Cost–Volume–Profit Analysis

Learning Objectives

After studying the material in this chapter, you should be able to:

- **LO1** Use the contribution margin in its various forms to determine the impact of changes in sales on income.
- **LO2** Analyze what-if decisions by using CVP analysis.
- **LO3** Compute a company's break-even point in single- and multiproduct environments.
- **LO4** Analyze target profit before and after the impact of income tax.
- **LO5** Compute a company's operating leverage and understand the relationship of leverage to cost structure.

Introduction

Some of the more important decisions managers make involve analyzing the relationships among the cost, volume, and profitability of products produced and services provided by a company. **Cost–volume–profit (CVP) analysis** focuses on the relationships among the following five factors and the overall profitability of a company:

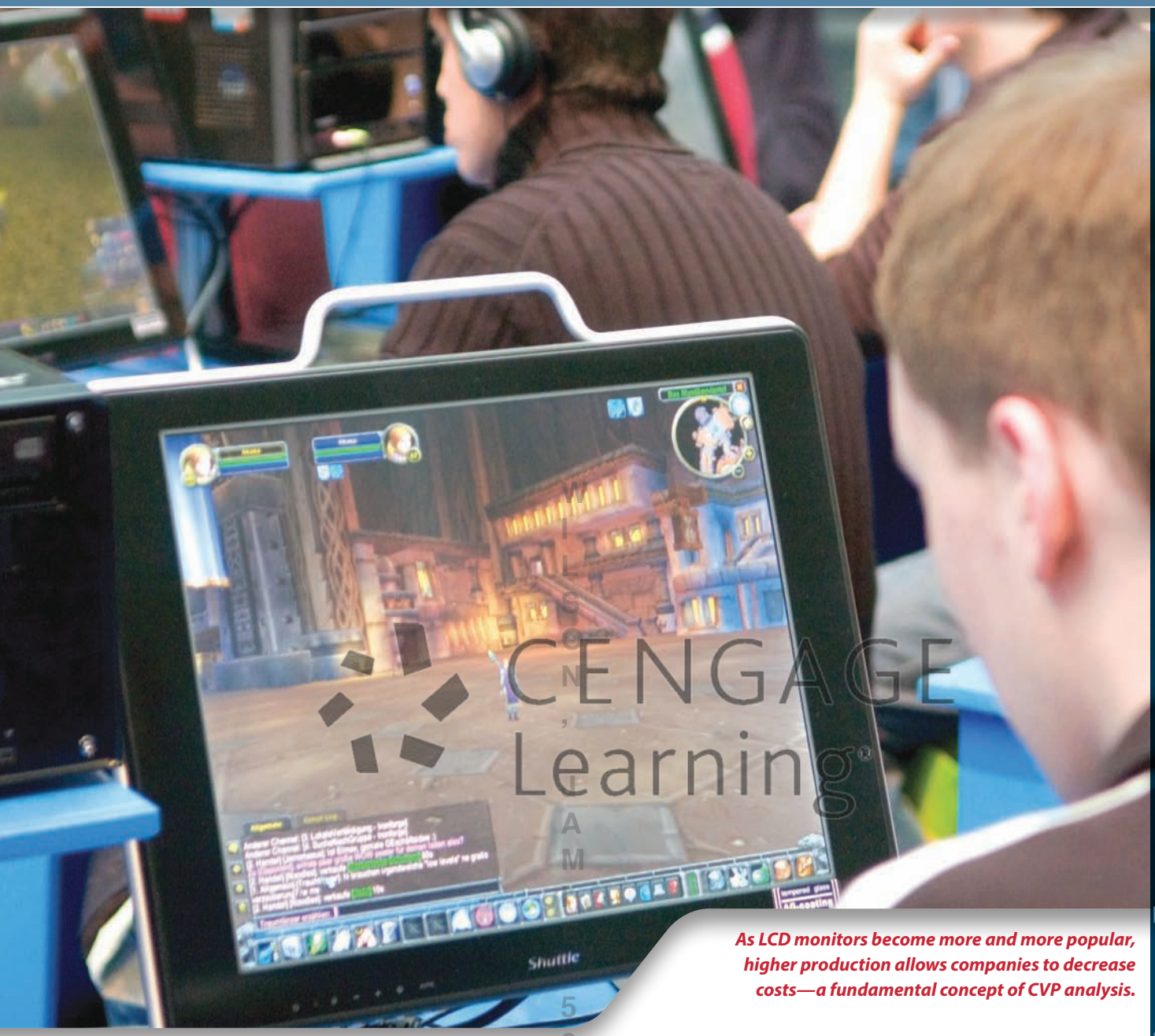
1. The prices of products or services
2. The volume of products or services produced and sold
3. The per-unit variable costs
4. The total fixed costs
5. The mix of products or services produced

As in any form of analysis involving projections of the future, certain assumptions must be considered. The major assumptions are as follows:

1. The selling price is constant throughout the entire relevant range. In other words, we assume that the sales price of the product will not change as the volume changes.
2. Costs are linear throughout the relevant range. As discussed in Chapter 5, although costs may behave in a curvilinear fashion, they can often be approximated by a linear relationship between cost and volume within the relevant range.
3. The sales mix used to calculate the weighted-average contribution margin is constant.
4. The amount of inventory is constant. In other words, the number of units produced is equal to the number of units sold.

Cost–volume–profit (CVP) analysis A tool that focuses on the relationships among a company's profits and (1) the prices of products or services, (2) the volume of products or services, (3) the per-unit variable costs, (4) the total fixed costs, and (5) the mix of products or services produced.

Although some of these assumptions are often violated in real business settings, the violations are usually minor and have little or no impact on management decisions. CVP analysis can still be considered valid and very useful in decision making.



As LCD monitors become more and more popular, higher production allows companies to decrease costs—a fundamental concept of CVP analysis.

LO1 The Contribution Margin and Its Uses

As mentioned in Chapter 5, the traditional income statement required for external financial reporting focuses on function (product costs versus period costs) in calculating the cost of goods sold and a company's gross profit. **Gross profit** is the difference between sales and cost of goods sold. However, because cost of goods sold includes both fixed costs (facility-level costs, such as rent) and variable costs (unit-level costs, such as direct materials), the behavior of cost of goods sold and gross profit is difficult to predict when production increases or decreases.

Gross profit The difference between sales and cost of goods sold.

In contrast, the contribution margin income statement is structured by behavior rather than by function. In Exhibit 6-1, a traditional income statement and a contribution margin income statement are shown side by side so that you can see the difference.

As you can see, although the net income is the same for both statements, the traditional statement focuses on the function of the costs, whereas the contribution margin income statement focuses on the behavior of the costs. In the traditional income statement, the cost of goods sold and selling, general, and administrative (S, G, & A) costs include both variable and fixed costs. In the contribution margin income statement, costs are separated by behavior (variable versus fixed) rather than by function. Note, however, that the contribution margin income statement combines product and period costs. Variable costs include both variable product costs (direct materials) and variable selling, general, and administrative costs (commissions on sales), whereas fixed costs likewise include both product and period costs.

The contribution margin income statement is structured to emphasize cost behavior as opposed to cost function.

Exhibit 6-1 Comparison of Income Statements

Traditional		
Sales		$1,000
Less: Cost of goods sold:		
Variable costs	$350	
Fixed costs	150	
Total cost of goods sold		500
Gross profit		$ 500
Less: S, G, & A costs:		
Variable costs	$ 50	
Fixed costs	250	
Total S, G, & A costs		300
Net operating income		$ 200

Contribution Margin		
Sales		$1,000
Less: Variable costs:		
Manufacturing costs	$350	
S, G, & A costs	50	
Total variable costs		400
Contribution margin		$ 600
Less: Fixed costs:		
Manufacturing costs	$150	
S, G, & A costs	250	
Total fixed costs		400
Net operating income		$ 200

Contribution Margin per Unit

To illustrate the many uses of the contribution margin income statement in managerial decision making, let's look at the income statement of Happy Daze Games. Happy Daze, unlike large established firms such as **Blizzard Entertainment** and **Bioware Corp.**, is a start-up company and produces just one game but plans to increase its product line to include more games in the near future.

A contribution margin income statement for Happy Daze Game Company follows.

	Total	Per Unit
Sales (8,000 units)	$100,000	$12.50
Less: Variable costs	72,000	9.00
Contribution margin	$ 28,000	$ 3.50
Less: Fixed costs	35,000	
Net operating income (loss)	$ (7,000)	

Note that, in addition to the total sales, variable costs, and contribution margin, per-unit cost information is also shown in the statement. Happy Daze sells each game for $12.50, and the variable cost of manufacturing each game is $9.00. As you can see, the **contribution margin per unit** is $3.50 and can be found by subtracting the per-unit variable costs of $9.00 from the per-unit

Contribution margin per unit The sales price per unit of product, less all variable costs to produce and sell the unit of product; used to calculate the change in contribution margin resulting from a change in unit sales.

sales price of $12.50. The contribution margin per unit can also be calculated by dividing the contribution margin (in dollars) by the number of units sold:

$$\text{Contribution margin (per unit)} = \frac{\text{Contribution margin (in \$)}}{\text{Units sold}}$$
$$= \frac{28{,}000}{8{,}000} = \$3.50$$

What exactly does this tell us? It tells us that every game that is sold adds $3.50 to the contribution margin. Assuming that fixed costs don't change, net operating income increases by the same $3.50.

What happens if sales increase by 100 games? Because we know that the contribution margin is $3.50 per game, if sales increase by 100 games, net operating income will increase by $350 ($3.50 × 100). In a similar fashion, if sales were to decrease by 200 games, then net operating income would decrease by $700 ($3.50 × −200).

As summarized in Exhibit 6-2, the use of contribution margin per unit makes it very easy to predict how both increases and decreases in sales volume affect contribution margin and net income.

The contribution margin per unit and the contribution margin ratio will remain constant as long as sales vary in direct proportion to volume.

The **contribution margin ratio** is calculated by dividing the contribution margin in dollars by sales in dollars:

$$\text{Contribution margin ratio} = \frac{\text{Contribution margin (in \$)}}{\text{Sales (in \$)}}$$

Exhibit 6-2 The Impact of Changes in Sales on Contribution Margin and Net Income

	Decreased by 200 units	Original Total	Increased by 100 units
	7,800 units	8,000 units	8,100 units
Sales (sales price, $12.50/unit)	$97,500	$100,000	$101,250
Less: Variable costs ($9/unit)	70,200	72,000	72,900
Contribution margin ($3.50/unit)	$27,300	$ 28,000	$ 28,350
Less: Fixed costs	35,000	35,000	35,000
Net operating income (loss)	$ (7,700)	$ (7,000)	$ (6,650)
Change in income	Decreased by $700 (200-unit decrease × $3.50)		Increased by $350 (100-unit increase × $3.50)

Contribution Margin Ratio

The contribution margin income statement can also be presented in terms of percentages, as shown in the following income statement:

	Total	Percentage
Sales (8,000 units)	$100,000	100
Less: Variable costs	72,000	72
Contribution margin	$ 28,000	28 ($28,000/$100,000)
Less: Fixed costs	35,000	
Net operating income (loss)	$ (7,000)	

The contribution margin ratio can be viewed as the amount of each sales dollar contributing to the payment of fixed costs and increasing net operating profit; that is, 28 cents of each sales dollar contributes to the payment of fixed costs or increases net income.

Contribution margin ratio The contribution margin divided by sales; used to calculate the change in contribution margin resulting from a dollar change in sales.

Like the contribution margin per unit, the contribution margin ratio will remain constant as long as sales vary in direct proportion to volume.

Like contribution margin per unit, the contribution margin ratio allows us to very quickly see the impact of a change in sales on contribution margin and net operating income. As you saw in Exhibit 6-2, a $1,250 increase in sales (100 units) will increase contribution margin by $350 ($1,250 × 28%). Assuming that fixed costs don't change, this $350 increase in contribution margin increases net operating income by the same amount. Likewise, in Exhibit 6-2, we decreased sales by 200 units ($2,500), resulting in a decrease in contribution margin and net operating income of $700 ($2,500 × 28%).

LO2 What-If Decisions Using CVP

Continuing with our example, we note that Happy Daze had a net loss of $7,000 when 8,000 units were sold. At that level of sales, the total contribution margin of $28,000 is not sufficient to cover fixed costs of $35,000. The CEO of the company would like to consider options to increase net income while maintaining the high quality of the company's products. After consultation with marketing, operations, and accounting managers, the CEO identifies three options that she would like to consider in more depth:

1. Reducing the variable costs of manufacturing the product
2. Increasing sales through a change in the sales incentive structure or commissions (which would also increase variable costs)
3. Increasing sales through improved features and increased advertising

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Option 1—Reduce Variable Costs

When variable costs are reduced, the contribution margin will increase. So the question becomes, What can be done to reduce the variable costs of manufacturing? Happy Daze could find a less expensive supplier of raw materials. The company could also investigate the possibility of reducing the amount of labor used in the production process or of using lower wage employees in the production process.

In either case, qualitative factors must be considered. If Happy Daze finds a less expensive supplier of raw materials, the reliability of the supplier (shipments may be late, causing downtime) and the quality of the material (paper products are not as good, adhesive is not bonding) must be considered. Reducing labor costs also has both quantitative and qualitative implications. If less labor is involved in the production process, more machine time may be needed. Although this option certainly lowers variable costs, it may also raise fixed costs. Using lower skilled workers to save money could result in more defective products, owing to mistakes made by inexperienced workers. Another possible result of using fewer workers is that it can adversely affect employee morale. Being short staffed can cause stress on workers, owing to the likelihood that they will be overworked.

Happy Daze decides to decrease variable costs by reducing the costs of direct labor. The operations manager assures the CEO that the change can be made by outsourcing some of the current production activities. This change reduces variable costs by 10 percent and, as shown in the following analysis, results in an overall increase in net operating income of $7,200:

Impact of Reducing Variable Costs By 10 Percent

	Current	Option 1
Sales	$100,000	$100,000
Less: Variable costs	72,000	64,800
Contribution margin	$ 28,000	$ 35,200
Less: Fixed costs	35,000	35,000
Net operating income (loss)	$ (7,000)	$ 200

Option 2—Increase Sales Incentives (Commissions)

The CEO of Happy Daze would also like to consider providing additional sales incentives to motivate the sales staff in an effort to increase sales volume. The

marketing manager estimates that if Happy Daze raises the sales commission by 10 percent on all sales above the present level, sales will increase by $40,000, or 3,200 games. (The additional sales commission will be $4,000.)

Happy Daze can increase net operating income by $7,200 by increasing the sales commission by 10 percent on all sales of more than $100,000. The new variable costs are calculated by using a variable-cost percentage of 72 percent on sales up to $100,000 and 82 percent on all sales of more than $100,000. As you can see in the following income statement, if sales increase by $40,000, operating income will increase by $7,200, and Happy Daze will report net operating income of $200:

Impact of Increasing Sales Incentives (Sales Increase to $140,000)

	Current	Option 2
Sales	$100,000	$140,000
Less: Variable costs	72,000	104,800
Contribution margin	$ 28,000	$ 35,200
Less: Fixed costs	35,000	35,000
Net operating income (loss)	$ (7,000)	$ 200

In Option 1 and Option 2, the ultimate change in net income can be determined by focusing solely on the change in contribution margin. Fixed costs are not relevant in either analysis because they do not vary. However, as you will see in Option 3, that is not always the case.

Option 3—Change Game Features and Increase Advertising

Changes can be made to more than one variable at a time. In fact, changes in cost, price, and volume are never made in a vacuum and almost always affect one or both of the other variables. Happy Daze has decided to change some key features of its game. Although this change will add $0.25 to the variable cost per game, the marketing manager estimates that with additional advertising of $5,000, sales volume will increase by 40 percent, or 3,200 units. In order to offset some of these costs, the accounting manager proposes an increase of $0.75 per unit in the sales price. As shown next, this option increases the contribution margin per unit to $4.00 per unit. The new sales price per unit is $13.25, and variable costs increase from $9.00 to $9.25 per unit. The increase in contribution margin of $16,800 is more than enough to offset the $5,000 increase in fixed costs and results in an overall increase of $11,800 in net operating income.

MAKING IT REAL

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As consumer spending slowed during the recent recession, managers and owners of both large and small companies employed CVP analysis in an effort to bolster income. For example, Drue Sanders, founder of Drue Sanders Custom Jewelers, created a new line of jewelry using silver rather than more costly gold and platinum as the main component. This approach allowed the company to sell items for $150 to $200 rather than the normal $500 and up prices she normally charged. The result was increased volume as consumers reacted to the lower pricing.

In a similar fashion, in order to lure cost-conscious customers, PC makers such as Hewlett-Packard Co. and Dell shifted their product lines toward cheaper laptops and notebooks that sold for as little as $399. With consumers balking at spending thousands of dollars on a new computer, offering lower priced computers with fewer (and less expensive) features allowed the companies to continue making sales in a difficult economy.

Source: "Smart Ways to Cut Prices," by Diana Ransom, and "Leaner Laptops, Lower Prices," by Justin Scheck and Loretta Chao, *The Wall Street Journal*, April 22, 2009.

Impact of Changes to Cost, Price, and Volume

	Current (8,000 units)	Option 3 (11,200 units)
Sales	$100,000 ($8,000 × $12.50)	$148,400 (11,200 × $13.25)
Less: Variable costs	72,000 (8,000 × $9.00)	103,600 (11,200 × $9.25)
Contribution margin	$ 28,000 (8,000 × $3.50)	$ 44,800 (11,200 × $4.00)
Less: Fixed costs	35,000	40,000
Net operating income (loss)	$ (7,000)	$ 4,800

How well does each option meet the stated objectives of increasing net operating income while maintaining a high-quality product? The CEO of Happy Daze should analyze each alternative solution in the same manner and choose the best course of action on the basis of both quantitative and qualitative factors.

From a quantitative perspective, Option 1 results in an increase in net operating income of $7,200, Option 2 increases net operating income by the same $7,200, and Option 3 increases net operating income by $11,800. The CEO must also assess the risk inherent in each option, including the sensitivity of a decision to make changes in key assumptions. For example, although Option 1 appears to have little quantitative risk because the decrease in costs is known with certainty and no increase in sales is projected, Happy Daze should consider whether reducing labor costs in Option 1 will have a negative impact on the quality of its product. If the reduction in labor costs results from using lower paid but inadequately skilled workers, quality may be adversely affected.

LO_3 Break-Even Analysis

In addition to considering what-if analysis, it is useful for managers to know the number of units sold or the dollar amount of sales that is necessary for a company to break even. The **break-even point** is the level of sales at which the contribution margin just covers fixed costs and, consequently, income is equal to zero. Break-even analysis is really just a variation of CVP analysis in which volume is increased or decreased in an effort to find the point at which income is equal to zero.

Break-even point The level of sales at which the contribution margin just covers fixed costs and income is equal to zero.

Break-even analysis is facilitated through the use of a mathematical equation derived directly from the contribution margin income statement. Another way to look at these relationships is to put the income statement into equation form:

$$\text{Sales} - \text{Variable Costs} - \text{Fixed Costs} = \text{Income}$$
$$SP(x) - VC(x) - FC = I$$

where

SP = Sales price per unit
VC = Variable costs per unit
FC = Total fixed costs
I = Income
x = Number of units sold

At the break-even point, income is equal to zero, so

$$SP(x) - VC(x) - FC = 0$$

Rearranging and dividing each side by SP − VC, we find that the number of units (x) that must be sold to reach the break-even point is

$$(SP - VC)(x) = FC$$
$$\text{and } x = \frac{FC}{CM}$$

Because the selling price per unit (SP) less variable costs per unit (VC) is equal to the contribution margin per unit, by dividing the contribution margin of each product into the fixed cost, we are calculating the number of units that must be sold to cover the fixed costs—the break-even point:

$$\text{Break-even (units)} = \frac{\text{Fixed costs}}{\text{Contribution margin per unit}}$$

At that point, the total contribution margin will be equal to the fixed cost and net income will be zero.

For example, if Happy Daze has fixed costs of $35,000 and the contribution margin per unit is $3.50, the break-even point is computed as follows:

$$\text{Break-even (units)} = \frac{\text{Fixed costs}}{\text{Contribution margin per unit}}$$
$$= \$35{,}000 \div \$3.50$$
$$= 10{,}000 \text{ units}$$

We can use a similar formula to compute the amount of sales dollars needed to break even:

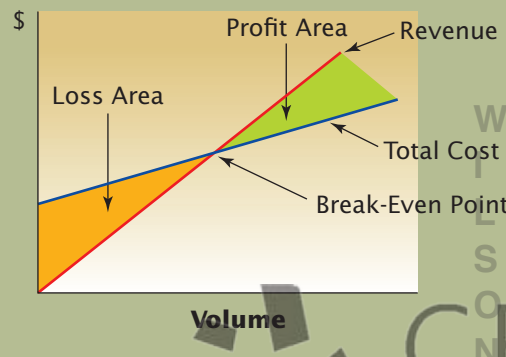
$$\text{Break-even (\$)} = \frac{\text{Fixed costs}}{\text{Contribution margin ratio}}$$

Using the amounts from the previous example gives

$$\text{Break-even (\$)} = \frac{\$35{,}000}{28\% \text{ (see page 123)}}$$
$$= \$125{,}000$$

Graphically, the break-even point can be found by comparing a company's total revenue with its total costs (both fixed and variable). As shown in Exhibit 6-3, the break-even point is the volume at which total revenue is equal to total cost.

Exhibit 6-3 Break-Even Graph



Break-Even Calculations with Multiple Products

Break-even calculations become more difficult when more than one product is produced and sold. In a multiproduct environment, a manager calculating the break-even point is concerned not so much with the unit sales or the dollar sales of a single product but with the amount of total sales necessary to break even. This requires the calculation of an "average" contribution margin for all the products produced and sold. This calculation in turn requires an estimate of the sales mix: the relative percentage of total units or total sales dollars expected from each product.[1] However, customers (and sales volume) will not always behave in the manner that we predict. For example, although the expected sales product mix may be 600 units of Product A and 400 units of Product B, we can estimate our customers' buying habits only from past experience. If the sales product mix ends up being 700 units of A and 300 units of B, the break-even analysis will change accordingly.

[1]Calculating the optimum mix of products to produce given limited resources and demand constraints is addressed in Chapter 7. The optimum mix will result in the highest overall contribution margin and also the highest overall profit for a company.

A thorough understanding of fixed and variable costs is necessary before a manager can calculate and understand a break-even analysis.

Now, assume that Happy Daze adds another game to its product line. The company estimates that the new game will achieve sales of approximately 4,500 units. The expected sales product mix (in units) is therefore 64 percent (8,000 ÷ 12,500) old game and 36 percent (4,500 ÷ 12,500) new game. The new game will be priced at $15 per unit and requires $11 of variable production, selling, and administrative costs, so the contribution margin per unit is $4. The game will also require an investment of $15,000 in additional fixed costs. A summary of the price and cost of the old and new games follows:

Happy Daze Game Company

	Old Game (8,000 units)	Per Unit	New Game (4,500 units)	Per Unit
Sales	$100,000	$12.50	$67,500	$15.00
Less: Variable costs	72,000	9.00	49,500	11.00
Contribution margin	$ 28,000	$ 3.50	$18,000	$ 4.00
Less: Fixed costs	35,000		15,000	
Net operating income (loss)	$ (7,000)		$ 3,000	

The average contribution margin can be found by weighting the contribution margins per unit for the old game and the new game by the relative sales mix and then summing the products. The weighting is as follows:

Old game = 0.64 × $3.50 = $2.24
New game = 0.36 × $4.00 = $1.44

The weighted-average contribution margin for Happy Daze Game Company is therefore $3.68 per game ($2.24 + $1.44). The amount can also be calculated by dividing the total contribution margin earned by selling both games ($46,000) by the total number of units sold (12,500 games) ($46,000 ÷ 12,500 games = $3.68

per game). The break-even formula for a company with multiple products is as follows:

$$\text{Break-even (units)} = \frac{\text{Fixed costs}}{\text{Weighted-average contribution margin per unit}}$$

Happy Daze's break-even point is therefore 13,587 units ($50,000 ÷ $3.68). How is this number interpreted? Remember that the weighted-average contribution margin is dependent on the sales mix. Likewise, the break-even point is dependent on the sales mix. Assuming a sales mix of 64 percent old games and 36 percent new games, Happy Daze must sell 8,696 old games and 4,891 new games to break even:

$$\text{Old game} = 13{,}587 \times 0.64 = 8{,}696$$
$$\text{New game} = 13{,}587 \times 0.36 = 4{,}891$$

If the sales mix changes to 50 percent old games and 50 percent new games, what will be the impact on the break-even point? What if the sales mix changes to 40 percent old games and 60 percent new games? With the sales mix at 50 percent old and 50 percent new, the weighted-average contribution margin becomes $3.75 [(0.50 × $3.50) + (0.50 × $4.00)]. When the mix changes to 40 percent old and 60 percent new, the weighted-average contribution margin changes to $3.80 [(0.40 × $3.50) + (0.60 × $4.00)]. Notice that when the volume shifts toward selling more of the product with the highest contribution margin, the weighted-average contribution margin increases. As the weighted-average contribution margin increases, the break-even point will decrease.

The break-even point calculated with a weighted-average contribution margin for multiple products is valid only for the sales mix used in the calculation. If the sales mix changes, the break-even point will also change. The more products involved in the sales mix, the more sensitive the calculation becomes to changes in sales mix.

LO4 Target Profit Analysis (Before and After Tax)

The goal of most businesses is not to break even but to earn a profit. Luckily, we can easily modify the break-even formula to compute the amount of sales needed to earn a target profit (before tax). Instead of solving for the sales necessary to earn a net income of zero, we simply solve for the sales necessary to reach a target profit:

$$\text{Sales} - \text{Variable costs} - \text{Fixed costs} = \text{Target profit (before tax)}$$
$$SP(x) - VC(x) - FC = TP,$$

where

SP = Sales price per unit
VC = Variable costs per unit
FC = Total fixed costs
TP = Target profit (before tax)
x = Number of units sold

Rearranging and dividing each side by SP − VC, we find the number of units (x) that must be sold to earn a before-tax target profit by dividing the sum of the fixed costs and the target profit by the contribution margin (CM) per unit:

$$(SP - VC)(x) = (FC + TP)$$

$$x = \frac{[FC + TP \text{ (before tax)}]}{CM}$$

Consequently,

$$\text{Sales volume (to reach a target profit before tax)} = \frac{[FC + TP \text{ (before tax)}]}{CM}$$

Happy Daze has decided that it must earn a target profit of $100,000 on sales of the old game or the owners will not want to continue their investment in the business. The question is how many old games does the company have to sell to earn that amount of profit?

$$\text{Sales volume (to reach a target profit before tax)} = \frac{(\$35{,}000 + \$100{,}000)}{\$3.50}$$
$$= 38{,}571 \text{ units (rounded)}$$

Although Happy Daze must sell only 10,000 old games to break even, the company must sell 38,571 old games to reach a before-tax target profit of $100,000. In fact, once we know that Happy Daze's break-even point is 10,000 units, we can directly calculate the sales necessary to reach a target profit of $100,000 by using the CM per unit. Because each additional unit sold (above the break-even point) will contribute $3.50 toward net income, Happy Daze must sell an additional 28,572 units ($100,000 ÷ $3.50) to earn a profit of $100,000.

The multiple-product break-even formula can be modified in a similar fashion to solve for the sales

necessary to reach a target profit. In a multiple-product environment,

$$\text{Sales volume (to reach target profit)} = \frac{\text{(Fixed costs + Target profit)}}{\text{Weighted-average contribution margin per unit}}$$

The Impact of Taxes

The payment of income taxes also needs to be considered in the target profit formula. If Happy Daze sells 38,572 games and earns the projected $100,000 in target profit, the company still won't have $100,000 in cash flow to distribute to the owners as dividends, because it must pay income tax on the profit. If we assume that the income tax rate for Happy Daze is 35 percent, the company will have to pay $35,000 in income tax ($100,000 × 35%) and will be left with after-tax profit of $65,000. The after-tax profit can be found by multiplying the before-tax profit by (1 − tax rate). Correspondingly, the before-tax profit equals the after-tax profit divided by (1 − tax rate):

$$\text{Before-tax profit} = \frac{\text{After-tax profit}}{(1 - \text{tax rate})}$$

If Happy Daze desires to earn an after-tax profit of $100,000, the company must earn a before-tax profit of $153,846 (rounded):

$$\text{Before-tax profit} = \frac{\$100{,}000}{(1 - 0.35)} = \$153{,}846$$

Consequently, Happy Daze must sell 53,956 units of the old game in order to reach a before-tax profit of $153,846 and an after-tax profit of $100,000:

$$\text{Sales volume (to reach an after-tax target profit)} = \frac{(\$35{,}000 + \$153{,}846)}{\$3.50} = 53{,}956 \text{ units}$$

This is confirmed in the following income statement for Happy Daze:

Sales (53,956 units)	$674,450
Less: Variable costs	485,604
Contribution margin	$188,846
Less: Fixed costs	35,000
Income before taxes	$153,846
Less: Income tax @35%	53,846
Net income after tax	$100,000

The payment of income taxes is an important variable in target profit and other CVP decisions if managers are to understand the bottom-line effect of their decisions.

LO5 Cost Structure and Operating Leverage

As mentioned in Chapter 5, *cost structure* refers to the relative proportion of fixed and variable costs in a company. On the one hand, highly automated manufacturing companies with large investments in property, plant, and equipment are likely to have cost structures dominated by fixed costs. On the other hand, labor-intensive companies such as home builders are likely to have cost structures dominated by variable costs. Even companies in the same industry can have very different cost structures. A company's cost structure is important because it directly affects the sensitivity of that company's profits to changes in sales volume. Consider, for example, two companies that make the same product (furniture), with the same sales and same net income. Company A is highly automated and uses state-of-the-art machinery to design, cut, and assemble its products. Company B is highly labor intensive and uses skilled craftspeople to cut and assemble its products. Contribution margin income statements for both companies are provided in Exhibit 6-4.

Which company would you prefer to run? Although you might opt for Company A, with its high level of

Exhibit 6-4 Contribution Margin Ratio and Operating Leverage

	Company A	Company B
Sales	$200,000	$200,000
Less: Variable costs	40,000	80,000
Contribution margin	$160,000	$120,000
Less: Fixed costs	80,000	40,000
Net operating income	$ 80,000	$ 80,000
Contribution margin ratio	80%	60%
Operating leverage	2.0	1.5

automation and correspondingly higher contribution margin ratio relative to Company B, consider the impact of changes in sales volume on the net income of each company. Although *increasing* sales will benefit Company A more than Company B, what happens when sales *decline*? If sales decline by 10 percent ($20,000), the income of Company A will decline by $16,000 ($20,000 × 80%), whereas the income of Company B will decline by $12,000 ($20,000 × 60%).

A company with a cost structure characterized by a large proportion of fixed costs relative to variable costs will experience wider fluctuations in net income as sales increase and decrease than a company with more variable costs in its cost structure.

Operating Leverage

Operating leverage is a measure of the proportion of fixed costs in a company's cost structure and is used as an indicator of how sensitive profit is to changes in sales volume. A company with high fixed costs in relation to variable costs will have a high level of operating leverage. In this case, net income will be very sensitive to changes in sales volume. In other words, a small percentage increase in sales dollars will result in a large percentage increase in net income. In contrast, a company with high variable costs in relation to fixed costs will have a low level of operating leverage and income will not be as sensitive to changes in sales volume. Operating leverage is computed with the following formula:

$$\text{Operating leverage} = \frac{\text{Contribution margin}}{\text{Net operating income}}$$

In Exhibit 6-4, Company A has an operating leverage of 2.0 ($160,000 ÷ $80,000) whereas Company B has an operating leverage of 1.5 ($120,000 ÷ $80,000). What does this mean? When sales increase (decrease) by a given percentage, the operating income of Company A will increase (decrease) by 2 times that percentage increase (decrease), whereas the operating income of Company B will increase (decrease) by 1.5 times the percentage change in sales. When sales increase by 10 percent, the operating income of Company A will increase by 20 percent, or $16,000 ($80,000 × 20%). In other words, when sales of Company A increase to $220,000, operating income will increase to $96,000. The operating income of Company B will increase by 15 percent, or $12,000 ($80,000 × 15%), to a new operating income of $92,000. Likewise, when sales decrease by 10 percent, the operating income of Company A will decrease by 20 percent whereas the operating income of Company B will decrease by 15 percent.

Operating leverage The contribution margin divided by net income; used as an indicator of how sensitive net income is to a change in sales.

As summarized in Exhibit 6-5, when operating leverage is high, a change in sales results in large changes in profit. By contrast, when operating leverage is low, a change in sales results in small changes in profits.

Exhibit 6-5 Operating Leverage and the Impact on Profit

	Operating Leverage	
	High	Low
Percent increase in profit with increase in sales	Large	Small
Percent increase in loss with decrease in sales	Large	Small

Unlike measures of contribution margin, operating leverage changes as sales change (see Exhibit 6-6). At a sales level of 1,000 units ($200,000), Company B's operating leverage is 1.5. A 10 percent increase in sales increases net income by 15 percent. At a sales level of 500 units, operating leverage increases to 3.0 and a 10 percent increase in sales will increase net income by 30 percent (3 × 10%). At a sales level of 2,000 units, operating leverage is reduced to 1.2 and a 10 percent increase in sales will increase income by 12 percent.

As a company gets closer and closer to the break-even point, operating leverage will continue to increase and income will be very sensitive to changes in sales.

Exhibit 6-6 Company B—Operating Leverage at Various Levels of Sales

	500 Units	1,000 Units	2,000 Units
Sales	$100,000	$200,000	$400,000
Less: Variable costs	40,000	80,000	160,000
Contribution margin	$ 60,000	$120,000	$240,000
Less: Fixed costs	40,000	40,000	40,000
Net operating income	$ 20,000	$ 80,000	$200,000
Operating leverage	$\frac{\$60,000}{\$20,000} = 3.0$	$\frac{\$120,000}{\$80,000} = 1.5$	$\frac{\$240,000}{\$200,000} = 1.2$

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A company operating near the break-even point will have a high level of operating leverage, and income will be very sensitive to changes in sales volume.

For example, when Company B sells 334 units (see Exhibit 6-7), the contribution margin is equal to $40,080, operating income is equal to $80, and operating leverage is equal to 501 ($40,080 ÷ $80). A 10 percent increase in sales at this point will increase net operating income by a whopping 5,010 percent.

Understanding the concepts of contribution margin and operating leverage and how they are used in CVP analysis is very important in managerial decision making. Using these tools, managers can quickly estimate the impact on net income of changes in cost, sales volume, and price.

Exhibit 6-7 Company B—Operating Near the Break-Even Point

Sales (334 units)	$66,800
Less: Variable costs	26,720
Contribution margin	$40,080
Less: Fixed costs	40,000
Net operating income	$ 80
Operating leverage	$\frac{\$40,080}{\$80} = 501$

STUDY TOOLS 6

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- Learning Objective and Key Concept Reviews
- Key Definitions and Formulas

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- Flash Cards and Crossword Puzzles
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- Homework Assignments (as directed by your instructor)

BRIEF EXERCISES

1. Contribution Margin LO1

Companies that wish to distribute their income statements to outside parties such as banks must prepare those statements by using the traditional income statement format. These same companies may also prepare contribution margin income statements to more fully understand their costs. The following terms are commonly used in describing contribution margin income statements and related topics:

Gross profit	Decrease
Contribution margin	Fixed costs
Net income	Contribution margin ratio
Variable costs	Increase

Required

Choose the term from the preceding list that most appropriately completes the following statements.

a. Once a company has paid all of its fixed costs, net income increases in an amount equal to _____ for each unit sold to customers.
b. When production and sales are equal, whether a company prepares a traditional income statement or a contribution margin income statement, two numbers do not change. One of these is sales, and the other is _____.
c. _____, the difference between sales and cost of goods sold, is not reported on the contribution margin income statement.
d. For every unit sold, contribution margin will _____ in total.
e. The _____ is computed by dividing the contribution margin by sales dollars.
f. Of these two cost categories, only _____ increases and decreases contribution margin.
g. If a company is unable to increase sales or _____ variable costs, the company can increase net income by reducing _____.

2. What-If Analysis LO2

Mike's Motorcycles has enjoyed several years of business success, but recently the company has seen some indications of a slowdown in sales. The company's owner has decided to increase the advertising budget by 10% and reduce sales prices by 4%. The following partial income statement shows the company's results for the most recent quarter:

Mike's Motorcycles Partial Income Statement	
Sales	$800,000
Less: Variable costs	560,000
Contribution margin	240,000
Less: Fixed costs	175,000
Net operating income	$ 65,000

Required

Assuming that the advertising budget was $30,000 for the quarter and was included in the fixed costs, calculate Mike's Motorcycles' new net income or loss if the changes are made. You should assume that the variable costs will not change if Mike implements the preceding changes.

3. Break-Even Analysis LO3

Katie and Holly founded Hokies Plumbing Company after graduating from college. They wanted to be competitive, so they set their rate for house calls at a modest $100. After paying the company's gas and other variable costs of $60, the women thought there would be enough profit. Because they were ready to live life a bit, they set their salaries at $100,000 each. There were no other fixed costs at all.

Required

Calculate the number of house calls that Hokies Plumbing must make to break even.

4. Target Profit Analysis LO4

Nellie's Nursery has the following information related to sales of one popular type of spring flower that is widely sold to landscapers in a multistate region of the country:

Sales price per flower	$ 0.70
Variable costs per flower	0.20
Total fixed costs for the type of flower	$20,000

Required

If Nellie's Nursery wishes to earn a before-tax profit of $30,000 on this type of flower, how many flowers must be sold to landscapers?

5. Operating Leverage LO5

Naru's has the following information for the most recent year:

Naru's Partial Income Statement	
Sales	$1,200,000
Less: Variable costs	700,000
Contribution margin	500,000
Less: Fixed costs	250,000
Net operating income	$ 250,000

Required

What is Naru's operating leverage?

EXERCISES

6. CVP: The Impact on Income LO2

Eric Ziegler started a lawn-mowing service in high school. He currently prices his lawn-mowing service at $35 per yard. He estimates that variable expenses related to gasoline, supplies, and depreciation on his equipment total $21 per yard.

Required

If Eric wants to increase his price by 40 percent, how many fewer yards can he mow before his net income decreases?

7. CVP: What-If Analysis LO2

Last year, Mayes Company had a contribution margin of 30 percent. This year, fixed expenses are expected to remain at $120,000 and sales are expected to be $550,000, which is 10 percent higher than last year.

Required

What must the contribution margin ratio be if the company wants to increase net income by $15,000 this year?

8. What-If Decisions with Changing Fixed Costs LO2

Walker Company has current sales of $600,000 and variable costs of $360,000. The company's fixed costs are equal to $200,000. The marketing manager is considering a new advertising campaign, which will increase fixed costs by $10,000. She anticipates that the campaign will cause sales to increase by 5 percent as a result.

Required

Should the company implement the new advertising campaign? What will be the impact on Walker's net operating income?

9. Operating Leverage LO2, 5

Burger Queen Restaurant had the following information available related to its operations from last year:

Sales (150,000 units)	$500,000
Variable costs	200,000
Contribution margin	$300,000
Fixed costs	150,000
Net operating income	$150,000

Required

A. What is Burger Queen's operating leverage?
B. If sales increased by 30 percent, what would Burger Queen's net operating income be?

10. Break-Even Analysis LO3

Jimmy's Seafood Restaurant is a family-owned business on the North Carolina coast. In the last several months, the owner has seen a drop-off in business. Last month, the restaurant broke even. The owner looked over the records and saw that the restaurant served 1,000 meals last month (variable cost is $10 per meal) and incurred fixed costs totaling $25,000.

Required

Calculate Callahan's average selling price for a meal.

11. Break-Even Analysis LO3

Lincoln Company sells logs for an average of $18 per log. The company's president, Abraham, estimates that the variable manufacturing and selling costs total $6 per log. Logging operations require substantial investments in equipment, so fixed costs are quite high and total $108,000 per month. Abraham is considering making an investment in a new piece of logging equipment that will increase monthly fixed costs by $12,000.

Required

Assist Abraham by calculating the number of additional logs that must be sold to break even after investing in the new equipment.

12. Break-Even Analysis: Multiproduct Environment LO3

Kim Johnson's company produces two well-known products: Glide Magic and Slide Magic. Glide Magic accounts for 60 percent of her sales, and Slide Magic accounts for the rest. Glide currently sells for $16 per tube and has variable manufacturing and selling costs of $8. Slide sells for just $12 and has variable costs of $9 per tube. Kim's company has total fixed costs of $36,000.

Required

Calculate the total number of tubes that must be sold for Kim's company to break even.

13. Break-Even Analysis: Multiproduct Environment LO3

Donald Tweedt started a company to produce and distribute natural fertilizers. Donald's company sells two fertilizers that are wildly popular: green fertilizer and compost fertilizer. Green fertilizer, the most popular among environmentally minded consumers, commands the highest price and sells for $16 per 30-pound bag. Green fertilizer also requires additional processing and includes environmentally friendly ingredients that increase its variable costs to $10 per bag. Compost fertilizer sells for $12 and has easily acquired ingredients that require no special processing. It has variable costs of $8 per bag. Tweedt's total fixed costs are $35,000. After some aggressive marketing efforts, Tweedt has been able to drive consumer demand to be equal for each fertilizer.

Required

Calculate the number of bags of green fertilizer that will be sold at break-even.

14. Sales to Reach After-Tax Profit LO4

Lockwood Company currently sells its deadbolt locks for $30 each. The locks have a variable cost of $10, and the company's annual fixed costs are $150,000. The company's tax rate is 40 percent.

Required

Calculate the number of locks that must be sold to earn an after-tax profit of $24,000.

15. Target Profit Analysis LO4

Kingman Corp. has been concerned with maintaining a solid annual profit. The company sells a line of fire extinguishers that are perfect for homeowners, for an average of $10 each. The company has perfected its production process and now produces extinguishers with a variable cost of $4 per extinguisher. Kingman's annual fixed costs are $92,000. Kingman's tax rate is 40 percent.

Required

Calculate the number of extinguishers Kingman must sell to earn an after-tax profit of $60,000.

PROBLEMS

16. Multiproduct Break-Even Analysis LO1, 3

Don Waller and Company sells canisters of three mosquito-repellant products: Citronella, DEET, and Mean Green. The company has annual fixed costs of $260,000. Last year, the company sold 5,000 canisters of its mosquito repellant in the ratio of 2:4:4. Waller's accounting department has compiled the following data related to the three mosquito repellants:

	Citronella	DEET	Mean Green
Price per canister	$11.00	$15.00	$17.00
Variable costs per canister	6.00	12.00	16.00

Required

A. Calculate the total number of canisters that must be sold for the company to break even.
B. Calculate the number of canisters of Citronella, DEET, and Mean Green that must be sold to break even.
C. How might Don Waller and Company reduce its break-even point?

17. CVP: What-If Analysis LO1, 2, 3

Hacker Aggregates mines and distributes various types of rocks. Most of the company's rock is sold to contractors who use the product in highway construction projects. Treva Hacker, company president, believes that the company needs to advertise to increase sales. She has proposed a plan to the other managers that Hacker Aggregates spend $100,000 on a targeted advertising campaign. The company currently sells 25,000 tons of aggregate for total revenue of $5,000,000. Other data related to the company's production and operational costs follow:

Direct labor	$1,500,000
Variable production overhead	200,000
Fixed production overhead	350,000
Selling and administrative expenses:	
Variable	50,000
Fixed	300,000

Required

A. Compute the break-even point in units (i.e., tons) for Hacker Aggregates.
B. Compute the contribution margin ratio for Hacker Aggregates.
C. If Treva decides to spend $100,000 on advertising and the company expects the advertising to increase sales by $200,000, should the company increase the advertising? Why or why not?

18. CVP and Break-Even Analysis LO1, 2, 3

Lauren Tarson and Michele Progransky opened Top Drawer Optical seven years ago with the goal of producing fashionable and affordable eyewear. Tarson and Progransky have been very pleased with their revenue growth. One particular design, available in plastic and metal, has become one of the company's best sellers. The following data relate to this design:

	Plastic Frames	Metal Frames
Sales price	$ 60.00	$ 80.00
Direct materials	20.00	18.00
Direct labor	13.50	13.50
Variable overhead	6.50	8.50
Budgeted unit sales	10,000	30,000

Currently, the company produces exactly as many frames as it can sell. Therefore, it has no opportunity to substitute a more expensive frame for a less expensive one. Top Drawer Optical's annual fixed costs are $1.225 million.

Required

Each of the following is an independent situation.

A. Calculate the total number of frames that Top Drawer Optical needs to produce and sell to break even.
B. Calculate the total number of frames that Top Drawer Optical needs to produce and sell to break even if budgeted direct material costs for plastic frames decrease by $10 and annual fixed costs increase by $12,500 for depreciation of a new production machine.

C. Tarson and Progransky have been able to reduce the company's fixed costs by eliminating certain unnecessary expenditures and downsizing supervisory personnel. Now, the company's fixed costs are $1,122,000. Calculate the number of frames that Top Drawer Optical needs to produce and sell to break even if the company sales mix changes to 35 percent plastic frames and 65 percent metal frames.

19. Decision Focus: Basic CVP and Break-Even Analysis LO1, 2, 3

Gigi LeBlanc founded a company to produce a special bicycle suspension system several years ago after her son, who worked for a bicycle delivery service, was hurt in a riding accident. The market's response has been overwhelmingly favorable to the company's new suspension system. Riders report feeling that they experience fewer "unpredictable" bumps than with traditional suspension systems. Gigi made an initial investment of $100,000 and has set a target of earning a 30 percent return on her investment. Gigi expects her company to sell approximately 10,000 suspension systems in the coming year. Based on this level of activity, variable manufacturing costs will be $5 for each suspension system. Fixed selling and administrative expenses will be $2 per system, and other fixed costs will be $1 per system.

Required

A. Calculate the sales price that Gigi LeBlanc's company must charge for a suspension system if she is to earn a 30 percent return on her investment.
B. Calculate the company's break-even point.
C. Assuming that Gigi's company maintains the current activity level, how can she increase her return on investment to 35 percent?

20. Break-Even and Target Profit LO1, 2, 3, 4

Matthew Hagen started his company, The Sign of Things to Come, three years ago after graduating from Upper State University. While earning his engineering degree, Matthew became intrigued by all of the neon signs he saw at bars and taverns around the university. Few of his friends were surprised to see him start a neon sign company after leaving school. Matthew is currently considering the introduction of a new custom neon sign that he believes will sell like hot cakes. In fact, he is estimating that the company will sell 700 of the signs. The new signs are expected to sell for $75 and require variable costs of $25. The new signs will require a $30,000 investment in new equipment.

Required

A. How many new signs must be sold to break even?
B. How many new signs must be sold to earn a profit of $15,000?
C. If 700 new signs are sold, how much profit will they generate?
D. What would be the break-even point if the sales price decreased by 20 percent? Round your answer to the next-highest number.
E. What would be the break-even point if variable costs per sign decreased by 40 percent?
F. What would be the break-even point if the additional fixed costs were $50,000 rather than $30,000?

21. Decision Focus: Break-Even and Target Profit LO1, 2, 3, 4

ZIA Motors is a small automobile manufacturer. Chris Rickard, the company's president, is currently evaluating the company's performance and is considering options that might be effective at increasing ZIA's profitability. The company's controller, Holly Smith, has prepared the following cost and expense estimates for next year, on the basis of a sales forecast of $3,000,000:

Direct materials	$ 800,000
Direct labor	700,000
Factory overhead	750,000
Selling expenses	300,000
Other administrative expenses	100,000
	$2,650,000

After Chris received and reviewed the cost and expense estimates, he realized that Holly had given him all the data without breaking it out into fixed and variable components. He called her, and she told him the following: "Factory overhead and selling expenses are 40 percent variable, but other administrative expenses are 30 percent variable."

Required

A. How much revenue must ZIA generate to break even?
B. Chris Rickard has set a target profit of $700,000 for next year. How much revenue must ZIA generate to achieve Chris's goal?

22. Decision Focus: Multiproduct Break-Even Analysis LO4

Clean Skin Company sells bottles of three face-wash products: Daily Wash, Mud Mask, and Face Cleanser. The company has annual fixed costs of $300,000. Last year, the company sold 7,500 bottles of its face-wash products in the ratio of 4:2:4. Clean Skin's accounting department has compiled the following data related to the three face-wash products:

	Daily Wash	Mud Mask	Face Cleanser
Price per bottle	$12.00	$20.00	$14.00
Variable costs per bottle	2.00	8.00	6.00

A. Calculate the total number of bottles that must be sold for the company to break even.
B. Calculate the number of bottles of Daily Wash, Mud Mask, and Face Cleanser that must be sold to break even.
C. How might Clean Skin Company reduce its break-even point?

CASES

23. CVP Analysis: Target Profit with Constraints LO1, 2, 4

Moore, Inc., invented a secret process to double the growth rate of hatchery trout. The company manufactures a variety of products related to this process. Each product is independent of the others and is treated as a separate division. Product managers have a great deal of freedom to manage their divisions as they think best. Failure to produce target division income is dealt with severely; however, rewards for exceeding one's profit objective are, as one division manager described them, lavish.

The Morey Division sells an additive that is added to pond water. Morey has had a new manager in each of the three previous years because each manager failed to reach Moore's target profit. Bryan Endreson has just been promoted to manager and is studying ways to meet the current target profit for Morey.

The target profit for Morey for the coming year is $800,000 (20 percent return on the investment in the annual fixed costs of the division). Other constraints on division operations are as follows:

- Production cannot exceed sales, because Moore's corporate advertising stresses completely new additives each year, even though the "newness" of the models may be only cosmetic.
- The Morey selling price may not vary above the current selling price of $200 per gallon, but it may vary as much as 10 percent below $200 (i.e., $180).

Endreson is now examining data gathered by his staff to determine whether Morey can achieve its target profit of $800,000. The data are as follows:

- Last year's sales were 30,000 units at $200 per gallon.
- The present capacity of Morey's manufacturing facility is 40,000 gallons per year, but capacity can be increased to 80,000 gallons per year with an additional investment of $1 million per year in fixed costs.
- Present variable costs amount to $80 per unit, but if commitments are made for more than 60,000 gallons, Morey's vendors are willing to offer raw material discounts amounting to $20 per gallon, beginning with gallon 60,001.

Endreson believes that these projections are reliable, and he is now trying to determine what Morey must do to meet the profit objectives assigned by Moore's board of directors.

Required

A. Calculate the dollar value of Morey's current annual fixed costs.
B. Determine the number of gallons that Morey must sell at $200 per gallon to achieve the profit objective. Be sure to consider any relevant constraints. What if the selling price is $180?
C. Without prejudice to your previous answers, assume that Bryan Endreson decides to sell 40,000 gallons at $200 per gallon and 24,000 gallons at $180 per gallon. Prepare a pro forma income statement for Morey, showing whether Endreson's decision will achieve Morey's profit objectives.

24. Break-Even and Target Profit Analysis LO1, 2, 3, 4

Boeing Corporation (formerly McDonnell Douglas Corporation) manufactures the C-17, the most flexible jet transport used by the U.S. Air Force. The company originally sold the C-17 for a "flyaway cost" of $175 million per jet. The variable production cost of each C-17 was estimated to be approximately $165 million. When the C-17 was first proposed in 1981, the Air Force expected to eventually purchase 400 jets. However, as of June 2011, only 232 C-17s have been produced and sold.

Production began, and at one point the company was faced with the following situation: With 20 jets finished, a block of 20 more in production, and funding approved for the purchase of a third block of 20 jets, the U.S. Congress began indicating that it would approve funding for the order and purchase of only 20 more jets (for a total of 80). This was a problem for the company because company officials had indicated previously that the break-even point for the C-17 project was around 100 aircraft.

Required

A. Given the previous facts concerning the sales price, variable cost, and break-even point, what were McDonnell Douglas's fixed costs associated with the development of the C-17?
B. What would the income or loss be if the company sold only 80 C-17s?
C. Assume that McDonnell Douglas had been told up front that the Air Force would buy only 80 jets. Calculate the selling price per jet that the company would have to charge to achieve a target profit (before tax) of $10 million per jet.
D. Assuming that the costs and sales price of the jet have remained the same over the years, how much income have McDonnell Douglas and Boeing made from the sale of the C-17?

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