

# 4

## COST-VOLUME-PROFIT ANALYSIS: A MANAGERIAL PLANNING TOOL

### DISCUSSION QUESTIONS

1. CVP analysis allows managers to focus on selling prices, volume, costs, profits, and sales mix. Many different “what-if” questions can be asked to assess the effect of changes in key variables on profits.
2. The units sold approach defines sales volume in terms of units of product and gives answers in these same terms. The unit contribution margin is needed to solve for the break-even units. The sales revenue approach defines sales volume in terms of revenues and provides answers in these same terms. The overall contribution margin ratio can be used to solve for the break-even sales dollars.
3. *Break-even point* is the level of sales activity where total revenues equal total costs or where zero profits are earned.
4. At the break-even point, all fixed costs are covered. Above the break-even point, only variable costs need to be covered. Thus, contribution margin per unit is profit per unit, provided that the unit selling price is greater than the unit variable cost (which it must be for breakeven to be achieved).
5. Variable cost ratio = Total variable cost/Sales  
Contribution margin ratio = Contribution margin/Sales  
Contribution margin ratio = 1 – Variable cost ratio
6. No. The increase in contribution is \$9,000 ( $0.3 \times \$30,000$ ) and the increase in advertising expense is \$10,000. If the contribution margin ratio is 0.4, then the increased contribution margin is \$12,000 ( $0.4 \times \$30,000$ ). This is \$2,000 above the increased advertising expense, so the increased advertising would be a good decision.
7. *Sales mix* is the relative proportion sold of each product. For example, a sales mix of 3:2 means that three units of one product are sold for every two units of another product.
8. Packages of products, based on the expected sales mix, are defined as a single product. Selling price and cost information for this package can then be used to carry out CVP analysis.
9. This statement is wrong; break-even analysis can be easily adjusted to focus on targeted profit.
10. The basic break-even equation is adjusted for targeted profit by adding the desired targeted profit to total fixed cost in the numerator. The denominator remains the contribution margin per unit.
11. A change in sales mix will change the contribution margin of the package (defined by the sales mix), and thus will change the units needed to break even.

12. *Margin of safety* is the sales activity in excess of that needed to break even. The higher the margin of safety, the lower the risk.
13. *Operating leverage* is the use of fixed costs to extract higher percentage changes in profits as sales activity changes. It is achieved by increasing fixed costs while lowering variable costs. Therefore, increased leverage implies increased risk, and vice versa.
14. Sensitivity analysis is a “what-if” technique that examines the impact of changes in underlying assumptions on an answer. A company can input data on selling prices, variable costs, fixed costs, and sales mix and set up formulas to calculate break-even points and expected profits. Then, the data can be varied as desired to see what impact changes have on the expected profit.
15. A declining margin of safety means that sales are moving closer to the break-even point. Profit is going down, and the possibility of loss is greater. Managers should analyze the reasons for the decreasing margin of safety and look for ways to increase revenue and/or decrease costs.

### MULTIPLE-CHOICE EXERCISES

- 4-1.    **b**
- 4-2.    **d**
- 4-3.    **a**
- 4-4.    **d**
- 4-5.    **e**
- 4-6.    **b**
- 4-7.    **a**
- 4-8.    **d**
- 4-9.    **b**    Break-even units =  $\$8,400/(\$10 - \$3) = 1,200$
- 4-10.   **c**    Variable cost ratio =  $\$3/\$10 = 0.3$ , or 30%  
                   Contribution margin ratio =  $(\$10 - \$3)/\$10 = 0.7$ , or 70%
- 4-11.   **e**
- 4-12.   **c**    Units to be sold =  $(\$15,000 + \$3,600)/(\$8 - \$6) = 9,300$

**CORNERSTONE EXERCISES****CE 4-13**

1. Variable cost per unit = Direct materials + Direct labor + Variable factory overhead + Variable selling expense  
 = \$30 + \$8 + \$4 + \$3  
 = \$45
2. Total fixed expense = \$20,000 + \$29,500 = \$49,500

3.

Head-First Company Contribution Margin Income Statement For the Coming Year		
	Total	Per Unit
Sales (\$75 × 5,000 helmets).....	\$375,000	\$75.00
Total variable cost (\$45 × 5,000 helmets).....	225,000	45.00
Total contribution margin.....	\$150,000	\$30.00
Total fixed cost.....	49,500	
Operating income .....	\$100,500	

**CE 4-14**

1. Break-even units =  $\frac{\text{Total fixed cost}}{\text{Price} - \text{Variable cost per unit}}$   
 = \$49,500/(\$75 – \$45)  
 = 1,650 helmets

2.

Head-First Company Contribution Margin Income Statement At Break-Even Point	
	Total
Sales (\$75 × 1,650 helmets).....	\$ 123,750
Total variable cost (\$45 × 1,650 helmets).....	74,250
Total contribution margin.....	\$ 49,500
Total fixed cost.....	49,500
Operating income.....	\$ 0

## CE 4-15

1. Variable cost ratio =  $\frac{\text{Variable cost per unit}}{\text{Price}}$   
 = \$45/\$75  
 = 0.60, or 60%
2. Contribution margin ratio =  $\frac{\text{Price} - \text{Variable cost per unit}}{\text{Price}}$   
 =  $\frac{\text{Contribution margin per unit}}{\text{Price}}$   
 = (\$75 - \$45)/\$75  
 = 0.40, or 40%

3. Head-First Company Contribution Margin Income Statement For the Coming Year		
		Percent of Sales
Sales (\$75 × 5,000 helmets).....	\$375,000	100%
Total variable cost (\$45 × 5,000 helmets).....	225,000	60%
Total contribution margin.....	\$150,000	40%
Total fixed cost.....	49,500	
Operating income .....	<u>\$100,500</u>	

## CE 4-16

1. Break-even sales dollars =  $\frac{\text{Total fixed cost}}{\text{Contribution margin ratio}}$   
 = \$49,500/0.40  
 = \$123,750

2. Head-First Company Contribution Margin Income Statement At Break-Even Point	
	Total
Sales.....	\$ 123,750
Total variable cost (\$123,750 × 0.60).....	74,250
Total contribution margin.....	\$ 49,500
Total fixed cost.....	49,500
Operating income.....	<u>\$ 0</u>

## CE 4-17

$$\begin{aligned}
 1. \text{ Break-even units} &= \frac{\text{Total fixed cost} + \text{Target income}}{\text{Price} - \text{Variable cost per unit}} \\
 &= (\$49,500 + \$81,900)/(\$75 - \$45) \\
 &= 4,380 \text{ helmets}
 \end{aligned}$$

Head-First Company Contribution Margin Income Statement At 4,380 Helmets Sold	
	Total
Sales (\$75 × 4,380 helmets).....	\$ 328,500
Total variable cost (\$45 × 4,380 helmets).....	197,100
Total contribution margin.....	\$ 131,400
Total fixed cost.....	49,500
Operating income.....	\$ 81,900

## CE 4-18

$$\begin{aligned}
 1. \text{ Sales for target income} &= \frac{\text{Total fixed cost} + \text{Target income}}{\text{Contribution margin ratio}} \\
 &= (\$49,500 + \$81,900)/0.40 \\
 &= \$328,500
 \end{aligned}$$

Head-First Company Contribution Margin Income Statement At 4,380 Helmets Sold	
	Total
Sales.....	\$ 328,500
Total variable cost (\$328,500 × 0.60).....	197,100
Total contribution margin.....	\$ 131,400
Total fixed cost.....	49,500
Operating income.....	\$ 81,900

## CE 4-19

1. Any package with 5 bicycle helmets for every 2 motorcycle helmet is fine. For example, 5:2, or 10:4, or 30:12. Throughout the rest of this exercise, we will use 5:2.

Product	Price	–	Unit Variable Cost	=	Unit Contribution Margin	×	Sales Mix	=	Package Unit Contribution Margin
Bicycle helmet	\$ 75.00		\$ 45.00		\$30.00		5		\$150.00
Motorcycle helmet	220.00		140.00		80		2		160.00
Package total									<u>\$310.00</u>

2. Break-even packages =  $\frac{\text{Total fixed cost}}{\text{Package contribution margin}}$   
 = \$58,900/\$310  
 = 190 packages
- Break-even bicycle helmets = Number of packages × Sales mix amount  
 = 190 × 5  
 = 950
- Break-even motorcycle helmets = Number of packages × Sales mix amount  
 = 190 × 2  
 = 380

3.

Head-First Company Contribution Margin Income Statement At Break-Even Point	
	Total
Sales [(\$75 × 950) + (\$220 × 380)].....	\$ 154,850
Total variable cost [(\$45 × 950) + (\$140 × 380)].....	95,950
Total contribution margin.....	\$ 58,900
Total fixed cost.....	58,900
Operating income.....	<u>\$ 0</u>

**CE 4-20**

$$\begin{aligned}
 1. \text{ Contribution margin ratio} &= \frac{\text{Price} - \text{Variable cost per unit}}{\text{Price}} \\
 &= (\$570,000 - \$388,000)/\$570,000 \\
 &= 0.3193^*
 \end{aligned}$$

$$\begin{aligned}
 \text{Break-even sales dollars} &= \frac{\text{Total fixed cost}}{\text{Contribution margin ratio}} \\
 &= \$58,900/0.3193^* \\
 &= \$184,466
 \end{aligned}$$

\*Rounded

2. <b>Head-First Company</b> <b>Contribution Margin Income Statement</b> <b>At Break-Even Sales Dollars</b>	
	<b>Total</b>
Sales.....	\$ 184,466
Total variable cost (\$184,466 × 0.6807).....	125,566
Total contribution margin.....	\$ 58,900
Total fixed cost.....	58,900
Operating income.....	\$ 0

**CE 4-21**

$$\begin{aligned}
 1. \text{ Margin of safety in units} &= \text{Budgeted units} - \text{Break-even units} \\
 &= 5,000 - 1,650 \\
 &= 3,350 \\
 2. \text{ Margin of safety in sales revenue} &= \text{Budgeted sales} - \text{Break-even sales} \\
 &= \$375,000 - \$123,750 \\
 &= \$251,250
 \end{aligned}$$



**CE 4-22**

$$\begin{aligned}
 \text{Degree of operating leverage} &= \frac{\text{Total contribution margin}}{\text{Operating income}} \\
 &= \$150,000 / \$100,500 \\
 &= 1.5^*
 \end{aligned}$$

\*Rounded

**CE 4-23**

$$\begin{aligned}
 1. \text{ Percent change in operating income} &= \text{DOL} \times \text{Percent change in sales} \\
 &= 1.5 \times 10\% \\
 &= 15\% \\
 \\ 
 2. \text{ Expected operating income} &= \text{Original income} + (\text{Percent change} \times \\
 &\quad \text{Original income}) \\
 &= \$100,500 + (0.15 \times \$100,500) \\
 &= \$115,575
 \end{aligned}$$

## EXERCISES

## E 4-24

1. Direct materials.....	\$3.90
Direct labor.....	1.40
Variable factory overhead.....	2.10
Variable selling and administrative expense.....	1.60
Unit variable cost.....	<u>\$9.00</u>

Unit contribution margin = Price – Unit variable cost  
 = \$20 – \$9  
 = \$11

2. Contribution margin ratio = \$11/\$20 = 0.55, or 55%

Variable cost ratio = \$9/\$20 = 0.45, or 45%

3. Break-even units = (\$52,000 + \$38,530)/(\$20 – \$9) = 8,230

4. Sales (\$20 × 8,230).....	\$ 164,600
Variable cost (\$9 × 8,230).....	<u>74,070</u>
Total contribution margin.....	\$ 90,530
Fixed cost (\$52,000 + \$38,530).....	<u>90,530</u>
Operating income.....	<u>\$ 0</u>

## E 4-25

1. At breakeven:

Total fixed cost = Total contribution margin = \$349,600

Contribution margin per unit = Total contribution margin/Break-even units  
 = \$349,600/115,000  
 = \$3.04

Contribution margin per unit = Price – Variable cost per unit

\$3.04 = Price – \$4.56

Price = \$3.04 + \$4.56 = \$7.60

2. Operating income = (Price × Quantity) – (Variable cost per unit × Quantity) – Fixed cost

\$166,000 = (\$120 × 15,600) – (Variable cost per unit × 15,600) – \$458,000

\$166,000 = \$1,872,000 – (Variable cost per unit × 15,600) – \$458,000

Variable cost per unit × 15,600 = \$1,248,000

Variable cost per unit = \$1,248,000/15,600 = \$80

**E 4-25 (Continued)**

$$\begin{aligned}
 3. \text{ Total contribution margin} &= \text{Actual revenue} \times \text{Contribution margin ratio} \\
 &= \$235,000 \times 0.25 \\
 &= \$58,750
 \end{aligned}$$

$$\begin{aligned}
 \text{Total fixed cost} &= \text{Total contribution margin} - \text{Operating income} \\
 &= \$58,750 - \$22,500 = \$36,250
 \end{aligned}$$

$$\begin{aligned}
 4. \text{ Break-even units} &= \text{Total fixed cost} / (\text{Price} - \text{Variable cost per unit}) \\
 23,600 &= \$103,840 / [\text{Price} - (0.56 \times \text{Price})] \\
 \text{Price} - (0.56 \times \text{Price}) &= \$103,840 / 23,600 \\
 \text{Price}(1.00 - 0.56) &= \$4.40 \\
 \text{Price} &= \$4.40 / (1.00 - 0.56) \\
 \text{Price} &= \$4.40 / 0.44 = \$10.00
 \end{aligned}$$

$$\begin{aligned}
 \text{Variable cost per unit} &= \text{Price} \times \text{Variable cost ratio} \\
 &= \$10.00 \times 0.56 = \$5.60
 \end{aligned}$$

$$\begin{aligned}
 \text{Contribution margin per unit} &= \text{Price} - \text{Variable cost per unit} \\
 &= \$10.00 - \$5.60 = \$4.40
 \end{aligned}$$

**E 4-26**

1. Contribution margin ratio  $= \frac{\text{Contribution margin}}{\text{Sales}}$   
 $= \$22,320/\$93,000 = 0.24, \text{ or } 24\%$
2. Variable cost ratio  $= \$70,680/\$93,000 = 0.76, \text{ or } 76\%$   
**OR**  
 Variable cost ratio  $= 1 - \text{Contribution margin ratio}$   
 $= 1.00 - 0.24 = 0.76$
3. Break-even sales revenue  $= \frac{\text{Total fixed cost}}{\text{Contribution margin ratio}}$   
 $= \$12,000/0.24 = 50,000$
4. To increase operating income without increasing sales revenue, Andreston would have to find a way to decrease variable cost (thus decreasing the variable cost ratio and increasing the contribution margin ratio), decrease fixed cost, or a combination of both.

**E 4-27**

1. Sales (\$16.00 × 26,800).....	\$ 428,800
Variable cost (\$11.50 × 26,800).....	308,200
Total contribution margin.....	<u>\$ 120,600</u>
Fixed cost.....	126,000
Operating income (loss).....	<u><u>\$ (5,400)</u></u>

2. Break-even units  $= \$126,000/(\$16.00 - \$11.50) = 28,000$
3. Units to earn target income  $= (\$126,000 + \$12,150)/(\$16.00 - \$11.50)$   
 $= 30,700$

**E 4-28**

1. Break-even units  $= (\$111,425 + \$48,350)/(\$2.75 - \$1.65)$   
 $= \$159,775/\$1.10$   
 $= 145,250$
2. Unit variable cost includes all variable costs on a unit basis:
 

Direct materials.....	\$0.37
Direct labor.....	0.63
Variable factory overhead.....	0.53
Variable selling expense.....	0.12
Unit variable cost.....	<u><u>\$1.65</u></u>

**E 4-28 (Continued)**

Unit variable manufacturing cost includes the variable costs of production on a unit basis:

Direct materials.....	\$0.37
Direct labor.....	0.63
Variable factory overhead.....	0.53
Unit variable manufacturing cost.....	<u>\$1.53</u>

Unit variable cost is used in CVP because it includes all variable costs, not just manufacturing costs.

$$\begin{aligned}
 3. \text{ Units to earn } \$13,530 &= (\$111,425 + \$48,350 + \$13,530)/(\$2.75 - \$1.65) \\
 &= 157,550
 \end{aligned}$$

$$4. \text{ Sales revenue to earn } \$13,530 = 157,550 \times \$2.75 = \$433,262.50$$

**E 4-29**

$$1. \text{ Break-even units} = (\$245,650 + \$301,505)/(\$8.42 - \$4.56) = 141,750$$

2. Expected sales in units.....	225,000
Break-even units.....	(141,750)
Margin of safety (in units).....	<u>83,250</u>
3. Expected sales revenue (\$8.42 × 225,000).....	\$ 1,894,500
Break-even sales revenue*.....	1,193,535
Margin of safety (in dollars).....	<u>\$ 700,965</u>

\*Break-even revenue = Price × Break-even units = \$8.42 × 141,750 units

4. If the price decreases, then the risk facing the company will go up. The price decrease means that the contribution margin per unit will decrease and the break-even units will increase. The increase in the break-even units will lead to a decrease in the margin of safety, as Yuan, then, would be operating closer to the break-even point.

**E 4-30**

	<u>Laertes</u>	<u>Ophelia</u>	<u>Fortinbras</u>	<u>Claudius</u>
Sales	\$ 15,000	\$ 15,600 *	\$16,250 *	\$10,600
Total variable cost	<u>5,000</u>	<u>11,700</u>	<u>9,750</u>	<u>5,300 *</u>
Total contribution margin	\$ 10,000	\$ 3,900	\$ 6,500 *	\$ 5,300 *
Total fixed cost	9,500 *	4,000	6,136 *	4,452
Operating income (loss)	<u>\$ 500</u>	<u>\$ (100) *</u>	<u>\$ 364</u>	<u>\$ 848</u>

**E 4-30 (Continued)**

	<u>Laertes</u>	<u>Ophelia</u>	<u>Fortinbras</u>	<u>Claudius</u>
Units sold	3,000 *	1,300	125	1,000
Price per unit	\$5.00	\$12 *	\$130	\$10.60 *
Variable cost per unit	\$1.67 *	\$9	\$78 *	\$5.30 *
Contribution margin per unit	\$3.33 *	\$3	\$52 *	\$5.30 *
Contribution margin ratio	67% *	25% *	40%	50% *
Break-even units	2,853 *	1,333 *	118 *	840 *

\*Designates calculated amount.

(Note: Calculated break-even units that include a fractional amount have been rounded to the nearest whole unit.)

**E 4-31**

- Variable cost ratio =  $\$282,200/\$415,000 = 0.68$ , or 68%  
Contribution margin ratio =  $\$132,800/\$415,000 = 0.32$ , or 32%

- Because all fixed costs are covered at the break-even, any revenue above breakeven contributes directly to operating income.

Sales × Contribution margin ratio = Increased operating income

$\$30,000 \times 0.32 = \$9,600$

Therefore, operating income will be \$9,600 higher.

- Break-even sales revenue =  $\$63,000/0.32 = \$196,875$

Sales.....	\$ 196,875
Variable cost ( $\$196,875 \times 0.68$ ).....	133,875
Contribution margin.....	\$ 63,000
Fixed cost.....	63,000
Operating income.....	<u>\$ 0</u>

- Expected sales..... \$415,000  
Break-even sales..... 196,875  
Margin of safety..... \$218,125
- Sales revenue..... \$ 380,000  
Break-even sales..... 196,875  
Margin of safety..... \$183,125

**E 4-32**

1. Sales mix is 4:1 (four times as many DVDs are sold as equipment sets).

Product	Price	–	Variable Cost	=	CM	×	Sales Mix	=	Total CM
DVDs	\$8		\$4		\$4		4		\$16
Equipment sets	25		16		9		1		9
<b>Total</b>									<b>\$25</b>

Break-even packages =  $\$85,000/\$25 = 3,400$

Break-even DVDs =  $4 \times 3,400 = 13,600$

Break-even equipment sets =  $1 \times 3,400 = 3,400$

**E 4-33**

1. Sales mix is 4: 1: 2 (four times as many DVDs will be sold as equipment sets, and twice as many yoga mats will be sold as equipment sets).

Product	Price	–	Variable Cost	=	CM	×	Sales Mix	=	Total CM
DVDs	\$8		\$4		\$4		4		\$16
Equipment sets	25		16		9		1		9
Yoga mats	18		13		5		2		10
<b>Total</b>									<b>\$35</b>

Break-even packages =  $\$114,100/\$35 = 3,260$

Break-even DVDs =  $4 \times 3,260 = 13,040$

Break-even equipment sets =  $1 \times 3,260 = 3,260$

Break-even yoga mats =  $2 \times 3,260 = 6,520$

Peace River Products, Inc. Income Statement For the Coming Year	
Sales.....	\$ 418,500
Total variable cost.....	261,000
Contribution margin.....	\$ 157,500
Total fixed cost.....	114,100
Operating income.....	\$ 43,400

Contribution margin ratio =  $\$157,500/\$418,500 = 0.376^*$ , or 37.6%

Break-even sales revenue =  $\$114,100/0.376 = \$303,457$

\*Rounded

4. Margin of safety =  $\$418,500 - \$303,457 = \$115,043$

**E 4-34**

1. Sales mix is 4:10:1 (four times as many portable grills will be sold as smokers, and 10 times as many stationary grills will be sold as smokers).

Product	Price	–	Variable Cost	=	CM	×	Sales Mix	=	Total CM
Portable	\$ 90		\$ 45		\$ 45		4		\$180
Stationary	200		130		70		10		700
Smoker	250		140		110		1		110
Total									<u>\$990</u>

Break-even packages =  $\$2,128,500 / \$990 = 2,150$

Break-even portable grills =  $4 \times 2,150 = 8,600$

Break-even stationary grills =  $10 \times 2,150 = 21,500$

Break-even smokers =  $1 \times 2,150 = 2,150$

Texas-Q Company Income Statement For the Coming Year	
Sales.....	\$13,050,000
Total variable cost.....	<u>8,100,000</u>
Contribution margin.....	\$ 4,950,000
Total fixed cost.....	<u>2,128,500</u>
Operating income.....	<u>\$ 2,821,500</u>

Contribution margin ratio =  $\$4,950,000 / \$13,050,000$   
= 0.3793\*, or 37.93%

Break-even revenue =  $\$2,128,500 / 0.3793 = \$5,611,653$

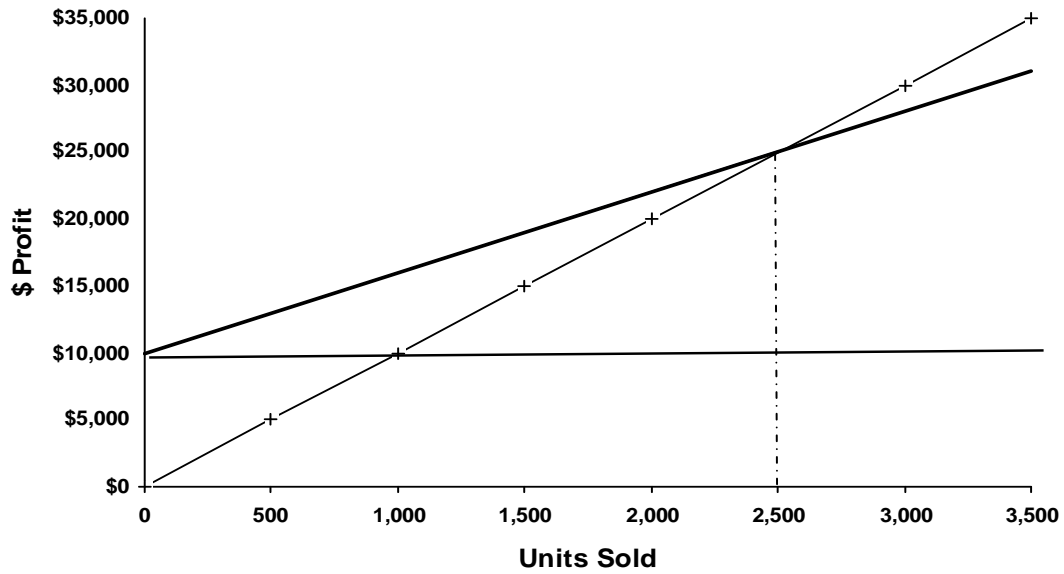
\*Rounded

4. Margin of safety =  $\$13,050,000 - \$5,611,653 = \$7,438,347$



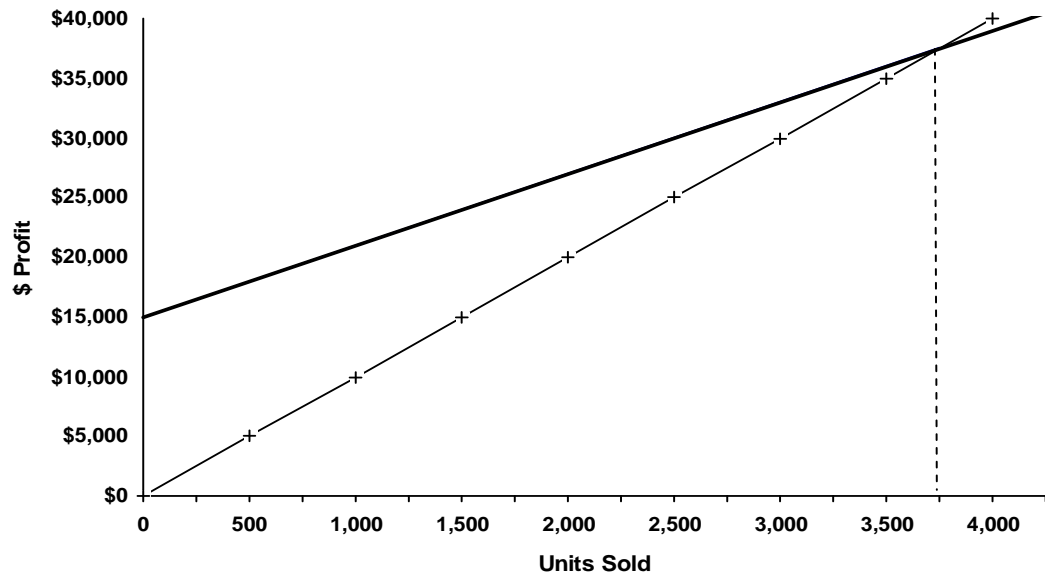
**E 4-35**

1.



**Break-even point = 2,500 units; + line is total revenue, and X line is total cost.**

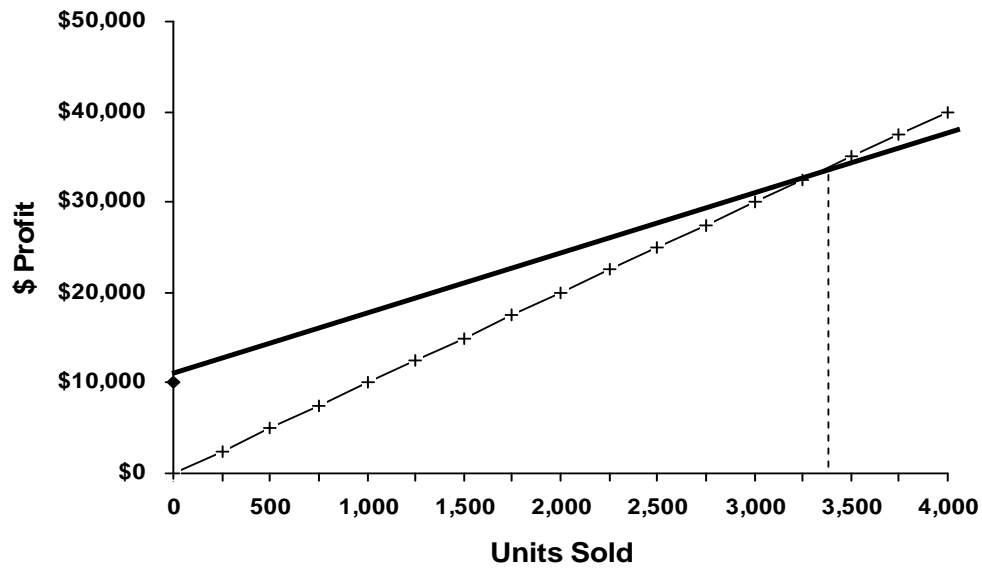
2. a. Fixed cost increases by \$5,000:



**Break-even point = 3,750 units**

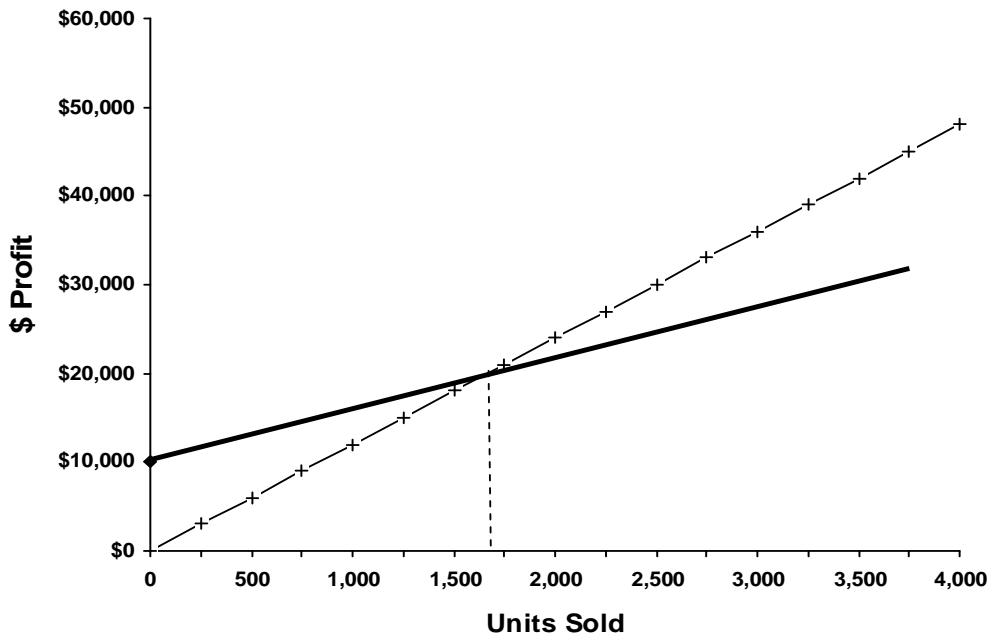
**E 4-35 (Continued)**

**2. b. Unit variable cost increases to \$7:**

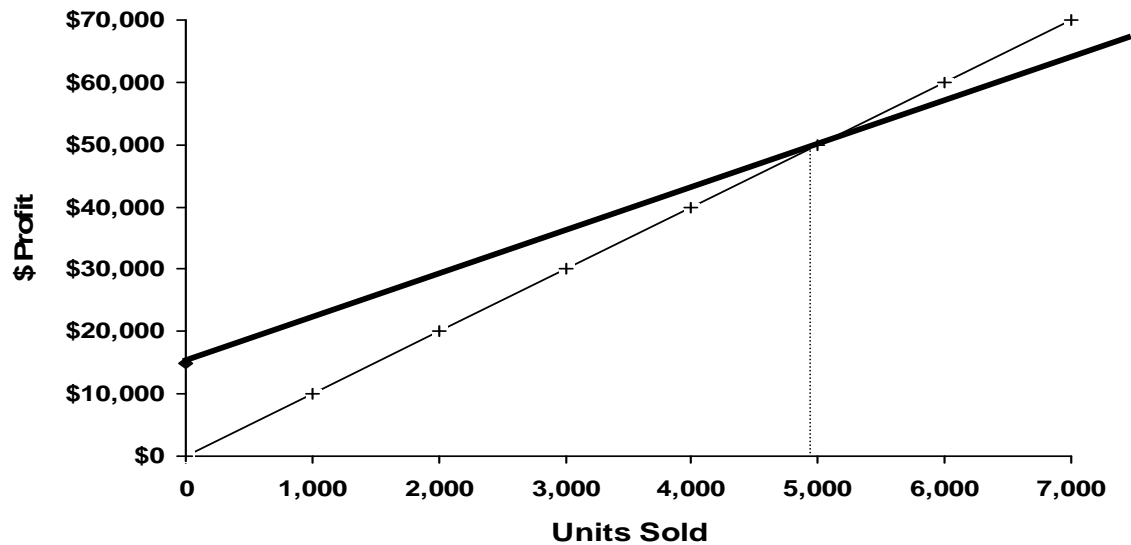


**Break-even point = 3,333 units**

**2. c. Unit selling price increases to \$12:**



**Break-even point = 1,667 units**

**E 4-35 (Continued)****2. d. Both fixed cost and unit variable cost increase:****Break-even point = 5,000 units****E 4-36****1. Unit contribution margin =  $\$877,680 / 53,000 = \$16.56$** **Break-even units =  $\$898,380 / \$16.56 = 54,250$** **2. Operating income =  $10,000 \times \$16.56 = \$165,600$** **3. Contribution margin ratio =  $\$16.56 / \$36.00 = 0.46$ , or 46%****Break-even sales revenue =  $\$898,380 / 0.46 = \$1,953,000$** **Profit =  $(\$200,000 \times 0.46) - \$20,700 = \$71,300$**

**E 4-37**

1. Break-even sales dollars =  $\$916,650 / 0.42^* = \$2,182,500$

\*Contribution margin ratio =  $\$945,000 / \$2,250,000 = 0.42$ , or 42%

2. Margin of safety =  $\$2,250,000 - \$2,182,500 = \$67,500$

3. Degree of operating leverage =  $\frac{\text{Contribution margin}}{\text{Operating income}}$   
 =  $\$945,000 / \$28,350$   
 = 33.33\*

4. Percent change in operating income =  $33.33 \times 0.20 = 6.67^*$

New operating income =  $\$28,350 + (6.67 \times \$28,350) = \$217,445$

\*Rounded

**E 4-38**

1.

Product	Price	–	Variable Cost	=	CM	×	Sales Mix	=	Total CM
Vases	\$40		\$30		\$10		2		\$20
Figurines	70		42		28		1		28
Total									<u>\$48</u>

Break-even packages =  $\$30,000 / \$48 = 625$

Break-even vases =  $2 \times 625 = 1,250$

Break-even figurines =  $1 \times 625 = 625$

2. The new sales mix is 3 vases to 2 figurines.

Product	Price	–	Variable Cost	=	CM	×	Sales Mix	=	Total CM
Vases	\$40		\$30		\$10		3		\$30
Figurines	70		42		28		2		56
Total									<u>\$86</u>

Break-even packages =  $\$35,260 / \$86 = 410$

Break-even vases =  $3 \times 410 = 1,230$

Break-even figurines =  $2 \times 410 = 820$

**E 4-39**

1. a. Variable cost per unit =  $\$8,190,000/450,000 = \$18.20$
- b. Contribution margin per unit =  $\$3,510,000/450,000 = \$7.80$
- c. Contribution margin ratio =  $\$7.80/\$26.00^* = 0.30$ , or 30%
- d. Break-even units =  $\$2,254,200/\$7.80 = 289,000$  units
- e. Break-even sales dollars =  $\$2,254,200/0.30 = \$7,514,000$

**OR**

$$\text{Break-even sales dollars} = 289,000 \times \$26 = \$7,514,000$$

2. Units for target income =  $(\$2,254,200 + \$296,400)/\$7.80 = 327,000$  units
3. Additional operating income =  $\$50,000 \times 0.30 = \$15,000$
4. Margin of safety in units =  $450,000 - 289,000 = 161,000$  units  
Margin of safety in sales dollars =  $\$11,700,000 - \$7,514,000 = \$4,186,000$
5. Degree of operating leverage =  $\$3,510,000/\$1,255,800 = 2.8^{**}$
6. New operating income =  $\$1,255,800 + [(2.8 \times 0.10) \times (\$1,255,800)] = \$1,607,424$

\* $\$11,700,000/450,000 = \$26.00$

\*\*Rounded

## PROBLEMS

## P 4-40

$$\begin{aligned}
 1. \text{ Break-even units} &= \frac{\text{Fixed cost}}{(\text{Price} - \text{Variable cost per unit})} \\
 &= \$626,400/(\$20 - \$12) \\
 &= \$626,400/\$8 \\
 &= 78,300 \text{ units}
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ Units for target profit} &= (\$626,400 + \$450,000)/(\$20 - \$12) \\
 &= \$1,076,400/\$8 \\
 &= 134,550 \text{ units}
 \end{aligned}$$

$$3. \text{ Contribution margin ratio} = \$8/\$20 = 0.40$$

With additional sales of \$37,000, the additional profit would be  
 $0.40 \times \$37,000 = \$14,800$ .

$$\begin{aligned}
 4. \text{ Current units} &= \$2,480,000/\$20 = 124,000 \\
 \text{Margin of safety in units} &= 124,000 - 78,300 = 45,700
 \end{aligned}$$

## P 4-41

$$\begin{aligned}
 1. \text{ Break-even units} &= \frac{\text{Fixed cost}}{(\text{Price} - \text{Variable cost per unit})} \\
 &= \$197,600/(\$13.50 - \$9.85) \\
 &= 54,137^*
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ Break-even units} &= (\$197,600 - \$23,500)/(\$13.50 - \$9.85) \\
 &= 47,699^*
 \end{aligned}$$

3. The reduction in fixed cost reduces the break-even point because less contribution margin is needed to cover the new, lower fixed costs. Operating income goes up, and the margin of safety also goes up.

\*Rounded

**P 4-42**

1. Unit contribution margin =  $\$5,450,000/218,000 = \$25$

Break-even point in units =  $\$4,250,000/\$25 = 170,000$

Contribution margin ratio =  $\$25/\$60 = 0.4167$

Break-even sales revenue =  $\$4,250,000/0.4167 = \$10,199,184^*$

OR

$= \$60 \times 170,000 = \$10,200,000$

*Note* : Difference in break-even sales revenue due to rounding.

2. Increased contribution margin ( $\$1,000,000 \times 0.4167$ ).....	\$416,700
Less: Increased advertising expense.....	250,000
Increased operating income.....	<u>\$166,700</u>

3.  $\$1,500,000 \times 0.4167 = \$625,050$

4. Margin of safety =  $\$13,080,000 - \$10,199,184 = \$2,880,816^*$

OR

$= \$13,080,000 - \$10,200,000 = \$2,880,000$

*Note* : Difference in margin of safety due to rounding in break-even sales revenue.

5.  $\$5,450,000/\$1,200,000 = 4.54$  (operating leverage)

$8\% \times 4.54 = 36.32\%$  (increase in operating income)

\*Rounded

**P 4-43****1. Sales mix:**

**Basic:**       $\$3,000,000/\$30$       =      **100,000 units**

**Aero:**       $\$2,400,000/\$60$       =      **40,000 units**

Product	Price	–	Variable Cost*	=	Contribution Margin	×	Sales Mix	=	Total CM
Basic sleds	\$30		\$10		\$20		5		\$100
Aerosleds	60		25		35		2		70
Package									<u>\$170</u>

\* $\$1,000,000/100,000 = \$10$

$\$1,000,000/40,000 = \$25$

Break-even packages =  $(\$1,428,000 + \$198,900)/\$170 = 9,570$

Break-even basic sleds =  $9,570 \times 5 = 47,850$

Break-even aerosleds =  $9,570 \times 2 = 19,140$

**2. New mix:**

Product	Price	–	Variable Cost*	=	Contribution Margin	×	Sales Mix	=	Total CM
Basic sleds	\$30		\$10		\$20		5		\$100
Aerosleds	60		25		35		3		105
Package									<u>\$205</u>

Break-even packages =  $(\$1,428,000 + \$198,900)/\$205 = 7,936^*$

Break-even basic sleds =  $7,936 \times 5 = 39,680$

Break-even aerosleds =  $7,936 \times 3 = 23,808$

\*Rounded

3. Increase in contribution margin for aerosleds ( $12,000 \times \$35$ ).....	\$ 420,000
Decrease in contribution margin for basic sleds ( $5,000 \times \$20$ ).....	<u>(100,000)</u>
Increase in total contribution margin.....	\$ 320,000
Less: Additional fixed cost.....	<u>195,000</u>
Increase in income.....	<u>\$ 125,000</u>

Basu would gain \$125,000 by increasing advertising for the aerosleds.

This is a good strategy.



**P 4-44**

$$1. \text{ Break-even units} = \$58,140 / (\$3.40 - \$2.55) = 68,400$$

$$\text{Margin of safety in units} = 81,600 - 68,400 = 13,200$$

2. Sales revenue (\$3.40 × 81,600).....	\$ 277,440
Total variable cost (\$2.55 × 81,600).....	208,080
Total contribution margin.....	<u>\$ 69,360</u>
Total fixed cost.....	58,140
Operating income.....	<u><u>\$ 11,220</u></u>

$$3. \text{ Units for target profit} = (\$58,140 + \$25,500) / (\$3.40 - \$2.55) = 98,400$$

$$4. \text{ Operating income} = \text{Sales} - (\text{Variable cost ratio} \times \text{Sales}) - \text{Fixed cost}$$

$$0.10 \text{ Sales} = \text{Sales} - (0.75 \times \text{Sales}) - \$58,140$$

$$0.10 \text{ Sales} = 0.25 \text{ Sales} - \$58,140$$

$$\$58,140 = (0.25 \text{ Sales} - 0.10 \text{ Sales})$$

$$\$58,140 = 0.15 \text{ Sales}$$

$$\text{Sales} = \$387,600$$

**P 4-45**

$$1. \text{ Contribution margin ratio} = \$294,592 / \$460,300 = 0.64, \text{ or } 64\%$$

$$2. \text{ Break-even sales revenue} = \$150,000 / 0.64 = \$234,375$$

$$3. \begin{array}{rcl} \$460,300 \times 115\% & = & \$529,345 \\ \$165,708 \times 115\% & = & 190,564^* \\ \hline & & \$338,781 \end{array}$$

$$\text{Contribution margin ratio} = \$338,781 / \$529,345 = 0.64$$

The contribution margin ratio remains at 0.64.

\*Rounded

$$4. \text{ Additional variable expense: } \$460,300 \times 0.04 = \$18,412$$

$$\text{New contribution margin} = \$294,592 - \$18,412 = \$276,180$$

$$\text{New contribution margin ratio} = \$276,180 / \$460,300 = 0.60$$

$$\text{Break-even sales revenue} = \$150,000 / 0.60 = \$250,000$$

The effect is to increase the break-even sales revenue.

5. Projected contribution margin*.....	\$ 324,180
Present contribution margin.....	294,592
Increase in contribution margin/profit.....	<u><u>\$ 29,588</u></u>

\*(\$460,300 + \$80,000) × 0.60 = \$324,180

**P 4-45 (Continued)**

Operating leverage will decrease because the increase in variable cost (the sales commission) causes a decrease in the contribution margin.

Elgart should pay the commission because profit would increase by \$29,588.

**P 4-46**

1. Break-even sales revenue =  $\frac{\text{Fixed cost}}{(1 - \text{Variable rate})}$   
 $= \$150,000/(1/3)$   
 $= \$450,000$
2. Of total sales revenue, 60 percent is produced by floor lamps and 40 percent by desk lamps.  
 $\$360,000/\$30 = 12,000$  units  
 $\$240,000/\$20 = 12,000$  units  
 Thus, the sales mix is 1:1.

Product	Price	– Variable Cost	= Contribution Margin	×	Sales Mix	=	Total CM
Floor lamps	\$30	\$20.00	\$10.00		1		\$10.00
Desk lamps	20	13.33*	6.67		1		6.67
Package							<u>\$16.67</u>

$$\begin{aligned} \text{Number of packages} &= \frac{\text{Fixed cost}}{(\text{Price} - \text{Variable cost})} \\ &= \$150,000/\$16.67 \\ &= 8,998 \end{aligned}$$

$$\text{Floor lamps: } 1 \times 8,998 = 8,998$$

$$\text{Desk lamps: } 1 \times 8,998 = 8,998$$

\*Rounded

3. Operating leverage =  $\frac{\text{Contribution margin}}{\text{Operating income}}$   
 $= \$200,000/\$50,000$   
 $= 4.0$

$$\text{Percentage increase in profits} = 4.0 \times 40\% = 160\%$$

**P 4-47**

1.		<b>Door Handles</b>		<b>Trim Kits</b>	
	<b>CM</b>	$\$12 - \$9 = \$3$		$\$8 - \$5 = \$3$	
	<b>CM ratio</b>	$\$3/\$12 = 0.25$		$\$3/\$8 = 0.375$	

2. Contribution margin:		
(\$3 × 20,000) + (\$3 × 40,000)		\$ 180,000
Less: Fixed cost		146,000
Operating income		<u>\$ 34,000</u>

## 3. Sales mix (from Requirement 2): 1 door handle to 2 trim kits

Product	Price	Variable Cost	=	Contribution Margin	×	Sales Mix	=	Total CM
Door handle	\$12	\$9		\$3		1		\$3.00
Trim kit	8	5		3		2		6.00
Package								<u>\$9.00</u>

Break-even packages = \$146,000/\$9 = 16,222

Door handles = 1 × 16,222 = 16,222

Trim kits = 2 × 16,222 = 32,444

4. Revenue (70,000 × \$8).....	\$ 560,000
Variable cost (70,000 × \$5).....	350,000
Contribution margin.....	<u>\$ 210,000</u>
Fixed cost.....	111,000
Operating income.....	<u>\$ 99,000</u>

Yes, operating income is \$65,000 higher than when both door handles and trim kits are sold.

**P 4-48**

## 1. Break-even units = \$300,000/\$14\* = 21,429\*\*

\*\$406,000 / 29,000 = \$14

Break-even in sales dollars = 21,429 × \$42\*\*\* = \$900,018

OR

= \$300,000/(1/3) = \$900,000

The difference is due to rounding.

\*\*Rounded

\*\*\*\$1,218,000 / 29,000 = \$42

## 2. Margin of safety = \$1,218,000 – \$900,000 = \$318,000

**P 4-48 (Continued)**

<b>3. Sales.....</b>	<b>\$1,218,000</b>
<b>Variable cost (0.45 × \$1,218,000).....</b>	<b>548,100</b>
<b>Contribution margin.....</b>	<b>\$ 669,900</b>
<b>Fixed cost.....</b>	<b>550,000</b>
<b>Operating income.....</b>	<b>\$ 119,900</b>

**Break-even units = \$550,000/\$23.10\* = 23,810\*\***

**Break-even in sales dollars = \$550,000/0.55\*\*\* = 1,000,000**

**\*\$669,900/29,000 = \$23.10**

**\*\*Rounded**

**\*\*\*\$669,900/\$1,218,000 = 55%**

**P 4-49**

$$\begin{aligned}
 1. \text{ Variable cost ratio} &= \frac{\text{Variable costs}}{\text{Sales}} \\
 &= \$647,400/\$830,000 = 0.78, \text{ or } 78\% \\
 \text{Contribution margin ratio} &= \frac{(\text{Sales} - \text{Variable costs})}{\text{Sales}} \\
 &= (\$830,000 - \$647,400)/\$830,000 \\
 &= 0.22, \text{ or } 22\%
 \end{aligned}$$

$$2. \text{ Break-even sales revenue} = \$110,000/0.22 = \$500,000$$

$$\begin{aligned}
 3. \text{ Margin of safety} &= \text{Sales} - \text{Break-even sales} \\
 &= \$830,000 - \$500,000 = \$330,000
 \end{aligned}$$

$$4. \text{ Contribution margin from increased sales} = (\$12,000)(0.22) = \$2,640$$

**Cost of advertising = \$4,500**

**No, the advertising campaign is not a good idea, because the company's operating income will decrease by \$1,860 (\$4,500 – \$2,640).**

**P 4-50**

$$1. \text{ Income} = \text{Revenue} - \text{Variable cost} - \text{Fixed cost}$$

$$\$0 = 2,400P - \$42(2,400) - \$67,200$$

$$\$0 = 2,400P - \$100,800 - \$67,200$$

$$\$168,000 = 2,400P$$

$$P = \$70$$

$$2. \$314,400 / (\$6.50 - \text{Unit variable cost}) = 131,000$$

$$\text{Unit variable cost} = \$4.10$$

**P 4-51**

$$1. \text{ Contribution margin per unit} = \$5.60 - \$4.20^* \\ = \$1.40$$

\*Variable cost per unit:

$$\$0.70 + \$0.35 + \$1.85 + \$0.34 + \$0.76 + \$0.20 = \$4.20$$

$$\text{Contribution margin ratio} = \$1.40/\$5.60 = 0.25$$

$$2. \text{ Breakeven in units} = (\$32,300 + \$12,500)/\$1.40 = 32,000 \text{ boxes}$$

$$\text{Breakeven in sales revenue} = 32,000 \times \$5.60 = \$179,200$$

OR

$$= (\$32,300 + \$12,500)/0.25 = \$179,200$$

3. Sales (\$5.60 × 35,000).....	\$ 196,000
Variable cost (\$4.20 × 35,000).....	147,000
Contribution margin.....	\$ 49,000
Fixed cost.....	44,800
Operating income.....	<u>\$ 4,200</u>

$$4. \text{ Margin of safety} = \$196,000 - \$179,200 = \$16,800$$

$$5. \text{ Break-even units} = \$44,800/(\$6.20 - \$4.20) = 22,400$$

$$\text{New operating income} = \$6.20(31,500) - \$4.20(31,500) - \$44,800$$

$$= \$195,300 - \$132,300 - \$44,800 = \$18,200$$

Yes, operating income will increase by \$14,000 (\$18,200 - \$4,200).

**P 4-52**

1. Duncan:  $\$75,000/\$25,000 = 3$

Macduff:  $\$225,000/\$25,000 = 9$

2.	<u>Duncan</u>	<u>Macduff</u>
	$X = \$50,000/(1 - 0.80)$	$X = \$200,000/(1 - 0.40)$
	$X = \$50,000/0.20$	$X = \$200,000/0.60$
	$X = \$250,000$	$X = \$333,333$

Macduff must sell more than Duncan to break even because it must cover \$150,000 more in total fixed cost (it is more highly leveraged).

3. Duncan:  $3 \times 30\% = 90\%$

Macduff:  $9 \times 30\% = 270\%$

The percentage increase in profits for Macduff is much higher than Duncan's increase because Macduff has a higher degree of operating leverage (i.e., it has a larger amount of fixed costs in proportion to variable cost as compared to Duncan). Once fixed cost is covered, additional revenue must cover only variable cost, and 60% of Macduff's revenue above breakeven is profit, whereas only 20% of Duncan's revenue above breakeven is profit.

**P 4-53****1. Contribution margin ratios:**

**May of current year =  $\$23,910/\$43,560 = 0.549^*$ , or 54.9%**

**May of prior year =  $\$23,400/\$41,700 = 0.561^*$ , or 56.1%**

**2. Break-even point in sales dollars:**

**May of current year =  $\$20,330/0.549 = \$37,031^*$**

**May of prior year =  $\$13,800/0.561 = \$24,599^*$**

**3. Margin of safety:**

**May of current year =  $\$43,560 - \$37,031 = \$6,529$**

**May of prior year =  $\$41,700 - \$24,599 = \$17,101$**

**4. Clearly, the sharp rise in fixed cost from the prior year to the current year has had a strong impact on the break-even point and the margin of safety. Kicker will need to ensure that tight cost control is exercised since the margin of safety is much slimmer. Still, the decision to go with the OEM investment program could pay large dividends in the future. Note that the margin of safety and break-even point give the company important information on the potential risk of the venture but do not tell it the upside potential.**

**\*Rounded**

## CASES

## Case 4-54

1. Let X be a package of 3 Grade I cabinets and 7 Grade II cabinets.

$$0.3X(\$3,400) + 0.7X(\$1,600) = \$1,600,000$$

$$= 748^* \text{ packages}$$

$$\text{Grade I: } 0.3 \times 748 = 224^* \text{ cabinets}$$

$$\text{Grade II: } 0.7 \times 748 = 524^* \text{ cabinets}$$

Product	Price	–	Variable Cost	=	Contribution Margin	×	Sales Mix	=	Total CM
I	\$3,400		\$2,686		\$714		3		\$ 2,142
II	1,600		1,328		272		7		1,904
Package									<u>\$ 4,046</u>

$$\text{Direct fixed cost—I} \quad \$ 95,000$$

$$\text{Direct fixed cost—II} \quad 95,000$$

$$\text{Common fixed cost} \quad 35,000$$

$$\text{Total fixed cost} \quad \underline{\underline{\$225,000}}$$

$$\$225,000/\$4,046 = 56^*$$

$$\text{Grade I: } 3 \times 56 = 168$$

$$\text{Grade II: } 7 \times 56 = 392$$

Product	Price	–	Variable Cost	=	Contribution Margin	×	Sales Mix	=	Total CM
I	\$3,400		\$2,444		\$956		3		\$ 2,868
II	1,600		1,208		392		7		2,744
Package									<u>\$ 5,612</u>

$$\$21,400X = \$1,600,000 - \$600,000$$

$$X = 47^* \text{ packages remaining}$$

$$\text{Grade I: } 3 \times 47 = 141$$

$$\text{Grade II: } 7 \times 47 = 329$$

Additional contribution margin:

$$141(\$956 - \$714) + 329(\$392 - \$272) = \$73,602$$

$$\text{Increase in fixed cost} = \$44,000$$

$$\text{Break even: } (\$225,000 + \$44,000)/\$5,612 = 48^*$$

$$\text{Grade I: } 3 \times 48 = 144$$

$$\text{Grade II: } 7 \times 48 = 336$$

\*Rounded



**Case 4-54 (Continued)**

If the new break-even point is interpreted as a revised break-even point for the current year, then total fixed cost must be reduced by the contribution margin already earned (through the first five months) to obtain the units that must be sold for the last seven months. These units would then be added to those sold during the first five months:

$$\begin{aligned}\text{Contribution margin earned} &= \$600,000 - (83^* \times \$2,686) - (195^* \times \$1,328) \\ &= \$118,102\end{aligned}$$

$$^{*}224 - 141 = 83; 524 - 329 = 195$$

$$X = (\$225,000 + \$44,000 - \$118,102)/\$5,612 = 27^* \text{ packages}$$

From the first five months, 28 packages were sold (83/3 or 195/7). Thus, the revised break-even point is 55 packages (27 + 28)—in units 165 of Grade I and 196 of Grade II.

4.

Product	Price	Variable Cost	=	Contribution Margin	x	Sales Mix	=	Total CM
I	\$3,400	\$2,686		\$714		1		\$714
II	1,600	\$1,328		272		1		272
Package								<u>\$986</u>

$$\text{New sales revenue } \$1,000,000 \times 130\% = \$1,300,000$$

$$\$5,000X = \$1,300,000$$

$$X = 260 \text{ packages}$$

Thus, 260 units of each cabinet will be sold during the rest of the year.

Effect on profits:

Change in contribution margin:

$$\$714(260 - 141) - \$272(329 - 260) \quad \$ 66,198$$

Increase in fixed costs:

$$\$70,000(7/12) \quad \underline{40,833}^*$$

$$\text{Increase in operating income} \quad \underline{\underline{\$ 25,365}}$$

The break-even point (for the current year and the remaining 7 months, respectively) is computed as follows:

$$\begin{aligned}X &= \text{Fixed cost}/(\text{Price} - \text{Variable cost}) \\ &= \$295,000/\$986 \\ &= 299^* \text{ packages (or 299 of each cabinet)}\end{aligned}$$

$$\begin{aligned}X &= (\$295,000 - \$118,102)/\$986 \\ &= \$176,898/\$986 \\ &= 179^* \text{ packages (179 of each)}\end{aligned}$$

To this, add the units already sold, yielding the revised break-even point:

$$\text{Grade I: } 83 + 179 = 262$$

$$\text{Grade II: } 195 + 179 = 374$$

\*Rounded

**Case 4-55**

$$1. \text{ Break-even point in units} = \frac{\text{Fixed cost}}{(\text{Price} - \text{Variable cost per unit})}$$

$$\text{First process:} \quad \$100,000/(\$30 - \$10) = 5,000$$

$$\text{Second process:} \quad \$200,000/(\$30 - \$6) = 8,333^*$$

\*Rounded

$$\begin{aligned}
 2. \quad & \text{Income} = X(\text{Price} - \text{Variable cost}) - \text{Fixed cost} \\
 & X(\$30 - \$10) - \$100,000 = X(\$30 - \$6) - \$200,000 \\
 & \$20X - \$100,000 = \$24X - \$200,000 \\
 & \$100,000 = \$4X \\
 & X = 25,000 \text{ cases}
 \end{aligned}$$

The manual process is more profitable if sales are less than 25,000 cases; the automated process is more profitable at a level greater than 25,000 cases. It is important for the manager to have a sales forecast to help in deciding which process should be chosen.

3. The right to decide which process should be chosen belongs to the divisional manager. Danna has an ethical obligation to report the correct information to her superior. By altering the sales forecast, Danna unfairly and unethically influenced the decision-making process. Managers certainly have a moral obligation to assess the impact of their decisions on employees, and every effort should be taken to be fair and honest with employees. Danna's behavior, however, is not justified by the fact that it helped a number of employees retain their employment. First, Danna had no right to make that decision. Danna certainly has the right to voice her concerns about the impact of automation on the employees' well-being. In so doing, perhaps the divisional manager would come to the same conclusion even though the automated system appears to be more profitable. Second, the choice to select the manual system may not be the best for the employees anyway. The divisional manager may possess more information, making the selection of the automated system the best alternative for all concerned, provided the sales volume justifies its selection. For example, if the automated system is viable, the divisional manager may have plans to retrain and relocate the displaced workers in better jobs within the company. Third, her motivation for altering the forecast seems more driven by her friendship with Jerry Johnson than any legitimate concerns for the layoff of other employees. Danna should examine her reasoning carefully to assess the real reasons for her behavior. Perhaps in so doing, the conflict of interest that underlies her decision will become apparent.