\text{Sales revenue} = \frac{$57,400}{0.29} = $197,932 \text{ (rounded up)}
\]

Alternatively, you could calculate the average contribution margin ratio by subtracting the total variable costs from total sales and dividing the result (total contribution margin of $29,000) by total sales of $100,000. The company could then divide the average contribution margin ratio (29%) into fixed costs plus target income ($17,400 + $40,000). This revised, more compact formula is simply a restatement of the preceding equation.

\[
\frac{\text{Fixed costs + Target income}}{\text{Average contribution margin ratio}} = \frac{$57,400}{0.29} = $197,932 \text{ (rounded up)}
\]

Remember, though, that $197,932 in sales will achieve the target income only if the average variable cost and contribution margin ratios, and therefore the sales mix, do not change. In order for you to better understand this fact, assume that the total sales revenue and the sales price of each product remain the same but that the sales mix changes as follows:

<table>
<thead>
<tr>
<th>Product</th>
<th>Amount</th>
<th>Percent</th>
<th>Amount</th>
<th>Percent</th>
<th>Amount</th>
<th>Percent</th>
<th>Amount</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product A</td>
<td>$50,000</td>
<td>100%</td>
<td>$30,000</td>
<td>100.00%</td>
<td>$20,000</td>
<td>100%</td>
<td>$100,000</td>
<td>100%</td>
</tr>
<tr>
<td>Less variable costs</td>
<td>40,000</td>
<td>80</td>
<td>20,000</td>
<td>66.67</td>
<td>14,000</td>
<td>70</td>
<td>74,000</td>
<td>74</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$10,000</td>
<td>20%</td>
<td>$10,000</td>
<td>33.33%</td>
<td>$ 6,000</td>
<td>30%</td>
<td>$ 26,000</td>
<td>26%</td>
</tr>
<tr>
<td>Sales mix</td>
<td>50%</td>
<td>30%</td>
<td>20%</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As you can see in this example, the variable cost and contribution margin ratios for each product remain the same, but the sales mix changes. Product A now comprises 50% of total sales instead of 25%. Because Product A has a lower contribution margin ratio than Products B and C, the average contribution margin ratio decreases from 29 to 26% (stated another way, the average variable cost ratio increases from 71% to 74%). Now think about how this change in the sales mix would affect profit and the volume of sales revenue needed to break even. Would you expect the necessary sales volume to increase or decrease?

Let’s use the more compact formula based on the average contribution margin ratio to calculate the new sales volume. When we run the new C-V-P calculation, the sales volume needed to generate $40,000 of target income increases to $220,770, computed as follows:

\[
\frac{\text{Fixed costs + Target income}}{\text{Average contribution margin ratio}} = \frac{$57,400}{0.26} = $220,770 \text{ (rounded up)}
\]

The important thing that we’ve learned from these sales mix calculations is that one sensible profit-maximizing strategy for management would be to maintain as large a contribution margin as possible on all products and then...
to emphasize those products with the largest individual contribution margins. In
the remaining chapters of this text, we discuss procedures that management can
use to control costs and, hence, maintain high contribution margins. The sec-
ond part of this strategy—emphasizing the products with the highest contribu-
tion margin ratios—is a marketing function. Multi-Product, Inc., for example,
should promote Product B more aggressively than Product A. With other fac-
tors being equal, a company should spend more advertising dollars and pay higher
sales commissions on its products with higher contribution margin ratios. In fact,
instead of paying commissions based on total sales, a good strategy would be to
base sales commissions on the total contribution margin generated. This way,
the mix of products that maximizes the sales staff’s commissions will be the mix
that provides the company with the greatest overall profit.

STOP & THINK

Would maximizing the sales of the high-
est contribution margin products still be
the best profit-maximizing strategy if the
company experienced production con-
straints such that producing more of the
highest contribution margin products se-
verely limited the quality or production
speed of other products?

TO SUMMARIZE: Sales mix is the proportion
of the total units sold represented by each of a company’s
products. Changes in sales mix can affect profits because
not all products have the same contribution margin. Other
things being equal, to maximize profits, management should
put greater emphasis on the sale of products with higher
contribution margin ratios.

Cost Structure in Different Types of Organizations

Describe how fixed and variable costs differ in
manufacturing, service, merchandising, and e-
commerce organizations, and illustrate these differ-
ences with the operating leverage concept.

operating leverage The
extent to which fixed costs
are part of a company’s cost
structure; the higher the pro-
portion of fixed costs to vari-
able costs, the faster income
increases or decreases with
changes in sales volume.

Now that we have nearly completed this chapter, we have developed a lot of insight into how
to think about and manage costs in the process of making profit-planning decisions. This chap-
ter is actually a lot about the strategy—the strategy of how a company works with its specific
types of costs and activities to create a profit. Overall, we now basically understand how cost-
volume-profit relationships and contribution margins highlight the different effects that vari-
able and fixed costs have on profitability. As we close this chapter, an important management
issue to be understood has to do with the amount of fixed costs a company has in its cost struc-
ture. The amount of fixed costs an organization commits itself to often has a lot to do with its
type of business, e.g., merchandising, manufacturing, or service. In addition, the arrival of e-
commerce into the economy is having an impact on cost structures of organizations. We’ll talk
more about differences between merchandising, manufacturing, service, and e-commerce com-
panies throughout the remaining chapters in this textbook. For now, we’ll simply illustrate the
differences among these organizations by applying the concept of operating leverage to illus-
trate how a company can manage risk (in terms of profits) by the way it organizes its cost struc-
ture—in other words, how much the company is committed to using fixed costs versus variable
costs to do business.

Imagine that you have worked with two of your college friends to design a new computer
software game that you expect to market to college campuses across the nation. You and your
partners have identified three ways to approach the market. First, you can take on the role of
the merchant by contracting with a software manufacturing company to handle all the pro-
duction of the packaged software. You can then concentrate on the sales and marketing of their
new game. This approach won’t require an expensive production facility, but the reality is that
you will have to pay a high price per unit to the company that handles the production of the
packaged software. In the second approach, you can take on the role of manufacturer by set-
ing up your own production facilities. In this case, because all of your effort will be dedicated
to producing the game, you will need to wholesale the software product to another merchant
company that will then resell the product to the actual customers. Finally, you can “virtually”
sell the game to other college students by contracting with an e-commerce company that will
host your software download site for a significant fixed fee per month. In any case, regardless
of whether you and your partners will wholesale the game to another merchant or retail the
game directly to the college student market, you have determined that you can sell the game for $100. The costs of each of these methods of structuring your business are as follows:

<table>
<thead>
<tr>
<th>Business Structure</th>
<th>Variable Cost per Unit to Manufacture or to Purchase from a Manufacturer</th>
<th>Fixed Cost per Year for the Merchandising, Manufacturing, or E-Commerce Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional retail merchant</td>
<td>$80</td>
<td>$100,000</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>25</td>
<td>375,000</td>
</tr>
<tr>
<td>E-commerce merchant</td>
<td>0</td>
<td>500,000</td>
</tr>
</tbody>
</table>

As you can see, one of the issues that you must decide when selecting your company’s business structure is whether you and your partners want to commit to high fixed costs in order to have low variable costs, or vice versa. This trade-off of fixed versus variable costs is what we mean when we talk about operating leverage. As total fixed costs increase and variable costs per unit decrease, the operating leverage of the organization increases. In the example above, the operating leverage of your company will be very high if you choose to structure your company as an e-commerce merchant. So, the question you should be asking yourself is whether it is good or bad to have high operating leverage? The answer is that it depends on whether the company is operating above or below the break-even point.

The C-V-P graphs in Exhibit 11 show us the impact of operating leverage for these three types of companies. The break-even point (which is the same for all three companies) is at a sales volume of 5,000 games sold each year. At this point, all three companies would generate the same level of profit—nothing. As sales move above or below the break-even point, however, there are significant differences in profit (i.e., the distance between the revenue line and the total costs line) between the company structures. If sales are below the break-even point, then structuring the company as an e-commerce merchant will generate a lot of losses. If the company can sell more than 5,000 games per year, however, then the e-commerce merchant structure will generate the most profit per year. Essentially, operating leverage is a measure of risk. With high levels of operating leverage, the company is at risk of losing a lot of money if sales go down. But business risk often has an upside. In the case of operating leverage, the risk of loss is balanced by the potential for large gains in income as sales go up. So your decision on how to structure your company partly depends on the impact on operating leverage and on how much risk you are willing to accept.

Caution

Don’t confuse the concept of operating leverage with the concept of financial leverage, though there is a lot of similarity in these concepts. While both concepts focus on risk and the sensitivity of profit to changes in sales volume, financial leverage has to do with the use of debt versus equity to provide financing for a company. In general, the financial leverage (and risk) of a company increases as management chooses to use debt, rather than equity, to raise funds for the company. Similarly, the operating leverage (and risk) of a company increases as management chooses to emphasize fixed cost, rather than variable cost, to create or obtain the product for sale to the marketplace.

STOP & THINK

Think about the level of operating leverage you would expect to find in a service organization such as a consulting company or a law firm. Would these kinds of organizations typically have high or low levels of operating leverage?

TO SUMMARIZE: The relationship between fixed and variable costs differs across different types of organizations. Generally, traditional merchandising companies have relatively low levels of fixed costs and high levels of variable costs. On the other hand, manufacturing companies often have higher levels of fixed costs and lower levels of variable costs. The emergence of e-commerce in this economy has resulted in some companies that are even more extremely committed to fixed costs with little or no variable product costs. These cost structure differences are important and are illustrated in the concept of operating leverage. Operating leverage relates to the amount of fixed costs a company has in its cost structure. When sales are expected to increase, high operating leverage results in higher income, and vice versa.
Exhibit 11: “Seeing” Operating Leverages

**Merchandising Structure**

(Low Operating Leverage)

<table>
<thead>
<tr>
<th>Revenue</th>
<th>Total costs</th>
<th>Fixed costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>200,000</td>
<td>600,000</td>
<td>$1,000,000</td>
</tr>
</tbody>
</table>

**Manufacturing Structure**

(Medium Operating Leverage)

<table>
<thead>
<tr>
<th>Sales in Units</th>
<th>Revenue</th>
<th>Total Variable Costs</th>
<th>Contribution Margin</th>
<th>Total Fixed Costs</th>
<th>Operating Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price per unit</td>
<td>$100</td>
<td>3,000</td>
<td>$(240,000)</td>
<td>$60,000</td>
<td>$(100,000)</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>80</td>
<td>5,000</td>
<td>$(400,000)</td>
<td>100,000</td>
<td>(100,000)</td>
</tr>
<tr>
<td>Total fixed costs</td>
<td>100,000</td>
<td>7,000</td>
<td>$(560,000)</td>
<td>140,000</td>
<td>(100,000)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sales in Units</th>
<th>Revenue</th>
<th>Total Variable Costs</th>
<th>Contribution Margin</th>
<th>Total Fixed Costs</th>
<th>Operating Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price per unit</td>
<td>$100</td>
<td>3,000</td>
<td>$(75,000)</td>
<td>$225,000</td>
<td>$(375,000)</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>25</td>
<td>5,000</td>
<td>$(125,000)</td>
<td>375,000</td>
<td>(375,000)</td>
</tr>
<tr>
<td>Total fixed costs</td>
<td>375,000</td>
<td>7,000</td>
<td>$(175,000)</td>
<td>525,000</td>
<td>(375,000)</td>
</tr>
</tbody>
</table>
Understand the key factors involved in cost-volume-profit (C-V-P) analysis and why it is such an important tool in management decision making. C-V-P analysis is a very important management concept. It is a technique you will use as a manager to understand how profits may be expected to vary in relation to changes in key variables: sales price and volume, variable costs, fixed costs, and mix of products. C-V-P analysis is a particularly useful tool for planning and making operating decisions. It can provide data to stimulate increased sales efforts or cost reduction programs; assist in production scheduling or marketing strategy; and help establish company policies, for example, the appropriate product mix or the fixed cost structure of a company. In order to be effective as a manager, you will need a comprehensive understanding and ability to use C-V-P analysis.

Explain and analyze the basic cost behavior patterns—variable, fixed, mixed, and stepped. Understanding cost behavior patterns can assist you in making key operating decisions. The two basic cost behavior patterns are variable and fixed. Costs that vary in total in direct proportion to changes in the level of activity are variable costs. Therefore, per-unit variable costs remain constant. Generally, we assume that there is a linear relationship between variable costs and level of activity within the relevant range; for other ranges, variable costs are curvilinear. Costs that do not change in total with changes in activity level (within the relevant range) are fixed costs; thus, per-unit fixed costs decrease as level of activity increases. Costs that contain both fixed and variable components are mixed costs. Stepped costs increase in total in a stair-step fashion with the level of activity. If the steps are wide, the cost is treated as a fixed cost for analysis purposes; if the steps are narrow, the cost is approximated as a variable cost.

Analyze mixed costs using the scattergraph and high-low methods. Before mixed costs can be analyzed and used in decision making, they must be divided into their fixed and variable components. The scattergraph and high-low methods are commonly used to analyze mixed costs. The scatter-
tergraph method involves visually plotting a straight line (the regression line) through points on a graph of cost data at various activity levels. With the high-low method, the highest and lowest levels of activity and their associated costs are used to calculate the variable cost rate and the total fixed costs.

4 Perform C-V-P analyses, and describe the effects potential changes in C-V-P variables have on company profitability. C-V-P analysis is based on the computation of contribution margin, which is sales revenue less variable costs. Contribution margin is the amount available to cover fixed costs and then provide a profit. C-V-P analysis is commonly used to assess break-even points (where contribution margin equals fixed costs) and to compute target income levels. The basic C-V-P equation is:

\[
\text{Sales revenue} - \text{Variable costs} - \text{Fixed costs} = \text{Profit}
\]

The C-V-P equation will be especially useful to you as a manager in assessing how profits can be expected to change when costs or sales revenue change. Increases in fixed or variable costs result in a larger number of sales being required to break even and reach target income levels. Increases in sales price result in a decreased number of sales being required to break even and reach target income levels.

5 Visualize C-V-P relationships using graphs. C-V-P graphs and profit graphs are effective methods for visualizing the effect of impacts on key variables in the C-V-P equation. In addition, the graphic approach effectively allows managers to simultaneously analyze several different activity levels.

6 Identify the limiting assumptions of C-V-P analysis, and explain the issues of quality and time relative to C-V-P analysis decisions. C-V-P analysis has several limiting assumptions, including the following: (1) cost and revenue behavior patterns are linear and remain constant over the relevant range, (2) all costs can be categorized as either fixed or variable, and (3) the sales mix of products is constant over the relevant range. When making changes in costs, revenues, and volume, remember to consider the impact on the quality of products or services and the speed at which those products and services can be delivered to customers. Changes that result in decreased costs that also decrease product or service quality or that slow down the delivery of products or services may not be good decisions.

7 Analyze mixed costs using the least squares method. The least squares method uses a simple regression analysis to identify the variable and fixed portions of mixed costs. The formula for the least squares method is based on the following equation for a straight line:

\[
Y = a + bX
\]

where \( a \) is total fixed cost and \( b \) is per-unit variable cost. Least square calculations can be easily performed using basic computer software programs or programmed calculators. One output of least square analysis calculations is the \( R^2 \) statistic, which measures the amount of variance in the cost that is explained by changes in the activity level (depicted by \( X \) in the equation above).

8 Explain the effects of sales mix on profitability. Sales mix is the proportion of total units sold represented by each of a company’s products. Because all products do not have the same contribution margin ratios, changes in the sales mix of products sold can significantly affect total profits. When you are working as a manager to maximize profits, it is best to maintain as large a contribution margin as possible on all products and then emphasize those products with the largest individual contribution margin ratios.

9 Describe how fixed and variable costs differ in manufacturing, service, merchandising, and e-commerce organizations, and illustrate these differences with the operating leverage concept. The trade-off between fixed costs and variable costs is often related to whether a company is structured as a manufacturing, merchandising, or service firm. The advent of e-commerce has created the potential for companies to have very high levels of fixed costs and very low levels of variable costs. The impact of the fixed cost/variable cost relationship on profits is captured in the concept of operating leverage. Operating leverage is a measure of the extent to which a company’s costs are fixed rather than variable. Companies with higher fixed costs and lower per-unit variable costs will experience higher operating leverage and, therefore, a tendency for profits to increase at a faster rate when sales increase. Hence, a company with high operating leverage will be more profitable in good times but have higher losses in bad times.

**Key terms & Concepts**

- break-even point, 61
- contribution margin, 58
- contribution margin ratio, 59
- cost behavior, 44
- cost-volume-profit (C-V-P) analysis, 44
Variable and Fixed Costs Analyses
Blade Corporation manufactures two types of inline skates—a basic model and a racing model. During the year 2006, Blade accumulated the following summary information about its two products:

<table>
<thead>
<tr>
<th></th>
<th>Racing Model</th>
<th>Basic Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$130</td>
<td>$65</td>
</tr>
<tr>
<td>Number of units manufactured and sold</td>
<td>14,000</td>
<td>9,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Units</th>
<th>Costs</th>
<th>Units</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1,200</td>
<td>$112,000</td>
<td>800</td>
<td>$39,600</td>
</tr>
<tr>
<td>February</td>
<td>900</td>
<td>91,000</td>
<td>600</td>
<td>30,000</td>
</tr>
<tr>
<td>March</td>
<td>800</td>
<td>76,400</td>
<td>450</td>
<td>25,800</td>
</tr>
<tr>
<td>April</td>
<td>1,400</td>
<td>124,800</td>
<td>900</td>
<td>36,900</td>
</tr>
<tr>
<td>May</td>
<td>950</td>
<td>92,650</td>
<td>1,000</td>
<td>47,000</td>
</tr>
<tr>
<td>June</td>
<td>1,600</td>
<td>148,800</td>
<td>1,200</td>
<td>57,300</td>
</tr>
<tr>
<td>July</td>
<td>1,400</td>
<td>134,600</td>
<td>1,300</td>
<td>60,600</td>
</tr>
<tr>
<td>August</td>
<td>1,700</td>
<td>154,500</td>
<td>650</td>
<td>32,195</td>
</tr>
<tr>
<td>September</td>
<td>1,550</td>
<td>140,200</td>
<td>850</td>
<td>44,250</td>
</tr>
<tr>
<td>October</td>
<td>1,500</td>
<td>134,500</td>
<td>500</td>
<td>27,000</td>
</tr>
<tr>
<td>November</td>
<td>600</td>
<td>62,500</td>
<td>350</td>
<td>20,700</td>
</tr>
<tr>
<td>December</td>
<td>400</td>
<td>44,000</td>
<td>400</td>
<td>22,000</td>
</tr>
<tr>
<td>Totals</td>
<td>14,000</td>
<td>$1,313,950</td>
<td>9,000</td>
<td>$443,345</td>
</tr>
</tbody>
</table>

Required:
1. Use the high-low method to estimate the variable and fixed production costs of both the racing model and the basic model skates.
2. All selling costs are fixed, and they total $200,000 for the racing model and $80,000 for the basic model. Prepare a contribution margin income statement for each model at sales of 10,000 racing and 10,000 basic skates.

Solution
1. Variable and Fixed Costs
The high-low method involves finding the variable and fixed costs at the high and low levels of production. In this case:
Once the differences are known, the change in units (production) is divided into the change in costs to determine the variable cost rate.

\[
\text{Variable cost rate} = \frac{\text{Change in costs}}{\text{Change in units}}
\]

Racing model: \( \frac{\$110,500}{1,300} = \$85 \)

Basic model: \( \frac{\$39,900}{950} = \$42 \)

Because total variable costs equal unit variable cost times number of units produced, and total costs equal total variable costs plus total fixed costs, fixed costs can now be calculated.

\[
\text{Total costs} = (\text{Variable cost per unit} \times \text{Number of units}) + \text{Total fixed costs}
\]

Thus, we have the following:

<table>
<thead>
<tr>
<th>Racing Model</th>
<th>Basic Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable cost rate</td>
<td>$85</td>
</tr>
<tr>
<td>Total fixed costs</td>
<td>$10,000</td>
</tr>
</tbody>
</table>

2. Contribution Margin Income Statements

Blade Corporation
Contribution Margin Income Statements
For the Year Ended December 31, 2006

<table>
<thead>
<tr>
<th>Racing Model</th>
<th>Basic Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue (at 10,000 units)</td>
<td>$1,300,000</td>
</tr>
<tr>
<td>Less variable cost of goods sold*</td>
<td>( (850,000) )</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$450,000</td>
</tr>
<tr>
<td>Less fixed cost of goods sold</td>
<td>( (10,000) )</td>
</tr>
<tr>
<td>Less fixed selling costs</td>
<td>( (200,000) )</td>
</tr>
<tr>
<td>Income</td>
<td>$240,000</td>
</tr>
</tbody>
</table>

*\$85 per unit for racing model; \$42 per unit for basic model.
Assessing the Effects of Changes in Costs, Prices, and Volume on Profitability

K&D Company plans the following for the coming year:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume</td>
<td>100,000 units</td>
</tr>
<tr>
<td>Sales price</td>
<td>$2.50 per unit</td>
</tr>
<tr>
<td>Variable costs</td>
<td>$1.30 per unit</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$60,000</td>
</tr>
</tbody>
</table>

**Required:**
1. Determine K&D’s target income.
2. Compute what the target income would be under each of the following independent assumptions:
   a. The sales volume increases 20%.
   b. The sales price decreases 20%.
   c. Variable costs increase 20%.
   d. Fixed costs decrease 20%.

**Solution**

1. **Target Income**

   Basic C-V-P equation: Sales revenue − Variable costs − Fixed costs = Target income

   \[
   \text{Target income} = (\text{Units sold} \times \text{Sales price}) - (\text{Units sold} \times \text{Variable unit cost}) - \text{Fixed costs}
   \]

   \[
   \begin{align*}
   (100,000 \times 2.50) - (100,000 \times 1.30) - 60,000 &= X \\
   250,000 - 130,000 - 60,000 &= X \\
   60,000 &= X
   \end{align*}
   \]

   This answer can be validated by dividing fixed costs by the per-unit contribution margin to find the break-even point and then multiplying the excess units to be sold above the break-even point by the per-unit contribution margin of $1.20 ($2.50 - $1.30).

   \[
   \frac{\text{Fixed costs}}{\text{Per-unit contribution margin}} = \text{Break-even point}
   \]

   \[
   \begin{align*}
   \frac{60,000}{1.20} &= 50,000 \text{ units}
   \end{align*}
   \]

<table>
<thead>
<tr>
<th>Units sold</th>
<th>100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less break-even point (units)</td>
<td>50,000</td>
</tr>
<tr>
<td>Excess</td>
<td>50,000</td>
</tr>
<tr>
<td>Per-unit contribution margin</td>
<td>$1.20</td>
</tr>
<tr>
<td>Target income</td>
<td>$60,000</td>
</tr>
</tbody>
</table>

2a. The sales volume increases 20%.

\[
\begin{align*}
(100,000 \times 1.2 \times 2.50) - (100,000 \times 1.2 \times 1.30) - 60,000 &= X \\
300,000 - 156,000 - 60,000 &= X \\
84,000 &= X
\end{align*}
\]

In this case, the contribution margin does not change. Therefore, the answer can be validated by multiplying the units to be sold in excess of the break-even point by the per-unit contribution margin of $1.20 to find the target income.

<table>
<thead>
<tr>
<th>Units sold</th>
<th>120,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less break-even point (units)</td>
<td>50,000</td>
</tr>
<tr>
<td>Excess</td>
<td>70,000</td>
</tr>
<tr>
<td>Per-unit contribution margin</td>
<td>$1.20</td>
</tr>
<tr>
<td>Target income</td>
<td>$84,000</td>
</tr>
</tbody>
</table>
2b. The sales price decreases 20%.

\[
\begin{align*}
(100,000 \times $2.50 \times 0.8) - (100,000 \times $1.30) - $60,000 &= X \\
$200,000 - $130,000 - $60,000 &= X \\
$10,000 &= X
\end{align*}
\]

In this case, the contribution margin changes. Therefore, the answer can be validated by dividing fixed costs by the new per-unit contribution margin of $0.70 ($2.00 - $1.30) to find the new break-even point and then multiplying the units to be sold in excess of the break-even point by the new per-unit contribution margin.

\[
\frac{$60,000 \text{ (fixed costs)}}{$0.70 \text{ (new per-unit contribution margin)}} = 85,715 \text{ units (new break-even point, rounded up)}
\]

<table>
<thead>
<tr>
<th>Units sold</th>
<th>100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less break-even point (units)</td>
<td>85,715</td>
</tr>
<tr>
<td>Excess</td>
<td>14,285</td>
</tr>
<tr>
<td>Per-unit contribution margin</td>
<td>$0.70</td>
</tr>
<tr>
<td>Target income</td>
<td>$10,000 (rounded)</td>
</tr>
</tbody>
</table>

2c. Variable costs increase 20%.

\[
\begin{align*}
(100,000 \times $2.50) - (100,000 \times $1.30 \times 1.2) - $60,000 &= X \\
$250,000 - $156,000 - $60,000 &= X \\
$34,000 &= X
\end{align*}
\]

In this case, the contribution margin changes. Therefore, the answer can be validated by dividing fixed costs by the new per-unit contribution margin of $0.94 ($2.50 - $1.56) to find the new break-even point and then multiplying the units to be sold in excess of the break-even point by the new per-unit contribution margin.

\[
\frac{$60,000 \text{ (fixed costs)}}{$0.94 \text{ (new per-unit contribution margin)}} = 63,830 \text{ units (new break-even point, rounded up)}
\]

<table>
<thead>
<tr>
<th>Units sold</th>
<th>100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less break-even point (units)</td>
<td>63,830</td>
</tr>
<tr>
<td>Excess</td>
<td>36,170</td>
</tr>
<tr>
<td>Per-unit contribution margin</td>
<td>$0.94</td>
</tr>
<tr>
<td>Target income</td>
<td>$34,000 (rounded)</td>
</tr>
</tbody>
</table>

2d. Fixed costs decrease 20%.

\[
\begin{align*}
(100,000 \times $2.50) - (100,000 \times $1.30) - ($60,000 \times 0.8) &= X \\
$250,000 - $130,000 - $48,000 &= X \\
$72,000 &= X
\end{align*}
\]

In this case, the contribution margin does not change, but fixed costs, and hence the break-even point, do. Therefore, the answer can be validated by dividing the per-unit contribution margin of $1.20 into the new fixed costs to find the break-even point and then multiplying the units to be sold in excess of the break-even point by the per-unit contribution margin.

\[
\frac{$48,000 \text{ (new fixed costs)}}{$1.20 \text{ (per-unit contribution margin)}} = 40,000 \text{ units (new break-even point)}
\]

<table>
<thead>
<tr>
<th>Units sold</th>
<th>100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less break-even point (units)</td>
<td>40,000</td>
</tr>
<tr>
<td>Excess</td>
<td>60,000</td>
</tr>
<tr>
<td>Per-unit contribution margin</td>
<td>$1.20</td>
</tr>
<tr>
<td>Target income</td>
<td>$72,000</td>
</tr>
</tbody>
</table>
**Discussion Questions**

1. Explain how understanding cost behavior patterns can assist management.
2. Discuss how level of activity is measured in manufacturing, merchandising, and service firms.
3. What is meant by the linearity assumption, and why is it made? Relate this assumption to the relevant-range concept.
4. What factors in the current economy seem to have caused the shift from variable to fixed cost patterns?
5. How should stepped costs be treated in the planning process?
6. Why must all mixed costs be segregated into their fixed and variable components?
7. What is the major weakness of the scattergraph, or visual-fit, method of analyzing mixed costs?
8. What is the major limitation of the high-low method of analyzing mixed costs?
9. What is the basic C-V-P equation? What is a more detailed version of this equation?
10. What is the contribution margin, and why is it important for managers to know the contribution margins of their products?
11. How much will profits increase for every unit sold over the break-even point?
12. What is the major advantage of using C-V-P graphs?
13. When other factors are constant, what is the effect on profits of an increase in fixed costs? Of a decrease in variable costs?
14. What are the limiting assumptions of C-V-P analysis?
15. How do the issues of quality and time relate to C-V-P analysis decisions?
16. How does the method of least squares differ from the scattergraph method?
17. What effect is a change in the sales mix likely to have on a firm’s overall contribution margin ratio?

**Practice Exercises**

**Practice 2-1**  
**Measuring Level of Activity**  
Which one of the following is not an activity base used by a company?  

- a. Number of defects per hour in an assembly plant  
- b. Number of units sold for a merchandising firm  
- c. Number of units produced for a manufacturing firm  
- d. Number of client hours billed for an accounting firm  
- e. Number of hours a retail store is open

**Practice 2-2**  
**Variable Costs**  
Which one of the following would not be a variable cost for a construction company?  

- a. Cost of trusses used to construct a roof for a house  
- b. Cost of windows to be installed in a house  
- c. Salary paid to overall project supervisor  
- d. Cost of drywall to be installed in house  
- e. Cost of exterior house paint

**Practice 2-3**  
**Linearity of Variable Costs within the Relevant Range**  
The company has assembled the following data about its variable costs:

(continued)
<table>
<thead>
<tr>
<th>Level of Activity</th>
<th>Total Variable Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 units</td>
<td>$ 25,000</td>
</tr>
<tr>
<td>2,000 units</td>
<td>46,000</td>
</tr>
<tr>
<td>3,000 units</td>
<td>69,000</td>
</tr>
<tr>
<td>4,000 units</td>
<td>92,000</td>
</tr>
<tr>
<td>5,000 units</td>
<td>100,000</td>
</tr>
</tbody>
</table>

The company is currently producing 3,300 units. According to these data, what is the relevant range over which the company can assume that the variable cost per unit is constant?

**Practice 2-4**

**Fixed Costs**

If the level of activity increases during the month, does the fixed cost per unit increase, decrease, or remain constant?

**Practice 2-5**

**Break-Even Computation**

The company reports the following items.

- Direct materials per unit: $2.50
- Direct labor per unit: $4.60
- Variable overhead per unit: $2.10
- Monthly rent: $1,900.00
- Monthly depreciation: $650.00
- Other monthly fixed costs: $2,680.00
- Sales price per unit: $14.25

Using the above information, compute the company’s monthly break-even point (in units).

**Practice 2-6**

**Stepped Fixed Costs**

The company pays $3,000 per month to each of its four production supervisors. Each supervisor can handle the workload associated with up to 2,400 units of production per month; the current level of production is 9,000 units. If the company increases its level of production to 12,800 units per month, how much will the company pay, in total, for the salaries of the necessary production supervisors?

**Practice 2-7**

**Mixed Costs**

The company’s president receives a $100,000 base salary and a bonus of 0.5% of sales for the year. How much will the president earn at a sales level of $2,750,000 for the year?

**Practice 2-8**

**Scattergraph Method**

Which one of the following statements is incorrect?

a. The scattergraph method can be somewhat subjective depending on where one visually places the regression line.

b. The scattergraph method is the most accurate method of analyzing mixed costs.

c. When graphing mixed costs, the dollars go on the vertical axis, and the level of activity goes on the horizontal axis.

d. Regression lines attempt to minimize the average distance between all the data points and the fitted regression line.

e. The slope of the regression line is equal to the variable cost per unit of activity.

**Practice 2-9**

**Using the High-Low Method to Estimate the Variable Cost Rate**

The company reports the following utility costs for different levels of activity during the first half of the year:
Using the high-low method, estimate the variable cost rate.

**Practice 2-10**

**Using the High-Low Method to Estimate Fixed Costs**

Refer to the data in Practice 2-9. Using the high-low method, estimate the fixed costs per month based on the variable cost rate (computed in Practice 2-9).

**Practice 2-11**

**Contribution Margin Income Statement**

The company sells desks for $550 each. The variable cost per desk is $385. The company’s monthly fixed costs are $72,000. Prepare a contribution margin income statement for a month in which the company sells 500 desks.

**Practice 2-12**

**Contribution Margin Ratio and Variable Cost Ratio**

Refer to the data in Practice 2-11. Compute the contribution margin ratio and the variable cost ratio.

**Practice 2-13**

**The C-V-P Equation**

The company sells lawnmowers for $895 each. The variable cost per lawnmower is $520. The company’s monthly fixed costs are $84,500. Using the C-V-P equation, compute the amount of profit the company will have for a month in which the company sells 375 lawnmowers.

**Practice 2-14**

**Break-Even Units**

The company sells shovels for $27.75 each. The variable cost per shovel is $14.25. The company’s monthly fixed costs are $2,538. Compute the number of shovels the company must sell to break even.

**Practice 2-15**

**Determining Sales Volume to Achieve Target Income**

Refer to the data in Practice 2-14. How many shovels must the company sell to achieve a profit of $10,000?

**Practice 2-16**

**Determining Sales Volume to Achieve Target Return on Sales**

The company sells pianos for $7,000 each. The variable cost per piano is $5,500. The company has fixed costs per month of $45,000. Compute the number of units the company must sell in a month to achieve a 15% return on sales.

**Practice 2-17**

**Break-Even Sales Revenue**

The company has a variable cost ratio of 65% and monthly fixed costs of $91,000. What is the company’s break-even point in terms of sales dollars?

**Practice 2-18**

**C-V-P Analysis with Simultaneous Changes in Several Variables**

The company currently sells 50,000 feet of cable each month for $3.50 per foot. The variable cost of the cable is $1.10 per foot, and monthly fixed costs are $75,000. The company is considering whether to raise the sales price for the cable to $4.00 per foot. The marketing team has determined that such an increase in sales price will discourage some customers from purchasing

(continued)
the cable, so the company will be able to sell only 40,000 feet of cable per month. Calculate the profit for the company under both of the following scenarios:

1. 50,000 feet of cable at $3.50 per foot.
2. 40,000 feet of cable at $4.00 per foot.

In terms of profit maximization, should the company raise the price per foot?

**Practice 2-19**

**C-V-P Analysis with Simultaneous Changes in Several Variables**

Refer to the data in Practice 2-18. The company is considering whether to change its production process to reduce the variable cost per foot to $0.90 by raising fixed costs per month to $83,000. This change will have no impact on selling price ($3.50) or sales volume (50,000 feet). In terms of profit maximization, should the company change its production process?

**Practice 2-20**

**Interpreting a C-V-P Graph**

Look at the given C-V-P graph. Which one of the following sets of labels correctly labels items A, B, and C in the C-V-P graph?

a. A: Total cost line; B: Fixed costs; C: Break-even point
b. A: Revenue line; B: Variable costs; C: Fixed costs
c. A: Fixed cost line; B: Break-even point; C: Fixed costs
d. A: Revenue line; B: Break-even point; C: Fixed costs
e. A: Total cost line; B: Break-even point; C: Fixed costs
Look at the given profit graph. Which one of the following sets of labels correctly labels items A, B, and C in the profit graph?

a. A: Area of loss; B: Break-even point; C: Area of profit  
b. A: Area of loss; B: Area of profit; C: Break-even point  
c. A: Break-even point; B: Area of loss; C: Area of profit  
d. A: Area of profit; B: Break-even point; C: Area of loss  
e. A: Area of profit; B: Area of loss; C: Break-even point  

Limiting Assumptions of C-V-P Analysis
Which one of the following is not an assumption of C-V-P analysis?

a. Fixed costs are always greater than variable costs.  
b. All costs can be divided into fixed and variable categories.  
c. C-V-P analysis is valid only for a relevant range.  
d. The mix of a company’s products does not change over the relevant range.  

Least-Squares Method
The company reports the following costs at different levels of activity for the first half of the year.

(continued)
Using Excel (or another program with statistical capabilities), estimate the company’s fixed costs and variable costs per machine hour using the least-squares method.

**Sales Mix**
The company has fixed costs of $21,500 and the following sales mix.

<table>
<thead>
<tr>
<th></th>
<th>Product A</th>
<th>Product B</th>
<th>Product C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$35,000</td>
<td>$70,000</td>
<td>$45,000</td>
</tr>
<tr>
<td>Less variable costs</td>
<td>$20,000</td>
<td>$50,000</td>
<td>$36,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$15,000</td>
<td>$20,000</td>
<td>$9,000</td>
</tr>
</tbody>
</table>

Using this same sales mix, calculate the required sales (in dollars) to earn a target income of $25,000.

**Cost Structure**
If you experience much higher sales than expected this year, which kind of operating leverage would you like to have in your company for profit maximization?

a. High operating leverage  
b. Low operating leverage  
c. Medium operating leverage  
d. Operating leverage does not affect profitability.

### Exercises

**Exercise 2-1**

**Variable and Fixed Costs Over the Relevant Range**
Cook Corporation manufactures plastic garbage cans. In a typical year, the firm produces between 40,000 and 50,000 cans. At this level of production, fixed costs are $10,000 and variable costs are $2 per can.

1. Graph the cost of producing cans, with cost as the vertical axis and production output as the horizontal axis.
2. Indicate on the graph the relevant range of the $10,000 in fixed costs, and explain the significance of the relevant range.
3. What would total production costs be if 46,000 cans were produced?

**Exercise 2-2**

**Fixed Costs—The Relevant Range**
Sabrina Company manufactures large leisure boats. The following schedule shows total fixed costs at various levels of boat production:
### Exercise 2-3

**Scattergraph Method of Analyzing Mixed Costs**

Wyoming Company makes windmills. The company has the following total costs at the given levels of windmill production:

<table>
<thead>
<tr>
<th>Units Produced</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>$16,000</td>
</tr>
<tr>
<td>30</td>
<td>22,000</td>
</tr>
<tr>
<td>40</td>
<td>20,000</td>
</tr>
<tr>
<td>50</td>
<td>28,000</td>
</tr>
</tbody>
</table>

1. Use the scattergraph method to estimate the fixed and variable elements of Wyoming’s total costs.
2. Compute the total cost of making 44 windmills, assuming that total fixed costs are $10,000 and that the variable cost rate computed in part (1) does not change.

### Exercise 2-4

**Scattergraph Method of Analyzing Mixed Costs**

Given the following mixed costs at various levels of production, complete the requirements.

<table>
<thead>
<tr>
<th>Month</th>
<th>Units Produced</th>
<th>Mixed Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>2</td>
<td>$24.00</td>
</tr>
<tr>
<td>February</td>
<td>3</td>
<td>28.00</td>
</tr>
<tr>
<td>March</td>
<td>1</td>
<td>21.00</td>
</tr>
<tr>
<td>April</td>
<td>5</td>
<td>30.00</td>
</tr>
<tr>
<td>May</td>
<td>4</td>
<td>25.00</td>
</tr>
</tbody>
</table>

1. Plot the data on a scattergraph, and visually fit a straight line through the points.
2. Based on your graph, estimate the monthly fixed cost and the variable cost per unit produced.
3. Compute the total cost of producing eight units in a month, assuming that the same relevant range applies.
4. **Interpretive Question**: Why is it so important to be able to determine the components of a mixed cost?

### Exercise 2-5

**Scattergraph Method and High-Low Method of Analyzing Mixed Costs**

Sailmaster makes boats and has the following costs and production levels for the last eight quarters:

(continued)
Quarter | Boats Produced | Total Costs
--- | --- | ---
1 | 108 | $101,250
2 | 128 | 168,750
3 | 185 | 189,000
4 | 245 | 200,145
5 | 311 | 276,200
6 | 352 | 255,250
7 | 389 | 305,700
8 | 428 | 376,500

1. Plot the data on a scattergraph, and visually fit a straight line through the points.
2. Based on your graph, estimate the quarterly fixed cost and the variable cost per unit produced.
3. Use the high-low method to compute the variable and fixed elements of Sailmaster’s total costs, and then draw a straight line through the high and low data points on the scattergraph.
4. Compute the total cost of making 500 boats using first the scattergraph results and then using the high-low method results.
5. Comment on the differences between these two methods. Which method appears to most accurately represent the actual variable and fixed costs for Sailmaster?

**Exercise 2-6**

**High-Low Method of Analyzing Mixed Costs**
The *Stamford Times* has determined that the annual printing of 750,000 newspapers costs 11 cents per copy. If production were to be increased to 1,000,000 copies per year, the per-unit cost would drop to 9 cents per copy.

1. Using the high-low method, determine the total fixed and variable costs of printing 750,000 newspapers.
2. Using the fixed and variable costs you determined in part (1), what would be the total cost of producing 900,000 copies?

**Exercise 2-7**

**Contribution Margin Calculations**
Jerry Stone owns and operates a small beach shop in a mall on Sanibel Island, Florida. For the last six months, Jerry has had a display of sunglasses in the front window. Largely because of the display, Jerry has sold 100 pairs of sunglasses per month at an average cost of $26 and selling price of $50. The sales volume has doubled since the display was put in the window. One-fourth of Jerry’s storage space is occupied by 190 ice coolers. The coolers have not been selling as well as Jerry hoped, but he is convinced that a front window display of coolers would increase sales by 50%. The coolers cost Jerry a total of $2,280 and have been selling at a rate of 100 per month at $28 each.

1. Assuming that cost of goods sold is the only variable cost, compute the contribution margin per unit for sunglasses and ice coolers.
2. Compute the total contribution margins for both sunglasses and ice coolers assuming window displays and no window displays for both items.
3. What are the economic costs associated with keeping the sunglass display in the store window?
4. What are the economic costs associated with replacing the sunglass display with an ice cooler display?

**Exercise 2-8**

**Contribution Margin Income Statement**
The following data apply to Gordon Company for 2006:

- Sales revenue (10 units at $25 each) | $250
- Variable selling expenses | 45
- Variable administrative expenses | 25
- Fixed selling expenses | 30

**Spreadsheet**
Fixed administrative expenses ........................................ $ 15
Direct labor ................................................................. 50
Direct materials ......................................................... 60
Fixed manufacturing overhead ........................................ 5
Variable manufacturing overhead ..................................... 3

1. Prepare a contribution margin income statement. Assume there were no beginning or ending inventories in 2006.
2. How much would Gordon Company have lost if only five units had been sold during 2006?

**Exercise 2-9**

**Analysis of a Contribution Margin Income Statement**

Fill in the missing amounts for the following three cases:

<table>
<thead>
<tr>
<th>Case</th>
<th>Case II</th>
<th>Case III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue .................................................. $50,000 $60,000 $ (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable cost of goods sold:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials .............................................. $12,500 $ (4) $20,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct labor .................................................. (1) 15,000 20,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable selling and administrative costs .................. 3,500 (5) 10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution margin ........................................... $ (2) $20,000 $ (8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross margin .................................................... 20,000 30,000 40,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed selling and administrative costs* ...................... 5,500 10,000 (9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent expense on office building ................................ (3) 5,000 2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation expense on delivery trucks ..................... 5,000 2,500 8,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit .............................................................. $ 4,000 $ (6) $ 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Except rent and depreciation.

**Exercise 2-10**

**Analysis of the Contribution Margin**

Dr. Hughes and Dr. Hawkins, owners of the Spanish Fork Care Clinic, have $150,000 of fixed costs per year. They receive 20,000 patient visits in a year, charging each patient an average of $20 per visit; variable costs average $2 per visit (needles, medicines, and so on).

1. What is the contribution margin per patient visit?
2. What is the total contribution margin per year?
3. What is the total pretax profit for a year?
4. Drs. Hughes and Hawkins can bring in another doctor at a salary of $100,000 per year. If this new doctor can handle 5,000 patient visits per year, should the new doctor be hired? (Assume no additional fixed costs will be incurred.)

**Exercise 2-11**

**Contribution Margin Analysis**

Compute the missing amounts for the following independent cases. (Assume zero beginning and ending inventories.)

<table>
<thead>
<tr>
<th>Case</th>
<th>Case II</th>
<th>Case III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume (units) ......................................... 24,000 (5) 16,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales price per unit .......................................... $10 $8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable costs (total) ......................................... (1) $200,000 $100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution margin (total) .................................. (2) (6) $60,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution margin per unit (rounded) ...................... $4 $3 (10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed costs (total) ............................................ (3) (7) (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed costs per unit (rounded) ............................... (4) $2 (12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit ........................................................... $20,000 (8) $40,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Exercise 2-12

Break-Even Point and Target Income

Detienne Company manufactures and sells one product for $20 per unit. The unit contribution margin is 40% of the sales price, and fixed costs total $80,000.

1. Using the equation approach, compute:
   a. The break-even point in sales dollars and units.
   b. The sales volume (in units) needed to generate a profit of $40,000.
   c. The break-even point (in units) if variable costs increase to 80% of the sales price and fixed costs increase to $100,000.

2. See if you can recompute the solutions to 1(a), 1(b), and 1(c) in one equation step using either the contribution margin ratio or the contribution margin dollars per unit.

Exercise 2-13

Break-Even Point and Target Income

Steven Newman, Inc., estimates 2006 costs to be as follows:

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Per Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$5</td>
</tr>
<tr>
<td>Direct labor</td>
<td>$8</td>
</tr>
<tr>
<td>Variable manufacturing overhead</td>
<td>$3</td>
</tr>
<tr>
<td>Variable selling and administrative expenses</td>
<td>$2</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td>$80,000</td>
</tr>
</tbody>
</table>

1. Assuming that Newman will sell 55,000 units, what sales price per unit will be needed to achieve a $75,000 profit?
2. Assuming that Newman decides to sell its product for $23 per unit, determine the break-even sales volume in dollars and units.
3. Assuming that Newman decides to sell its product for $23 per unit, determine the number of units it must sell to generate a $100,000 profit.

Exercise 2-14

Break-Even Point—Graphic Analysis

Using the graph below, answer the following questions:

1. Copy the graph and identify (label) fixed costs, variable costs, total revenues, the total cost line, and the break-even point.
2. Determine the break-even point in both sales dollars and volume.
3. Suppose that as a manager you forecast sales volume at 7,000 units. At this level of sales, what would be your total fixed costs, approximate variable costs, and profit (or loss)?
4. At a sales volume of 3,000 units, what would be the level of fixed costs, variable costs, and approximate profit (or loss)?
Exercise 2-15

The Profit Graph
Using the graph below, answer the following questions:

1. What is the break-even point in sales volume (in units)?
2. Approximately what volume of sales (in units) must this company have to generate an income of $300?
3. How much are the fixed costs?

Exercise 2-16

Graphing Revenues and Costs
Montana Company manufactures chocolate candy. Its manufacturing costs are as follows:

- Annual fixed costs: $15,000
- Variable costs: $2 per box of candy

1. Plot variable costs, fixed costs, and total costs on a graph for activity levels of 0 to 30,000 boxes of candy.
2. Plot a revenue line on the graph, assuming that Montana sells the chocolates for $5 a box.

Exercise 2-17

C-V-P Analysis
The Last Outpost is a tourist stop in a western resort community. Kerry Yost, the owner of the shop, sells hand-woven blankets for an average price of $30 per blanket. Kerry buys the blankets from weavers at an average cost of $21. In addition, he has selling expenses of $3 per blanket. Kerry rents the building for $300 per month and pays one employee a fixed salary of $500 per month.

1. Determine the number of blankets Kerry must sell to break even.
2. Determine the number of blankets Kerry must sell to generate a profit of $1,000 per month.
3. Assume that Kerry can produce and sell his own blankets at a total variable cost of $16 per blanket, but that he would need to hire one additional employee at a monthly salary of $600.
   a. Determine the number of blankets Kerry must sell to break even.
   b. Determine the number of blankets Kerry must sell to generate a profit of $1,000 per month.

Exercise 2-18

C-V-P Analysis—Changes in Variables
Tracy, Inc., estimates that next year’s results will be:

- Sales revenue (75,000 units): $900,000
- Less variable costs: $(375,000)
- Less fixed costs: $(300,000)
- Profit: $225,000

Recompute profit, assuming each of the following independent conditions:

1. A 9% increase in the contribution margin.
2. An 8% increase in the sales volume.
3. A 4% decrease in the sales volume.

(continued)
4. A 6% increase in variable costs per unit.
5. A 5% decrease in fixed costs.
6. A 5% increase in fixed costs.
7. A 12% increase in the sales volume and a 6% increase in fixed costs.

**Exercise 2-19**

**C-V-P Analysis—Changes in Variables**

Modern Fun Corporation sells electronic games. Its three salespersons are currently being paid fixed salaries of $30,000 each; however, the sales manager has suggested that it might be more profitable to pay the salespersons on a straight commission basis. He has suggested a commission of 15% of sales. Current data for Modern Fun Corporation are as follows:

<table>
<thead>
<tr>
<th>Sales volume</th>
<th>15,000 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales price</td>
<td>$40 per unit</td>
</tr>
<tr>
<td>Variable costs</td>
<td>$29 per unit</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$140,000</td>
</tr>
</tbody>
</table>

1. Assuming that Modern Fun Corporation has a target income of $50,000 for next year, which alternative is more attractive?
2. The sales manager believes that by switching to a commission basis, sales will increase 20%. If that is the case, which alternative is more attractive? (Assume that sales are expected to remain at 15,000 units under the fixed salary alternative.)

**Exercise 2-20**

**Mixed Costs—Least Squares Analysis**

Given the following mixed costs at various levels of production, complete the requirements.

<table>
<thead>
<tr>
<th>Month</th>
<th>Units Produced</th>
<th>Mixed Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>8</td>
<td>$30</td>
</tr>
<tr>
<td>February</td>
<td>12</td>
<td>36</td>
</tr>
<tr>
<td>March</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>April</td>
<td>20</td>
<td>44</td>
</tr>
<tr>
<td>May</td>
<td>8</td>
<td>26</td>
</tr>
</tbody>
</table>

1. Using the least squares method (either the equation approach or a software package), calculate the monthly fixed and variable components of the mixed costs.
2. Using the estimates from part (1), compute the total cost of producing 16 units in a month.
3. Describe a major advantage and a major disadvantage of the least squares method.

**Exercise 2-21**

**Sales Mix**

Klein Brothers sells products X and Y. Because of the nature of the products, Klein sells two units of product X for each unit of product Y. Relevant information about the products is as follows:

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales price per unit</td>
<td>$10</td>
<td>$30</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>8</td>
<td>18</td>
</tr>
</tbody>
</table>

1. Assuming that Klein’s fixed costs total $140,000, compute Klein’s break-even point in sales dollars.
2. Assuming that Klein sells one unit of product X for each unit of product Y, and fixed costs remain at $140,000, compute Klein’s break-even point in sales dollars.

3. Explain any differences in your answers to parts (1) and (2).

Exercise 2-22

**C-V-P Analysis**

Mower Manufacturing’s income statement for January 2006 is given below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (25,000 units × $25)</td>
<td>$625,000</td>
</tr>
<tr>
<td>Less variable costs</td>
<td>468,750</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$156,250</td>
</tr>
<tr>
<td>Less fixed costs</td>
<td>125,000</td>
</tr>
<tr>
<td>Profit</td>
<td>$ 31,250</td>
</tr>
</tbody>
</table>

1. Calculate the company’s break-even point in sales dollars and units.
2. The company is contemplating the purchase of new production equipment that would reduce variable costs per unit to $16.25. However, fixed costs would increase to $175,000 per month. Assuming sales of 26,000 units next month, prepare an income statement for both the current and the proposed production methods. Calculate the break-even point (in dollars and units) for the new production method.
3. Comment on the difference (if any) in the break-even point for the new production method. What explains the difference in income at sales of 26,000 units between the two production methods?

Exercise 2-23

**Operating Leverage**

Ludlam Company and Kassandra Company both make school desks. They have the same production capacity, but Ludlam is more automated than Kassandra. At an output of 2,500 desks per year, the two companies have the following costs:

<table>
<thead>
<tr>
<th></th>
<th>Ludlam</th>
<th>Kassandra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed costs</td>
<td>$137,500</td>
<td>$ 37,500</td>
</tr>
<tr>
<td>Variable costs at $20 per desk</td>
<td>50,000</td>
<td></td>
</tr>
<tr>
<td>Variable costs at $60 per desk</td>
<td></td>
<td>150,000</td>
</tr>
<tr>
<td>Total cost</td>
<td>$187,500</td>
<td>$187,500</td>
</tr>
<tr>
<td>Unit cost (2,500 desks)</td>
<td>$ 75</td>
<td>$ 75</td>
</tr>
</tbody>
</table>

Assuming that both companies sell desks for $100 each and that there are no other costs or expenses for the two firms, complete the following:

1. Which company will lose the least money if production and sales fall to 1,000 desks per year?
2. What would be each company’s profit or loss at production and sales levels of 1,000 desks per year?
3. What would be each company’s profit or loss at production and sales levels of 4,000 desks per year?

**Problems**

**Problem 2-1**

**Graphing Revenues and Costs**

Cloward and Hawkins, CPAs, took in $350,000 of gross revenues this year. Besides themselves, they have two professional staff (one manager and one senior) and a full-time secretary. Fixed operating expenses for the office were $50,000 last year. This year the volume of activity is up.
5%, and fixed operating expenses are still $50,000. Total variable operating costs, except for bonuses, average $5 per billable hour. The billable time for all professionals is as follows:

- **Partners:** 3,000 hours at $75/hour
- **Manager:** 1,800 hours at $40/hour
- **Senior:** 2,120 hours at $25/hour

Salaries for the professional staff are $40,000 and $28,000, respectively; the secretary is paid $18,000. The partners each draw salaries of $60,000; plus they share a 5% bonus based on gross revenues. The manager is given a 2% bonus, also based on gross revenues.

**Required:**
1. Plot the data on a graph clearly showing (a) fixed costs, (b) variable costs, (c) total costs, and (d) total revenues.
2. How much profit did the CPA firm make this year (after partners’ salaries)?

### Problem 2-2

**High-Low and Scattergraph Methods of Analysis**

Woodfield Company makes bed linens. During the first six months of 2006, Woodfield had the following production costs:

<table>
<thead>
<tr>
<th>Month</th>
<th>Units Produced</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>10,000</td>
<td>$ 68,000</td>
</tr>
<tr>
<td>February</td>
<td>20,000</td>
<td>100,000</td>
</tr>
<tr>
<td>March</td>
<td>15,000</td>
<td>90,000</td>
</tr>
<tr>
<td>April</td>
<td>8,000</td>
<td>52,000</td>
</tr>
<tr>
<td>May</td>
<td>17,000</td>
<td>94,000</td>
</tr>
<tr>
<td>June</td>
<td>12,000</td>
<td>74,000</td>
</tr>
</tbody>
</table>

**Required:**
1. Use the high-low method to compute the monthly fixed cost and the variable cost rate.
2. Plot the costs on a scattergraph.
3. **Interpretive Question:** Based on your scattergraph, do you think the fixed costs and the variable cost rate determined in part (1) are accurate? Why?

### Problem 2-3

**Contribution Margin Income Statement**

Early in 2007, Lili H Company (a retailing firm) sent the following income statement to its stockholders:

```
Lili H Company
Income Statement
For the Year Ended December 31, 2006

Sales revenue (2,000 units) .................................. $240,000
Less cost of goods sold (variable) ................................ 160,000
Gross margin .................................................. $80,000

Operating expenses:
  Selling .......................................................... $ 24,000
  Administrative .................................................. 16,000
  Depreciation (fixed) ........................................... 4,000
  Insurance (fixed) .............................................. 200
  Utilities ($80 fixed and $120 variable) ....................... 200  44,400
Profit ............................................................ $35,600
```
**Required:**
1. Prepare a contribution margin income statement. (Assume that the fixed components of the selling and administrative expenses are $12,000 and $8,000, respectively.)

2. **Interpretive Question:** Why is a contribution margin income statement helpful to management?

3. **Interpretive Question:** How would the analysis in part (1) be different if the depreciation expense was considered a stepped cost with wide steps compared to the relevant range?

**Problem 2-4**

**Contribution Margin Income Statement**

Susan Young is an attorney for a small law firm in Arizona. She is also a part-time inventor and an avid golfer. One day Susan’s golf foursome included a man named Henry Jones, a manufacturer of Christmas ornaments. Henry explained to Susan that he manufactures an ornament everyone loves, but stores will not carry the ornaments because they are very fragile and often break during shipping. Susan told Henry about a plastic box she had developed recently that would protect such fragile items during shipping. After crash testing the plastic box, Henry offered Susan a contract to purchase 100,000 of the boxes for $2.20 each. Susan is convinced that the box has many applications and that she can obtain future orders. Production of the plastic boxes will take one year. Estimated costs for the first year are as follows:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lease payments on building</td>
<td>$800 per month</td>
</tr>
<tr>
<td>Lease payments on machine</td>
<td>$2,200 per month</td>
</tr>
<tr>
<td>Cost to retool machine</td>
<td>$10,000</td>
</tr>
<tr>
<td>Depreciation on machine</td>
<td>$9,600</td>
</tr>
<tr>
<td>Direct materials</td>
<td>$0.70 per box</td>
</tr>
<tr>
<td>Direct labor</td>
<td>$0.30 per box</td>
</tr>
<tr>
<td>Indirect materials and other manufacturing overhead</td>
<td>$10,000</td>
</tr>
<tr>
<td>Interest on loan</td>
<td>$2,500</td>
</tr>
<tr>
<td>Administrative salaries</td>
<td>$15,000</td>
</tr>
</tbody>
</table>

**Required:**
1. Using the information provided, determine Susan’s contribution margin and projected profit at a sales level of 100,000 boxes.

2. If Susan’s salary as an attorney is $44,500, determine how many boxes Susan must sell to earn profits equal to her salary.

**Problem 2-5**

**Functional and Contribution Margin Income Statements**

Basically Jammin’, Inc. (BJI) is a retail outlet for customized bass guitars. The average cost of a bass guitar to the company is $1,000. BJI includes a markup of 50% of cost in the sales price. In 2006, BJI sold 380 bass guitars and finished the year with the same amount of inventory it had at the beginning of the year. Additional operating costs for the year were as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling expenses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advertising (fixed)</td>
<td></td>
<td>$700 per month</td>
</tr>
<tr>
<td>Commissions (mixed)</td>
<td></td>
<td>3,000 per month plus 2% of sales</td>
</tr>
<tr>
<td>Depreciation (fixed)</td>
<td></td>
<td>$400 per month</td>
</tr>
<tr>
<td>Utilities (fixed)</td>
<td></td>
<td>$125 per month</td>
</tr>
<tr>
<td>Freight on delivery (variable)</td>
<td></td>
<td>$20 per bass guitar</td>
</tr>
<tr>
<td>Administrative expenses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries (fixed)</td>
<td></td>
<td>$4,200 per month</td>
</tr>
<tr>
<td>Depreciation (fixed)</td>
<td></td>
<td>$330 per month</td>
</tr>
<tr>
<td>Utilities (fixed)</td>
<td></td>
<td>$200 per month</td>
</tr>
<tr>
<td>Clerical (variable)</td>
<td></td>
<td>$12 per sale</td>
</tr>
</tbody>
</table>

**Required:**
1. Prepare a traditional income statement using the functional approach.

2. Prepare an income statement using the contribution margin format.

3. **Interpretive Question:** Which statement is more useful for decision making? Why?
**Problem 2-6**

**Contribution Margin and Functional Income Statements**

The following information is available for Dabney Company for 2006:

- Sales revenue (at $20 per unit) $151,200
- Fixed manufacturing costs 24,000
- Variable manufacturing costs (at $8 per unit) 60,480
- Fixed selling expenses 70,000
- Variable selling expenses (at $2 per unit) 15,120

**Required:**

1. Prepare a contribution margin income statement.
2. Prepare a functional income statement.
3. Calculate the number of units sold.
4. Calculate the contribution margin per unit.
5. **Interpretive Question:** Why is a knowledge of the contribution margin more useful than a knowledge of the markup per unit when management has to make a decision about profitability?

**Problem 2-7**

**Unifying Concepts: High-Low Method, Contribution Margins, and Analysis**

Press Publishing Corporation has two major magazines: *Star Life* and *Weekly News*. During 2006, *Star Life* sold 3 million copies at $1.00 each, and *Weekly News* sold 2.1 million copies at $1.10 each. Press Publishing accumulated the following cost information:

<table>
<thead>
<tr>
<th>Month</th>
<th><em>Star Life</em></th>
<th><em>Weekly News</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Copies</td>
<td>Manufacturing Cost</td>
</tr>
<tr>
<td>January</td>
<td>400,000</td>
<td>$170,000</td>
</tr>
<tr>
<td>February</td>
<td>300,000</td>
<td>150,000</td>
</tr>
<tr>
<td>March</td>
<td>400,000</td>
<td>180,000</td>
</tr>
<tr>
<td>April</td>
<td>200,000</td>
<td>120,000</td>
</tr>
<tr>
<td>May</td>
<td>250,000</td>
<td>140,000</td>
</tr>
<tr>
<td>June</td>
<td>200,000</td>
<td>125,000</td>
</tr>
<tr>
<td>July</td>
<td>240,000</td>
<td>130,000</td>
</tr>
<tr>
<td>August</td>
<td>200,000</td>
<td>130,000</td>
</tr>
<tr>
<td>September</td>
<td>180,000</td>
<td>110,000</td>
</tr>
<tr>
<td>October</td>
<td>230,000</td>
<td>130,000</td>
</tr>
<tr>
<td>November</td>
<td>200,000</td>
<td>125,000</td>
</tr>
<tr>
<td>December</td>
<td>200,000</td>
<td>126,000</td>
</tr>
</tbody>
</table>

**Required:**

1. Use the high-low method to estimate the per-unit variable and total fixed manufacturing costs of each magazine. (Round the variable cost rate to three decimal places.)
2. If all selling expenses are fixed and they total $500,000 for *Star Life* and $400,000 for *Weekly News*, prepare contribution margin income statements for the two magazines at sales of 3 million copies each.
3. Which magazine is more profitable at sales of 2 million copies?
4. **Interpretive Question:** If the same total dollar amount spent on either magazine will result in the same number of new subscriptions, which magazine should be advertised?

**Problem 2-8**

**Contribution Margin Analysis**

Clearview Company is a manufacturer of glass vases. The following information pertains to Clearview’s 2006 sales:
Sales price per unit $32
Variable costs per unit 24
Total fixed costs 500,000

**Required:**
1. Determine Clearview Company’s per-unit contribution margin and contribution margin ratio.
2. Using the per-unit contribution margin and the contribution margin ratio, compute:
   a. The break-even point in sales dollars and units.
   b. The sales volume (in dollars and units) needed to generate a target income of $75,000.
3. Using the equation approach of C-V-P analysis, compute:
   a. The break-even point in sales dollars and units.
   b. The sales volume (in dollars and units) needed to generate a 15% return on sales.

**Problem 2-9**

Jane Tamlyn paid $225 to rent a carnival booth for four days. She has to decide whether to sell doughnuts or popcorn. Doughnuts cost $1.80 per dozen and can be sold for $3.60 per dozen. Popcorn will require a $113 rental fee for the popcorn maker and $0.08 per bag of popcorn for the popcorn, butter, salt, and bags; a bag of popcorn could sell for $0.45.

**Required:**
1. Compute the break-even point in dozens of doughnuts if Jane decides to sell doughnuts exclusively and the break-even point in bags of popcorn if she decides to sell popcorn exclusively.
2. Jane estimates that she can sell either 75 doughnuts or 45 bags of popcorn every hour the carnival is open (10 hours a day for four days). Which product should she sell?
3. Jane can sell back to the baker at half cost any doughnuts she fails to sell at the carnival. Unused popcorn must be thrown away. If Jane sells only 70% of her original estimate, which product should she sell? (Assume that she bought or produced just enough to satisfy the demands she originally estimated.)

**Problem 2-10**

**C-V-P Graphic Analysis**

Using the graph below, complete the requirements.

---

**Required:**
1. Determine the following:
   a. The break-even point in sales dollars and volume.
   b. The sales price per unit.
   c. Total fixed costs.
   d. Total variable costs at the break-even point.
   e. The variable cost per unit.
   f. The unit contribution margin.
2. What volume of sales must the company generate to reach a target income of $7,500?
Problem 2-11

Contribution Margin Analysis—Changes in Variables

SMC, Inc., is a producer of hand-held electronic games. Its 2006 income statement was as follows:

<table>
<thead>
<tr>
<th>SMC, Inc.</th>
<th>Contribution Margin Income Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For the Year Ended December 31, 2006</td>
</tr>
<tr>
<td>Total</td>
<td>Per Unit</td>
</tr>
<tr>
<td>Sales revenue (150,000 games)</td>
<td>$5,250,000</td>
</tr>
<tr>
<td>Less variable costs</td>
<td>3,750,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Less fixed costs</td>
<td>900,000</td>
</tr>
<tr>
<td>Profit</td>
<td>$ 600,000</td>
</tr>
</tbody>
</table>

In preparing its budget for 2007, SMC is evaluating the effects of changes in costs, prices, and volume on profit.

Required:
1. Evaluate the following independent cases, and determine SMC’s 2007 budgeted profit or loss in each case. (Assume that 2006 figures apply unless stated otherwise.)
   a. Fixed costs increase $150,000.
   b. Fixed costs decrease $100,000.
   c. Variable costs increase $3 per unit.
   d. Variable costs decrease $4 per unit.
   e. Sales price increases $5 per unit.
   f. Sales price decreases $5 per unit.
   g. Sales volume increases 25,000 units.
   h. Sales volume decreases 15,000 units.
   i. Sales price decreases $4 per unit, sales volume increases 40,000 units, and variable costs decrease by $2.50 per unit.
   j. Fixed costs decrease by $100,000, and variable costs increase $4 per unit.
   k. Sales volume increases 30,000 units, with a decrease in sales price of $2 per unit. Variable costs drop $1.50 per unit, and fixed costs increase $50,000.
2. What sales volume in units would be needed to realize $1,000,000 in profit if SMC reduces its price to $30?

Problem 2-12

Income Statement and Break-Even Analysis

Zimmerman Company records the following costs associated with the production and sale of a steel slingshot:

<table>
<thead>
<tr>
<th>Selling expenses:</th>
<th>Administrative expenses:</th>
<th>Manufacturing costs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>Fixed</td>
<td>Fixed</td>
</tr>
<tr>
<td>$6,500</td>
<td>$4,500</td>
<td>$15,500</td>
</tr>
<tr>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>$0.50 per unit sold</td>
<td>$0.25 per unit sold</td>
<td>$7.50 per unit produced</td>
</tr>
</tbody>
</table>

Required:
Assume that in 2006 the beginning and ending inventories were the same. Also assume that 2006 sales were 11,000 units at $11.50 per slingshot.
1. Prepare a contribution margin income statement.
2. Determine the break-even point in sales dollars.
3. **Interpretive Question:** Zimmerman believes that sales volume could be improved 20% if an additional commission of $0.50 per unit were paid to the salespeople. Zimmerman also believes, however, that the same percentage increase could be achieved through an increase of $3,000 in annual advertising expense. Which action, if either, should Zimmerman take? Why?

### C-V-P Analysis—Changes in Variables

Wonder T Manufacturing Company produces lanterns. The firm has not been as profitable as expected in the past three years. As a result, it has excess capacity that could be used to produce an additional 20,000 lanterns per year. However, any production above that amount would require a capital investment of $100,000. Operating results for the previous year are shown here. Assume that there is never any ending inventory.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales revenue</strong></td>
<td>$1,250,000</td>
</tr>
<tr>
<td><strong>Variable costs</strong></td>
<td>$781,250</td>
</tr>
<tr>
<td><strong>Fixed costs</strong></td>
<td>$400,000</td>
</tr>
<tr>
<td><strong>Profit</strong></td>
<td>$ 68,750</td>
</tr>
</tbody>
</table>

**Required:**

Respond to the following independent proposals, and support your recommendations:

1. The production manager believes that profits could be increased through the purchase of more automated production machinery, which would increase fixed costs by $100,000 and reduce the variable costs by $2.00 per lantern. Is she correct if sales are to remain at 31,250 lanterns annually?
2. The sales manager believes that a 10% discount on the sales price would increase the sales volume to 40,000 units annually. If he is correct, would this action increase or decrease profits?
3. Would the implementation of both proposals be worthwhile?
4. The sales manager believes that an increase in sales commissions could improve the sales volume. In particular, he suggests that an increase of $2.50 per lantern would increase the sales volume 30%. If he is correct, would this action increase profits?
5. The accountant suggests another alternative: Reduce administrative salaries by $15,000 so that prices can be reduced by $0.50 per unit. She believes that this action would increase the volume to 35,000 units annually. If she is correct, would this action increase profits?
6. The corporate executives finally decide to spend an additional $42,000 on advertising to bring the sales volume up to 34,050 units. If the increased advertising can bring in these extra sales, is this a good decision?

### C-V-P Analysis—Return on Sales

The federal government recently placed a ceiling on the selling price of sheet metal produced by MOB Company. In 2006, MOB was limited to charging a price that would earn a 20% return on gross sales. On the basis of this restriction, MOB had the following results for 2006:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales revenue</strong></td>
<td>$2,300,000</td>
</tr>
<tr>
<td><strong>Variable costs</strong></td>
<td>$1,610,000</td>
</tr>
<tr>
<td><strong>Fixed costs</strong></td>
<td>$230,000</td>
</tr>
<tr>
<td><strong>Profit</strong></td>
<td>$ 460,000</td>
</tr>
</tbody>
</table>

In 2007, MOB predicted that the sales volume would decrease to 900,000 feet of sheet metal. With this level of sales, however, the company anticipated no changes in the levels of fixed and variable costs.

**Required:**

1. Determine MOB’s profit for 2007 if all forecasts are realized. Compute both the dollar amount of profit and the percentage return on sales.

(continued)
2. MOB plans to petition the government for a price increase so that the 2006 rate of return on sales (20%) can be maintained. What sales price should the company request, based on 2007 projections? (Round to the nearest cent.)

3. How much profit (in dollars) will MOB earn in 2007 if this sales price, as determined in part (2), is approved?

4. **Interpretive Question**: What other factors must be considered by MOB and the government?

---

**Problem 2-15**

**Unifying Concepts: C-V-P Analysis and Changes in Variables**

The 2006 pro-forma income statement for Grover Company is as follows (ignore taxes):

<table>
<thead>
<tr>
<th>Grover Company</th>
<th>Pro-Forma Income Statement</th>
<th>For the Year Ended December 31, 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (50,000 units)</td>
<td>$450,000</td>
<td></td>
</tr>
<tr>
<td><strong>Cost of goods sold:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>$35,000</td>
<td></td>
</tr>
<tr>
<td>Direct labor</td>
<td>60,000</td>
<td></td>
</tr>
<tr>
<td>Variable manufacturing overhead</td>
<td>14,000</td>
<td></td>
</tr>
<tr>
<td>Fixed manufacturing overhead</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total cost of goods sold</strong></td>
<td><strong>114,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Gross margin</strong></td>
<td><strong>$336,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Selling expenses:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>$45,000</td>
<td></td>
</tr>
<tr>
<td>Fixed</td>
<td>102,000</td>
<td></td>
</tr>
<tr>
<td><strong>Administrative expenses:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td>Fixed</td>
<td>75,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total selling and administrative expenses</strong></td>
<td><strong>237,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Profit</strong></td>
<td><strong>$99,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Required:**

1. Compute how many units must be sold to break even.
2. Compute the increase (decrease) in profit under the following independent situations:
   a. Sales increase 25%.
   b. Fixed selling and administrative expenses decrease 5%.
   c. Contribution margin decreases 20%.
3. Compute sales in units and dollars at the break-even point if fixed costs increase from $182,000 to $224,800.
4. Compute the number of units that must be sold if expected profit is $1 million.

---

**Problem 2-16**

**Least Squares Methods**

This problem uses the same data for Press Publishing Corporation as displayed in Problem 2-7.

**Required:**

Use the least squares method to estimate the per-unit variable and total fixed manufacturing costs of the *Star Life* and *Weekly News* magazines. (Round the variable cost rate to three decimal places.)
**Problem 2-17**

**Unifying Concepts: High-Low, Scattergraph, and Least Squares Methods**

You have been hired as a consultant for Jones Inc. The company manufactures high-density compact disks and sells them to a wide variety of business clients. Management is eager to learn more about the company's cost behavior. You have been provided the following data. Assume all production falls within the relevant range.

<table>
<thead>
<tr>
<th>Month</th>
<th>Machine Hours</th>
<th>Utility Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>290</td>
<td>$10,700</td>
</tr>
<tr>
<td>February</td>
<td>280</td>
<td>10,400</td>
</tr>
<tr>
<td>March</td>
<td>320</td>
<td>11,600</td>
</tr>
<tr>
<td>April</td>
<td>340</td>
<td>12,100</td>
</tr>
<tr>
<td>May</td>
<td>350</td>
<td>12,400</td>
</tr>
<tr>
<td>June</td>
<td>290</td>
<td>10,750</td>
</tr>
<tr>
<td>July</td>
<td>300</td>
<td>10,800</td>
</tr>
<tr>
<td>August</td>
<td>300</td>
<td>10,900</td>
</tr>
<tr>
<td>September</td>
<td>310</td>
<td>11,200</td>
</tr>
<tr>
<td>October</td>
<td>340</td>
<td>12,200</td>
</tr>
<tr>
<td>November</td>
<td>290</td>
<td>10,600</td>
</tr>
<tr>
<td>December</td>
<td>310</td>
<td>11,000</td>
</tr>
</tbody>
</table>

**Required:**

1. Using the high-low method, compute the variable and fixed elements of Jones’ utility costs.
2. Plot the information on a scattergraph. Based on your graph, determine the unit variable cost and monthly fixed costs.
3. Using the least squares method (either the equation approach or a software package), calculate the variable and fixed cost components. Determine the cost formula.
4. **Interpretive Question:** Why are the variable cost per unit and fixed costs different for each of these methods of analysis? Which method is the most accurate for determining variable and fixed cost components?

**Problem 2-18**

**Sales Mix**

Mike’s Ice Cream Company produces and sells ice cream in three sizes: quart, half-gallon, and gallon. Relevant information for each of the sizes is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Quart</th>
<th>Half-Gallon</th>
<th>Gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average sales price</td>
<td>$1.00</td>
<td>$1.85</td>
<td>$3.60</td>
</tr>
<tr>
<td>Less variable cost</td>
<td>0.80</td>
<td>1.40</td>
<td>2.40</td>
</tr>
<tr>
<td>Unit contribution margin</td>
<td>$0.20</td>
<td>$0.45</td>
<td>$1.20</td>
</tr>
<tr>
<td>Sales mix (% of sales)</td>
<td>15%</td>
<td>60%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Mike anticipates sales of $500,000 and fixed costs of $120,000 in 2006.

**Required:**

1. Determine the break-even sales volume in units and dollars for 2006.
2. Determine Mike’s 2006 projected profit.
3. Assume that Mike’s sales mix changes to 10% quarts, 40% half-gallons, and 50% gallons. Determine Mike’s break-even sales volume in units and dollars.

**Problem 2-19**

**Unifying Concepts: Break-Even Point and Operating Leverage**

The summary data are provided on the following page for Spencer Mercantile Corporation and James Service, Inc. During the year for which these data are reported, Spencer sold 50,000 units and James sold 100,000 units.

(continued)
(000’s omitted) | Spencer Mercantile Corporation | James Service, Inc.
---|---|---
Sales revenue | $1,040 | $2,100
Less variable costs | 520 | 630
Contribution margin | $ 520 | $1,470
Less fixed costs | 200 | 600
Income | $ 320 | $ 870

**Required:**
1. Determine the break-even point for Spencer and James in both sales dollars and units.
2. **Interpretive Question:** Which company has a higher operating leverage? Why?
3. **Interpretive Question:** Based on your analysis of the cost structures of Spencer and James, which company’s cost structure is better? What factors are important to consider in answering such a question?

**Case 2-1**

**Colorado Outdoors Federation**
The Colorado Outdoors Federation sponsors an annual banquet. This year the guest speaker is a noted wildlife photographer and lecturer. In planning for the event, the group’s treasurer has determined the following costs:

- Rental of meeting facility: $250
- Honorarium for speaker: 800
- Tickets and advertising: 300
- Cost of dinner (per person): 20
- Door prizes: 500

Last year, tickets were sold at $20 per person, and 350 people attended the banquet. This year the planning committee is hoping for an attendance of 450 at a price of $25 each.

1. a. At $25 per person, how many people must attend the banquet for the Federation to break even?
   b. How much profit (loss) will occur if 450 people attend?
2. Should the Federation increase its advertising costs by $200 and its door prizes by $300 if it can expect 550 people to attend the banquet?
3. If the Federation maintains its original expected costs but reduces the price per ticket from $25 to $22, it can expect 500 people to attend the banquet. Should the Federation reduce the price of its tickets to $22 per person?

**Case 2-2**

**Entertainment Enterprises**
Entertainment Enterprises, a firm that sells magazine subscriptions, is experiencing increased competition from a number of companies. The president, Betty Kincher, has asked you, the controller, to prepare an income statement that will highlight the fixed and variable costs; this will provide more useful information for planning and control purposes. Sales revenues are $25 per subscription. An analysis of company costs for the past six months reveals the following:

- Administrative salaries: $10,000 per month
- Advertising expense: $2,000 per month
- Cost of goods sold: $12.50 per subscription
- Rent expense: $5,000 per month
- Sales commissions: 15% of sales

In addition, the company makes most sales contacts through an extensive telephone network. Consequently, the telephone expense is significant and has both fixed and variable components. Relevant data concerning the telephone expense for the past six months follow:

<table>
<thead>
<tr>
<th>Month</th>
<th>Unit Sales</th>
<th>Telephone Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>4,000</td>
<td>$10,200</td>
</tr>
<tr>
<td>August</td>
<td>5,000</td>
<td>12,300</td>
</tr>
<tr>
<td>September</td>
<td>3,500</td>
<td>9,150</td>
</tr>
<tr>
<td>October</td>
<td>4,500</td>
<td>11,250</td>
</tr>
<tr>
<td>November</td>
<td>5,200</td>
<td>12,720</td>
</tr>
<tr>
<td>December</td>
<td>5,500</td>
<td>13,350</td>
</tr>
</tbody>
</table>

Prepare a management report for the president that:

1. Computes the fixed and variable portions of the telephone expense using the high-low method. **(Note: A scattergraph may be used to visually check your answer.)**
2. Presents a budgeted (pro-forma) contribution margin income statement for Entertainment Enterprises for the next six months (January through June), assuming that it expects to sell 30,000 subscriptions at a price of $25 each.

3. Explains how the information provided in part (2) might help the president make better management decisions.

Judgment calls

Judgment 2-1
You Decide: Should the management of a company consider fixed costs in the decision-making process, or should they ignore fixed costs and base their decision on what makes the most business sense?

Recently, the board of directors for a television manufacturing company was considering a change in products from TVs to computers. The board claims, after performing a C-V-P analysis of a new computer manufacturing plant facility, that the computer industry is more profitable and would increase the bottom line immediately. However, just six months earlier, the company built a state-of-the-art television manufacturing plant. The overhead costs on the television plant represent a sizable portion of the company’s fixed costs. If the board voted to begin computer manufacturing, a new plant would need to be constructed. What should the board do?

Judgment 2-2
You Decide: Should companies have large amounts of inventory on hand for customers, or should companies keep inventory at a minimum to free up cash for other parts of the business?

Your uncle, Tim, started a very successful “home improvement” business 10 years ago. He wanted to create a place where people could go to get anything they needed to complete their “do-it-yourself” home building projects. Coupled with excellent service, Tim believes that he can gain and retain customers by having a large assortment of inventory from which to choose. In addition, he can obtain significant purchase discounts by buying the inventory in large bulk. You argue that maintaining amounts of inventory requires significant commitments to fixed warehousing and other costs that could be avoided by setting up an e-commerce Web site and taking customer orders that are then acquired and delivered one customer at a time. Although this approach will increase the overall variable costs as a result of not receiving bulk discounts on the smaller individual orders, you are able to demonstrate with C-V-P analysis that there is less risk in your approach to selling home improvement products. Your uncle strongly argues that, “Having the inventory on hand for your customers is the key to success. If I don’t have what they are looking for, they will just go down the street to HOME DEPOT! I have got to have inventory in the stores. There is no other way!”
Analyzing Real Company Information

Analyzing 2-1 (Microsoft)

Annual revenues, as well as sales and marketing expenses, for the 1991–2002 years are provided below for MICROSOFT CORPORATION:

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales and Marketing Expenses</th>
<th>Annual Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>$ 490</td>
<td>$ 1,847</td>
</tr>
<tr>
<td>1992</td>
<td>758</td>
<td>2,777</td>
</tr>
<tr>
<td>1993</td>
<td>1,086</td>
<td>3,786</td>
</tr>
<tr>
<td>1994</td>
<td>1,135</td>
<td>4,714</td>
</tr>
<tr>
<td>1995</td>
<td>1,564</td>
<td>6,075</td>
</tr>
<tr>
<td>1996</td>
<td>2,185</td>
<td>9,050</td>
</tr>
<tr>
<td>1997</td>
<td>2,411</td>
<td>11,936</td>
</tr>
<tr>
<td>1998</td>
<td>2,887</td>
<td>15,262</td>
</tr>
<tr>
<td>1999</td>
<td>3,238</td>
<td>19,747</td>
</tr>
<tr>
<td>2000</td>
<td>4,126</td>
<td>22,956</td>
</tr>
<tr>
<td>2001</td>
<td>4,885</td>
<td>25,296</td>
</tr>
<tr>
<td>2002</td>
<td>5,407</td>
<td>28,365</td>
</tr>
</tbody>
</table>

1. Operating output data, such as the number of software products sold each year, are not provided in Microsoft’s Form 10-K. However, while it is a little odd to use revenues to predict marketing expense (instead of the other way around), it seems sensible that changes in revenues can serve as an approximate measure of changes in the number of products sold by Microsoft. Use the high-low method to analyze the data above to determine if there is a relationship between revenues and sales and marketing expenses. (Hint: Don’t round off the value you calculate for variable costs per revenue dollar.) What appears to be the amount of fixed costs in these expenses? Does this fixed cost amount make sense? (Note: Remember that the data are in millions of dollars!)

2. Using your calculator (or some computer software program such as Microsoft Excel®), compute a regression analysis on the data above. What do you learn from the analysis? The Management’s Discussion in Microsoft’s 2002 Form 10-K generally uses the following language to describe changes to sales and marketing expenses: “Sales and marketing expenses increased due to higher relative headcount-related costs, higher marketing and sales expenses associated with MSN (Microsoft’s popular portal destination on the Web), the Microsoft Agility advertising campaign, and other new sales initiatives.” Does this statement provide any help in understanding the analysis? (Hint: When setting up to perform the regression, remember that the revenue is the $X$ variable and the sales and marketing expense is the $Y$ variable.)

Analyzing 2-2 (Star Video)

It is likely that a number of grocery stores in your town have video rental departments. Generally, however, grocery stores do not focus much management attention on their small video rental businesses. The main purpose of having a video department is to encourage more customers to come into the store and purchase groceries! Nevertheless, a grocery store cannot simply buy a large selection of videotapes, corner off a section of floor space, and start renting tapes. Successfully managing a rental business requires being aware of an unimaginably large number of video titles. Obviously, new movies are constantly being released, while old movies gradually lose their appeal and are eventually scrapped. Further, large-scale video rental chains
such as BLOCKBUSTER constantly track shifting consumer tastes for certain titles and movie categories. These consumer preferences differ based on demographic data like geographic location, average age, ethnicity, average income, etc. A grocery store really can’t manage all these data without losing focus on its main business. Hence, most grocery stores contract out their video rental business to a large-scale video management company. These management companies can purchase huge quantities of tapes, maintain large distribution warehouses, and track demographic data that allow them to manage and move specific inventories to the appropriate grocery store locations. In 1992, one such video management company, Star Video (not its real name), was managing 86 stores representing three supermarket chains in five states—Arizona, California, Montana, Washington, and Wyoming. Total revenue in 1992 for Star Video was $3.6 million. Star Video made all the inventory investments and handled all management activities involved in providing video rentals at each of the 86 stores. Video rental revenue was then split between Star Video and each grocery store, with Star Video keeping the lion’s share. Stores liked this arrangement because they made most of their money on grocery sales to customers who came to rent videotapes. Star Video needed to carefully manage revenue and costs at each store in order to stay profitable. Following are the data for six stores located in Washington:

<table>
<thead>
<tr>
<th>Store Name</th>
<th>Monthly Revenue</th>
<th>Monthly Operating Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moses Lake</td>
<td>$6,408</td>
<td>$3,295</td>
</tr>
<tr>
<td>W. Kennewick</td>
<td>$4,264</td>
<td>$2,289</td>
</tr>
<tr>
<td>Pasco</td>
<td>$4,038</td>
<td>$2,270</td>
</tr>
<tr>
<td>S. Kennewick</td>
<td>$3,692</td>
<td>$2,142</td>
</tr>
<tr>
<td>E. Wenatchee</td>
<td>$1,395</td>
<td>$1,316</td>
</tr>
<tr>
<td>Richland</td>
<td>$2,104</td>
<td>$1,516</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$21,901</strong></td>
<td><strong>$12,828</strong></td>
</tr>
</tbody>
</table>

Use the high-low method to analyze the operating expenses at these six stores. Determine if operating expenses are related to store revenue. What appear to be the fixed costs of operating each store? Create a graph and plot these costs using revenue on the horizontal axis and operating expenses on the vertical axis. Does the scattergraph agree or disagree with the results of your high-low analysis?

**International Case**

**The Paper Company**

The GHANATA GROUP OF COMPANIES (GGC) is a locally owned and controlled company in Ghana, West Africa. One of its principal operating divisions, THE PAPER COMPANY, is one of Africa’s most modern and largest manufacturers/distributors of paper products. For both operating and reporting purposes, The Paper Company is organized into product lines: scholastic, envelope, and stationery. During the 1980s, the economy in Ghana was stagnant. The country faced severe economic problems as a result of unfavorable trade terms with other countries. The official exchange rate of U.S. $1.00 to the local currency, the cedi, was about 39.00 as of the end of 1984. (The unofficial rate, e.g., the black market rate, was at least five times worse!) As a result of the economy, it became very difficult for GGC to secure direct materials for its divisions. If a division could secure direct materials, it could sell almost everything it produced. Hence, in terms of being able to predict sales volumes, there was a great deal of risk for GGC divisions. The 1985 budgeted operating data for the three departments in The Paper Company were as follows:
Using these operating data, create C-V-P graphs for each department. (Note: Since you don’t have per-unit prices and costs, you may assume that the product sales price for each department is $1 per unit, and then plot your graphs at 0, 2 million, and 4 million units.) Given the high-risk business environment in Ghana at this time, which department presents the highest risk to GGC? The lowest risk? Be sure to explain your answer in terms of operating leverage. You may also want to consider each department’s break-even point compared to budgeted (expected) operations.


### Ethics Case

**Pickmore International**

Joan Hildabrand is analyzing some cost data for her boss, Ross Cumings. The data relate to a special sales order that Pickmore International is considering from a large customer in Singapore. The following data are applicable to the product being ordered:

<table>
<thead>
<tr>
<th></th>
<th>Scholastic</th>
<th>Envelope</th>
<th>Stationery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal unit sales price</td>
<td>$49.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable unit manufacturing costs</td>
<td>10.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable unit selling and administrative expenses</td>
<td>18.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The customer is requesting that the sales order be accepted on the following terms:

a. The unit sales price would equal the unit contribution margin plus 10%.

b. Freight would be paid by the customer.

c. Pickmore International would pay a $5,000 “facilitating payment” to a “friend of the customer” to get the product through customs more quickly.

In considering the order, Ross has indicated to Joan that this is a very important customer. Furthermore, this work would help some employees earn a little extra Christmas money with overtime.

1. What are the accounting and ethical issues involved in this case?
2. Should Joan recommend acceptance of the sales terms proposed for this special order?
**Writing Assignment**

**Issues of Quality and Time on C-V-P Analysis Decisions**

This chapter described how to analyze whether the difference between sales price and variable costs, as well as the volume of sales, is sufficient to pay for all fixed costs in an organization and provide a sufficient profit. A number of methods have been presented for analyzing these costs, volume, and price relationships. These methods all focus on quantitative issues that affect how a company manages its resources to maximize overall profits. However, there are a number of qualitative issues involving quality and time that should also affect decisions about what sales prices to set, how to manage fixed and variable costs, and which products should be emphasized within the organization. One way to trade off fixed costs for variable costs is to consider making large fixed cost investments in technology that result in automated production, merchandising, and service processes. These kinds of investments allow some variable costs, such as direct labor, to be reduced. Managing this cost trade-off often has strong implications on the quality of the product or service, as well as the timeliness with which it can be delivered. Both of these qualitative issues eventually affect the quantitative issues of costs, volume, and price. Go to your library and find an article describing one organization’s effort to invest in automation or other technologies in order to reduce costs. Determine what quality and time issues are affected by the investment. Write a one- to two-page memo describing what you found.

**The Debate**

**Which Cost Analysis Method Is Better?**

Many costs within an organization are mixed costs, combining elements of both fixed and variable costs. Separating these types of costs into their fixed and variable cost components is necessary before C-V-P analysis work can be done. Two potential cost analysis methods are the scattergraph (visual-fit) approach and the high-low approach. Each of these methods has both disadvantages and advantages compared to the other.

Divide your group into two teams and prepare a two-minute oral argument supporting your assigned position.

- One team represents “The scattergraph (visual-fit) method is superior!” Explain why this method should be used for determining the variable and fixed cost components in a mixed cost.
- The other team represents “High-low; the way to go!” Explain why this method should be used for determining the variable and fixed cost components in a mixed cost.

**Internet Search**

**Applied Ethics Resources on WWW**

We have discussed ethical issues for accountants in this text and have included an ethics case at the end of each chapter. Obviously, ethical issues are of concern to accountants and all other business professionals. There are a number of good resources on the Internet for those interested in further exploring ethical issues in business (hopefully, we’re all interested in this topic!). One of the better sites is Applied Ethics Resources on WWW Centre at [http://www.ethicsweb.ca/resources/](http://www.ethicsweb.ca/resources/). Sometimes Web addresses change, so if this address doesn’t work, access the Web site for this textbook ([http://swain.swlearning.com](http://swain.swlearning.com)) for an updated link.

Go to this site and explore the materials regarding applied ethics resources on the World Wide Web. Find a publication that discusses either business or professional ethics. Write a short paragraph that describes exactly where you found the article and give a brief summary.