15 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 × \$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 is \$12,000 (0.4 × \$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

15-1. b

15-2. d

15-3. a

15-4. d

15-5. e

15-6. b

15-7. a

15-8. d

15-9. b **Break-even units = $8,400/($10 – $3) = 1,200**

15-10. c **Variable cost ratio = $3/$10 = 0.3, or 30%**
Contribution margin ratio = ($10 – $3)/$10 = 0.7, or 70%

15-11. e

15-12. c **Units to be sold = ($15,000 + $3,600)/($8 – $6) = 9,300**

CORNERSTONE EXERCISES

CE 15-13

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 15-14

1. **Break-even units** = $\frac{\text{Total fixed cost}}{\text{Price – Variable cost per unit}}$
   = $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 15-15

1. Variable cost ratio $= \dfrac{\text{Variable cost per unit}}{\text{Price}}$

$= \$45/\$75$

$= 0.60$, or 60%

2. Contribution margin ratio $= \dfrac{\text{Price – Variable cost per unit}}{\text{Price}}$

$= \dfrac{\text{Contribution margin per unit}}{\text{Price}}$

$= (\$75 – \$45)/\$75$

$= 0.40$, 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	$100,500	

CE 15-16

1. Break-even sales dollars $= \dfrac{\text{Total fixed cost}}{\text{Contribution margin ratio}}$

$= \$49,500/0.40$

$= \$123,750$

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	$ 0

CE 15-17

1. Break-even units $= \dfrac{\text{Total fixed cost + Target income}}{\text{Price – Variable cost per unit}}$

$= (\$49{,}500 + \$81{,}900)/(\$75 - \$45)$

$= 4{,}380$ helmets

2.

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 15-18

1. Sales for target income $= \dfrac{\text{Total fixed cost + Target income}}{\text{Contribution margin ratio}}$

$= (\$49{,}500 + \$81{,}900)/0.40$

$= \$328{,}500$

2.

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 15-19

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									$310.00

2.

$$\text{Break-even packages} = \frac{\text{Total fixed cost}}{\text{Package contribution margin}}$$

$$= \$58{,}900/\$310$$

$$= 190 \text{ packages}$$

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	$ 0

CE 15-20

1. Contribution margin ratio $= \dfrac{\text{Price – Variable cost per unit}}{\text{Price}}$

$= (\$570{,}000 - \$388{,}000)/\$570{,}000$

$= 0.3193^*$

Break-even sales dollars $= \dfrac{\text{Total fixed cost}}{\text{Contribution margin ratio}}$

$= \$58{,}900/0.3193^*$

$= \$184{,}466$

*Rounded

2.

Head-First Company
Contribution Margin Income Statement
At Break-Even Sales Dollars

	Total
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 15-21

1. Margin of safety in units = Budgeted units – Break-even units

= 5,000 – 1,650

= 3,350

2. Margin of safety in sales revenue = Budgeted sales – Break-even sales

= $375,000 – $123,750

= $251,250

CE 15-22

$$\text{Degree of operating leverage} = \frac{\text{Total contribution margin}}{\text{Operating income}}$$

$$= \$150{,}000/\$100{,}500$$

$$= 1.5^*$$

*Rounded

CE 15-23

1. Percent change in operating income = DOL × Percent change in sales
   = 1.5 × 10%
   = 15%

2. Expected operating income = Original income + (Percent change × Original income)
   = $100,500 + (0.15 × $100,500)
   = $115,575

EXERCISES

E 15-24

1.

Direct materials	$3.90
Direct labor	1.40
Variable factory overhead	2.10
Variable selling and administrative expense	1.60
Unit variable cost	$9.00

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)	74,070
Total contribution margin	$ 90,530
Fixed cost ($52,000 + $38,530)	90,530
Operating income	$ 0

E 15-25

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 15-25 (Continued)

3. Total contribution margin = Actual revenue × Contribution margin ratio
= $235,000 × 0.25
= $58,750

Total fixed cost = Total contribution margin – Operating income
= $58,750 – $22,500 = $36,250

4. Break-even units = Total fixed cost/(Price – Variable cost per unit)
23,600 = $103,840/[Price – (0.56 × Price)]
Price – (0.56 × Price) = $103,840/23,600
Price(1.00 – 0.56) = $4.40
Price = $4.40/(1.00 – 0.56)
Price = $4.40/0.44 = $10.00

Variable cost per unit = Price × Variable cost ratio
= $10.00 × 0.56 = $5.60
Contribution margin per unit = Price – Variable cost per unit
= $10.00 – $5.60 = $4.40

E 15-26

1. Contribution margin ratio $= \dfrac{\text{Contribution margin}}{\text{Sales}}$

$= \$22,320/\$93,000 = 0.24, \text{ or } 24\%$

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 $= \dfrac{\text{Total fixed cost}}{\text{Contribution margin ratio}}$

$= \$12,000/0.24 = 50,000$

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 15-27

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

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 15-28

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	**$1.65**

E 15-28 (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……..	$1.53

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

3. **Units to earn $13,530 = ($111,425 + $48,350 + $13,530)/($2.75 – $1.65)**
   = 157,550

4. **Sales revenue to earn $13,530 = 157,550 × $2.75 = $433,262.50**

E 15-29

1. **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)……..	83,250

3.

Expected sales revenue ($8.42 × 225,000)……	$ 1,894,500
Break-even sales revenue*……	1,193,535
Margin of safety (in dollars)……..	$ 700,965

*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 15-30

	Laertes	Ophelia	Fortinbras	Claudius
Sales	$ 15,000	$ 15,600 *	$16,250 *	$10,600
Total variable cost	5,000	11,700	9,750	5,300 *
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)	$ 500	$ (100) *	$ 364	$ 848

E 15-30 (Continued)

	Laertes	Ophelia	Fortinbras	Claudius
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 15-31

1. Variable cost ratio = $282,200/$415,000 = 0.68, or 68%

   Contribution margin ratio = $132,800/$415,000 = 0.32, or 32%

2. 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 × 0.32 = $9,600

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

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

Sales	$ 196,875
Variable cost ($196,875 × 0.68)	133,875
Contribution margin	$ 63,000
Fixed cost	63,000
Operating income	$ 0

4.

Expected sales	$415,000
Break-even sales	196,875
Margin of safety	$218,125

5.

Sales revenue	$ 380,000
Break-even sales	196,875
Margin of safety	$183,125

E 15-32

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

2.

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

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

Break-even DVDs = 4 × 3,400 = 13,600

Break-even equipment sets = 1 × 3,400 = 3,400

E 15-33

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).

2.

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
Total									$35

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

Break-even DVDs = 4 × 3,260 = 13,040

Break-even equipment sets = 1 × 3,260 = 3,260

Break-even yoga mats = 2 × 3,260 = 6,520

3.

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 15-34

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).

2.

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									$990

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

Break-even portable grills = 4 × 2,150 = 8,600

Break-even stationary grills = 10 × 2,150 = 21,500

Break-even smokers = 1 × 2,150 = 2,150

3.

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

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

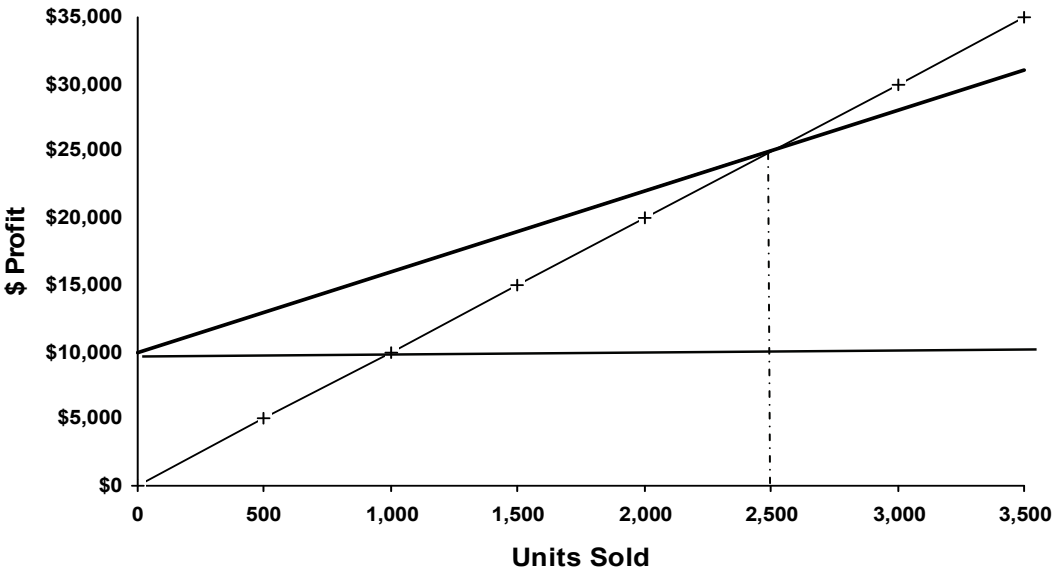
Break-even revenue = $2,128,500/0.3793 = $5,611,653

***Rounded**

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

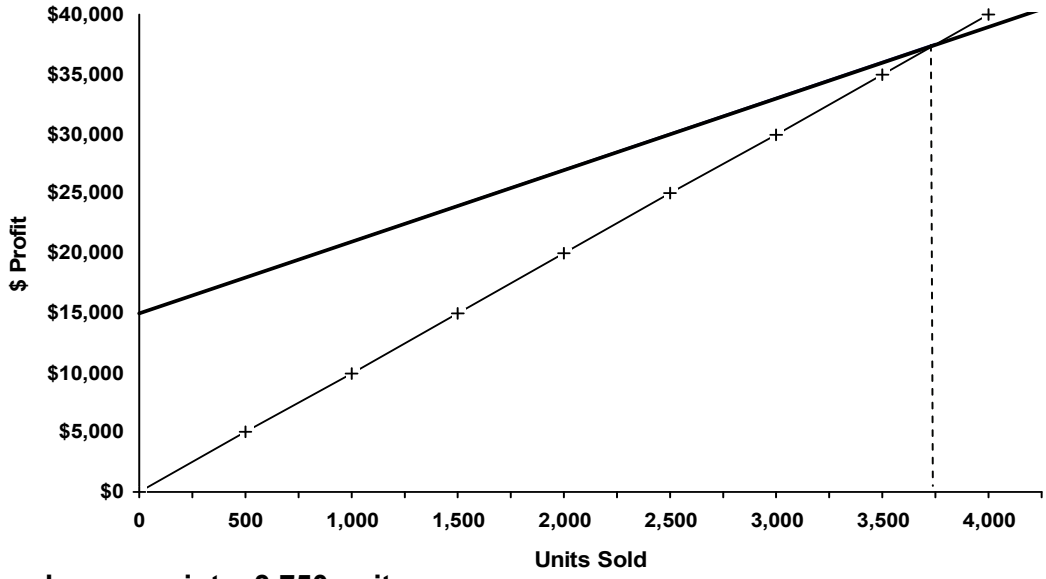
E 15-35

1.



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

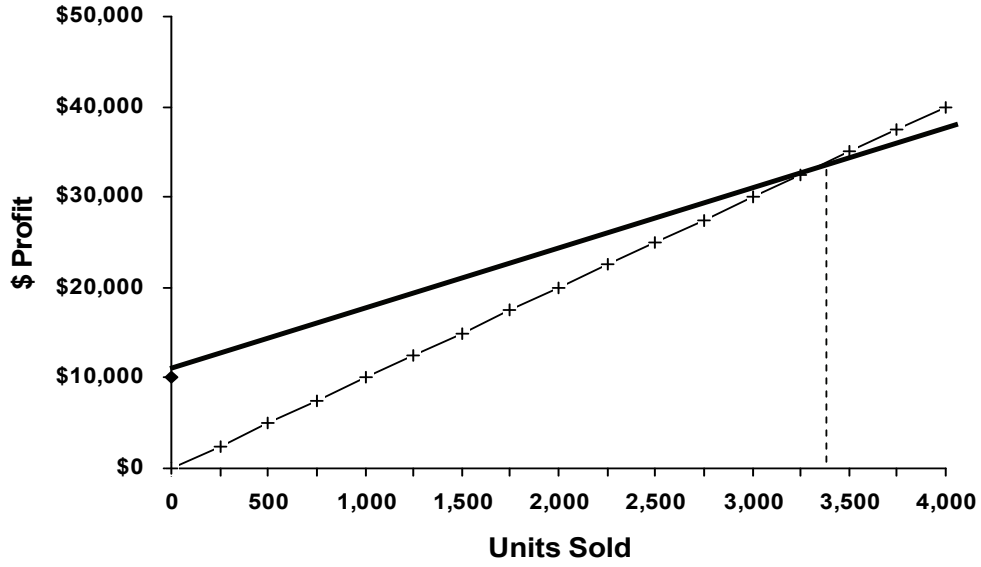
2. a. Fixed cost increases by $5,000:



Break-even point = 3,750 units

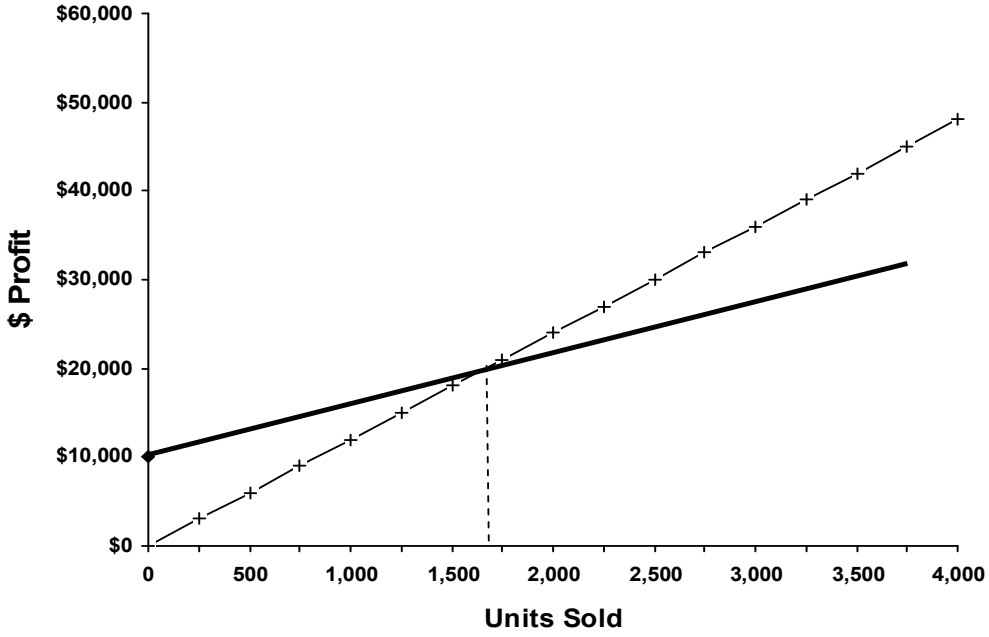
E 15-35 (Continued)

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



Break-even point = 3,333 units

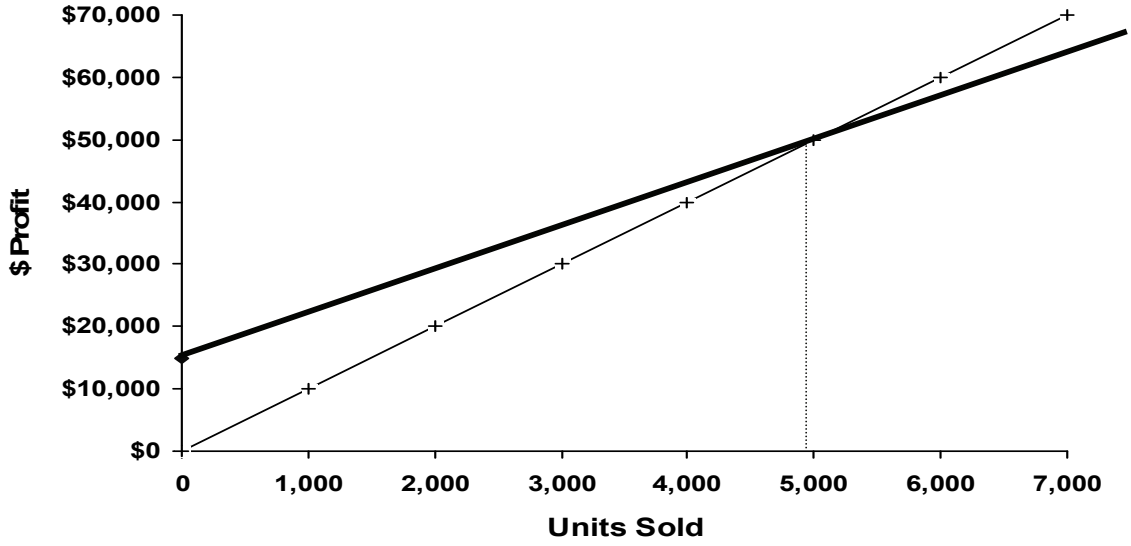
2. c. Unit selling price increases to $12:



Break-even point = 1,667 units

E 15-35 (Continued)

2. d. Both fixed cost and unit variable cost increase:



Break-even point = 5,000 units

E 15-36

1. Unit contribution margin = $877,680/53,000 = $16.56

Break-even units = $898,380/$16.56 = 54,250

2. Operating income = 10,000 × $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 × 0.46) – $20,700 = $71,300

E 15-37

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 = Contribution margin / Operating income**
   = $945,000/$28,350
   = 33.33*

4. **Percent change in operating income = 33.33 × 0.20 = 6.67***

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

   ***Rounded**

E 15-38

1.

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

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

Break-even vases = 2 × 625 = 1,250

Break-even figurines = 1 × 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									$86

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

Break-even vases = 3 × 410 = 1,230

Break-even figurines = 2 × 410 = 820

E 15-39

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

   Break-even sales dollars = 289,000 × $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 × 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 × 0.10) × ($1,255,800)] = $1,607,424**

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

PROBLEMS

P 15-40

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

$= \$626,400/(\$20 – \$12)$

$= \$626,400/\$8$

$= 78,300$ units

2. Units for target profit $= (\$626,400 + \$450,000)/(\$20 – \$12)$

$= \$1,076,400/\$8$

$= 134,550$ units

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

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

4. Current units $= \$2,480,000/\$20 = 124,000$

Margin of safety in units $= 124,000 – 78,300 = 45,700$

P 15-41

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

$= \$197,600/(\$13.50 – \$9.85)$

$= 54,137$*

2. Break-even units $= (\$197,600 – \$23,500)/(\$13.50 – \$9.85)$

$= 47,699$*

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 15-42

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 × 170,000 = $10,200,000

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

2. Increased contribution margin ($1,000,000 × 0.4167)……	**$416,700**
Less: Increased advertising expense……	**250,000**
Increased operating income……	**$166,700**

3. $1,500,000 × 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% × 4.54 = 36.32% (increase in operating income)

***Rounded**

P 15-43

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									$170

***$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 × 5 = 47,850

Break-even aerosleds = 9,570 × 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									$205

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

Break-even basic sleds = 7,936 × 5 = 39,680

Break-even aerosleds = 7,936 × 3 = 23,808

***Rounded**

3. Increase in contribution margin for aerosleds (12,000 × $35)……	**$ 420,000**
Decrease in contribution margin for basic sleds (5,000 × $20)……	**(100,000)**
Increase in total contribution margin……	**$ 320,000**
Less: Additional fixed cost……	**195,000**
Increase in income……	**$ 125,000**

Basu would gain $125,000 by increasing advertising for the aerosleds. This is a good strategy.

P 15-44

1. Break-even units = $58,140/($3.40 – $2.55) = 68,400

Margin of safety in units = 81,600 – 68,400 = 13,200

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

3. Units for target profit = ($58,140 + $25,500)/($3.40 – $2.55)
= 98,400

4. Operating income = Sales – (Variable cost ratio × Sales) – Fixed cost
0.10 Sales = Sales – (0.75 × Sales) – $58,140
0.10 Sales = 0.25 Sales – $58,140
$58,140 = (0.25 Sales – 0.10 Sales)
$58,140 = 0.15 Sales
Sales = $387,600

P 15-45

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

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

3.

$460,300 × 115% =	**$529,345**
$165,708 × 115% =	**190,564 ***
	$338,781

Contribution margin ratio = $338,781/$529,345 = 0.64
The contribution margin ratio remains at 0.64.
***Rounded**

4. Additional variable expense: $460,300 × 0.04 = $18,412
New contribution margin = $294,592 – $18,412 = $276,180
New contribution margin ratio = $276,180/$460,300 = 0.60
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	**$ 29,588**

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

P 15-45 (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 15-46

1. $$\text{Break-even sales revenue} = \frac{\text{Fixed cost}}{\text{(1 – Variable rate)}}$$

$$= \$150{,}000/(1/3)$$

$$= \$450{,}000$$

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									$16.67

$$\text{Number of packages} = \frac{\text{Fixed cost}}{\text{(Price – Variable cost)}}$$

$$= \$150{,}000/\$16.67$$

$$= 8{,}998$$

Floor lamps: 1 × 8,998 = 8,998

Desk lamps: 1 × 8,998 = 8,998

***Rounded**

3. $$\text{Operating leverage} = \frac{\text{Contribution margin}}{\text{Operating income}}$$

$$= \$200{,}000/\$50{,}000$$

$$= 4.0$$

Percentage increase in profits = 4.0 × 40% = 160%

P 15-47

1.

	Door Handles	Trim Kits
CM	$12 – $9 = $3	$8 – $5 = $3
CM ratio	$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	$ 34,000

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					$9.00

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	$ 210,000
Fixed cost	111,000
Operating income	$ 99,000

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

P 15-48

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 15-48 (Continued)

3.

Sales	**$1,218,000**
Variable cost (0.45 × $1,218,000)	**548,100**
Contribution margin	**$ 669,900**
Fixed cost	**550,000**
Operating income	**$ 119,900**

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 15-49

1. Variable cost ratio = $\frac{\text{Variable costs}}{\text{Sales}}$

= $647,400/$830,000 = 0.78, or 78%

Contribution margin ratio = $\frac{\text{(Sales – Variable costs)}}{\text{Sales}}$

= ($830,000 – $647,400)/$830,000

= 0.22, or 22%

2. Break-even sales revenue = $110,000/0.22 = $500,000

3. Margin of safety = Sales – Break-even sales

= $830,000 – $500,000 = $330,000

4. 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 15-50

1. Income = Revenue – Variable cost – 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 – Unit variable cost) = 131,000

Unit variable cost = $4.10

P 15-51

1. 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

Contribution margin ratio = $1.40/$5.60 = 0.25

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

Breakeven in sales revenue = 32,000 × $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	**$ 4,200**

4. Margin of safety = $196,000 – $179,200 = $16,800

5. Break-even units = $44,800/($6.20 – $4.20) = 22,400

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 15-52

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

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

2.

Duncan	Macduff
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 × 30% = 90%

Macduff: 9 × 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 15-53

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 15-54

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* packages

Grade I: 0.3 × 748 = 224* cabinets
Grade II: 0.7 × 748 = 524* cabinets

2.

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									$ 4,046

Direct fixed cost—I	$ 95,000
Direct fixed cost—II	95,000
Common fixed cost	35,000
Total fixed cost	$225,000

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

Grade I: 3 × 56 = 168
Grade II: 7 × 56 = 392

3.

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									$ 5,612

$21,400X = $1,600,000 – $600,000
X = 47* packages remaining

Grade I: 3 × 47 = 141
Grade II: 7 × 47 = 329

Additional contribution margin:
141($956 – $714) + 329($392 – $272) = $73,602
Increase in fixed cost = $44,000

Break even: ($225,000 + $44,000)/$5,612 = 48*

Grade I: 3 × 48 = 144
Grade II: 7 × 48 = 336

***Rounded**

Case 15-54 (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:

Contribution margin earned = $600,000 – (83* × $2,686) – (195* × $1,328)
= $118,102

***224 – 141 = 83; 524 – 329 = 195**

X = ($225,000 + $44,000 – $118,102)/$5,612 = 27* 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	×	Sales Mix	=	Total CM
I	$3,400		$2,686		$714		1		$714
II	1,600		$1,328		272		1		272
Package									$986

New sales revenue $1,000,000 × 130% = $1,300,000

$5,000X = $1,300,000
X = 260 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) – $272(329 – 260)	**$ 66,198**
Increase in fixed costs:	
$70,000(7/12)	**40,833 ***
Increase in operating income	**$ 25,365**

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

X = Fixed cost/(Price – Variable cost)
= $295,000/$986
= 299* packages (or 299 of each cabinet)

X = ($295,000 – $118,102)/$986
= $176,898/$986
= 179* packages (179 of each)

To this, add the units already sold, yielding the revised break-even point:
Grade I: 83 + 179 = 262
Grade II: 195 + 179 = 374

***Rounded**

Case 15-55

1. Break-even point in units = Fixed cost / (Price – Variable cost per unit)

First process: $100,000/($30 – $10) = 5,000

Second process: $200,000/($30 – $6) = 8,333*

***Rounded**

2.

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

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.