CHAPTER 3
COST-VOLUME-PROFIT ANALYSIS

NOTATION USED IN CHAPTER 3 SOLUTIONS

SP: Selling price
VCU: Variable cost per unit
CMU: Contribution margin per unit
FC: Fixed costs
TOI: Target operating income

3-1 Cost-volume-profit (CVP) analysis examines the behavior of total revenues, total costs, and operating income as changes occur in the units sold, selling price, variable cost per unit, or fixed costs of a product.

3-2 The assumptions underlying the CVP analysis outlined in Chapter 3 are

1. Changes in the level of revenues and costs arise only because of changes in the number of product (or service) units sold.
2. Total costs can be separated into a fixed component that does not vary with the units sold and a variable component that changes with respect to the units sold.
3. When represented graphically, the behaviors of total revenues and total costs are linear (represented as a straight line) in relation to units sold within a relevant range and time period.
4. The selling price, variable cost per unit, and fixed costs are known and constant.

3-3 Operating income is total revenues from operations for the accounting period minus cost of goods sold and operating costs (excluding income taxes):

Operating income = Total revenues from operations – Costs of goods sold and operating costs (excluding income taxes)

Net income is operating income plus nonoperating revenues (such as interest revenue) minus nonoperating costs (such as interest cost) minus income taxes. Chapter 3 assumes nonoperating revenues and nonoperating costs are zero. Thus, Chapter 3 computes net income as:

Net income = Operating income – Income taxes

3-4 Contribution margin is the difference between total revenues and total variable costs. Contribution margin per unit is the difference between selling price and variable cost per unit. Contribution-margin percentage is the contribution margin per unit divided by selling price.

3-5 Three methods to express CVP relationships are the equation method, the contribution margin method, and the graph method. The first two methods are most useful for analyzing operating income at a few specific levels of sales. The graph method is useful for visualizing the effect of sales on operating income over a wide range of quantities sold.

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3-6 Breakeven analysis denotes the study of the breakeven point, which is often only an incidental part of the relationship between cost, volume, and profit. Cost-volume-profit relationship is a more comprehensive term than breakeven analysis.

3-7 CVP certainly is simple, with its assumption of output as the only revenue and cost driver, and linear revenue and cost relationships. Whether these assumptions make it simplistic depends on the decision context. In some cases, these assumptions may be sufficiently accurate for CVP to provide useful insights. The examples in Chapter 3 (the software package context in the text and the travel agency example in the Problem for Self-Study) illustrate how CVP can provide such insights. In more complex cases, the basic ideas of simple CVP analysis can be expanded.

3-8 An increase in the income tax rate does not affect the breakeven point. Operating income at the breakeven point is zero, and no income taxes are paid at this point.

3-9 Sensitivity analysis is a "what-if" technique that managers use to examine how an outcome will change if the original predicted data are not achieved or if an underlying assumption changes. The advent of the electronic spreadsheet has greatly increased the ability to explore the effect of alternative assumptions at minimal cost. CVP is one of the most widely used software applications in the management accounting area.

3-10 Examples include:
Manufacturing—substituting a robotic machine for hourly wage workers.
Marketing—changing a sales force compensation plan from a percent of sales dollars to a fixed salary.
Customer service—hiring a subcontractor to do customer repair visits on an annual retainer basis rather than a per-visit basis.

3-11 Examples include:
Manufacturing—subcontracting a component to a supplier on a per-unit basis to avoid purchasing a machine with a high fixed depreciation cost.
Marketing—changing a sales compensation plan from a fixed salary to percent of sales dollars basis.
Customer service—hiring a subcontractor to do customer service on a per-visit basis rather than an annual retainer basis.

3-12 Operating leverage describes the effects that fixed costs have on changes in operating income as changes occur in units sold, and hence, in contribution margin. Knowing the degree of operating leverage at a given level of sales helps managers calculate the effect of fluctuations in sales on operating incomes.

3-13 CVP analysis is always conducted for a specified time horizon. One extreme is a very short-time horizon. For example, some vacation cruises offer deep price discounts for people who offer to take any cruise on a day's notice. One day prior to a cruise, most costs are fixed. The other extreme is several years. Here, a much higher percentage of total costs typically is variable.

CVP itself is not made any less relevant when the time horizon lengthens. What happens is that many items classified as fixed in the short run may become variable costs with a longer time horizon.

3-14 A company with multiple products can compute a breakeven point by assuming there is a constant sales mix of products at different levels of total revenue.

3-15 Yes, gross margin calculations emphasize the distinction between manufacturing and nonmanufacturing costs (gross margins are calculated after subtracting variable and fixed manufacturing costs). Contribution margin calculations emphasize the distinction between fixed and variable costs. Hence, contribution margin is a more useful concept than gross margin in CVP analysis.

3-16 (10 min.) **CVP computations.**

	Revenues	Variable Costs	Fixed Costs	Total Costs	Operating Income	Contribution Margin	Contribution Margin %
a.	**$2,000**	$ 500	$**300**	$ 800	$1,200	**$1,500**	**75.0%**
b.	2,000	**1,500**	300	**1,800**	200	**500**	**25.0%**
c.	1,000	700	**300**	1,000	**0**	**300**	**30.0%**
d.	1,500	**900**	300	**1,200**	**300**	**600**	40.0%

3-17 (10–15 min.) **CVP computations.**

1a.	Sales ($68 per unit × 410,000 units)	$27,880,000
	Variable costs ($60 per unit × 410,000 units)	24,600,000
	Contribution margin	$ 3,280,000
1b.	Contribution margin (from above)	$3,280,000
	Fixed costs	1,640,000
	Operating income	$1,640,000
2a.	Sales (from above)	$27,880,000
	Variable costs ($54 per unit × 410,000 units)	22,140,000
	Contribution margin	$ 5,740,000
2b.	Contribution margin	$5,740,000
	Fixed costs	5,330,000
	Operating income	$ 410,000

3. Operating income is expected to decrease by $1,230,000 ($1,640,000 − $410,000) if Ms. Schoenen's proposal is accepted.

The management would consider other factors before making the final decision. It is likely that product quality would improve as a result of using state of the art equipment. Due to increased automation, probably many workers will have to be laid off. Garrett's management will have to consider the impact of such an action on employee morale. In addition, the proposal increases the company's fixed costs dramatically. This will increase the company's operating leverage and risk.

3-18 (35–40 min.) **CVP analysis, changing revenues and costs.**

1a. SP = 6% × $1,500 = $90 per ticket
VCU = $43 per ticket
CMU = $90 – $43 = $47 per ticket
FC = $23,500 a month

$$Q = \frac{FC}{CMU} = \frac{\$23,500}{\$47 \text{ per ticket}}$$

= 500 tickets

1b.
$$Q = \frac{FC + TOI}{CMU} = \frac{\$23,500 + \$17,000}{\$47 \text{ per ticket}}$$

$$= \frac{\$40,500}{\$47 \text{ per ticket}}$$

= 862 tickets (rounded up)

2a. SP = $90 per ticket
VCU = $40 per ticket
CMU = $90 – $40 = $50 per ticket
FC = $23,500 a month

$$Q = \frac{FC}{CMU} = \frac{\$23,500}{\$50 \text{ per ticket}}$$

= 470 tickets

2b.
$$Q = \frac{FC + TOI}{CMU} = \frac{\$23,500 + \$17,000}{\$50 \text{ per ticket}}$$

$$= \frac{\$40,500}{\$50 \text{ per ticket}}$$

= 810 tickets

3a. SP = $60 per ticket
VCU = $40 per ticket
CMU = $60 – $40 = $20 per ticket
FC = $23,500 a month

$$Q = \frac{FC}{CMU} = \frac{\$23,500}{\$20 \text{ per ticket}}$$

= 1,175 tickets

3b. $Q = \frac{FC + TOI}{CMU} = \frac{\$23{,}500 + \$17{,}000}{\$20 \text{ per ticket}}$

$= \frac{\$40{,}500}{\$20 \text{ per ticket}}$

= 2,025 tickets

The reduced commission sizably increases the breakeven point and the number of tickets required to yield a target operating income of $17,000:

	6% Commission (Requirement 2)	**Fixed Commission of $60**
Breakeven point	470	1,175
Attain OI of $10,000	810	2,025

4a. The $5 delivery fee can be treated as either an extra source of revenue (as done below) or as a cost offset. Either approach increases CMU $5:

SP = $65 ($60 + $5) per ticket
VCU = $40 per ticket
CMU = $65 – $40 = $25 per ticket
FC = $23,500 a month

$Q = \frac{FC}{CMU} = \frac{\$23{,}500}{\$25 \text{ per ticket}}$

= 940 tickets

4b. $Q = \frac{FC + TOI}{CMU} = \frac{\$23{,}500 + \$17{,}000}{\$25 \text{ per ticket}}$

$= \frac{\$40{,}500}{\$25 \text{ per ticket}}$

= 1,620 tickets

The $5 delivery fee results in a higher contribution margin which reduces both the breakeven point and the tickets sold to attain operating income of $17,000.

3-19 (20 min.) **CVP exercises.**

	Revenues	Variable Costs	Contribution Margin	Fixed Costs	Budgeted Operating Income
Orig.	$10,000,000[G]	$8,000,000[G]	$2,000,000	$1,800,000[G]	$200,000
1.	10,000,000	7,800,000	2,200,000[a]	1,800,000	400,000
2.	10,000,000	8,200,000	1,800,000[b]	1,800,000	0
3.	10,000,000	8,000,000	2,000,000	1,890,000[c]	110,000
4.	10,000,000	8,000,000	2,000,000	1,710,000[d]	290,000
5.	10,800,000[e]	8,640,000[f]	2,160,000	1,800,000	360,000
6.	9,200,000[g]	7,360,000[h]	1,840,000	1,800,000	40,000
7.	11,000,000[i]	8,800,000[j]	2,200,000	1,980,000[k]	220,000
8.	10,000,000	7,600,000[l]	2,400,000	1,890,000[m]	510,000

[G]stands for given.

[a]$2,000,000 × 1.10; [b]$2,000,000 × 0.90; [c]$1,800,000 × 1.05; [d]$1,800,000 × 0.95; [e]$10,000,000 × 1.08; [f]$8,000,000 × 1.08; [g]$10,000,000 × 0.92; [h]$8,000,000 × 0.92; [i]$10,000,000 × 1.10; [j]$8,000,000 × 1.10; [k]$1,800,000 × 1.10; [l]$8,000,000 × 0.95; [m]$1,800,000 × 1.05

3-20 (20 min.) **CVP exercises.**

1a. [Units sold (Selling price – Variable costs)] – Fixed costs = Operating income
[5,000,000 ($0.50 – $0.30)] – $900,000 = $100,000

1b. Fixed costs ÷ Contribution margin per unit = Breakeven units
$900,000 ÷ [($0.50 – $0.30)] = 4,500,000 units
Breakeven units × Selling price = Breakeven revenues
4,500,000 units × $0.50 per unit = $2,250,000
or,

$$\text{Contribution margin ratio} = \frac{\text{Selling price - Variable costs}}{\text{Selling price}}$$

$$= \frac{\$0.50 - \$0.30}{\$0.50} = 0.40$$

Fixed costs ÷ Contribution margin ratio = Breakeven revenues
$900,000 ÷ 0.40 = $2,250,000

2. 5,000,000 ($0.50 – $0.34) – $900,000 = $ (100,000)

3. [5,000,000 (1.1) ($0.50 – $0.30)] – [$900,000 (1.1)] = $ 110,000

4. [5,000,000 (1.4) ($0.40 – $0.27)] – [$900,000 (0.8)] = $ 190,000

5. $900,000 (1.1) ÷ ($0.50 – $0.30) = 4,950,000 units

6. ($900,000 + $20,000) ÷ ($0.55 – $0.30) = 3,680,000 units

3-21 (10 min.) **CVP analysis, income taxes.**

1. Monthly fixed costs = $48,200 + $68,000 + $13,000 = $129,200
   Contribution margin per unit = $27,000 – $23,000 – $600 = $ 3,400

$$\text{Breakeven units per month} = \frac{\text{Monthly fixed costs}}{\text{Contribution margin per unit}} = \frac{\$129{,}200}{\$3{,}400 \text{ per car}} = 38 \text{ cars}$$

2. Tax rate 40%
   Target net income $51,000

$$\text{Target operating income} = \frac{\text{Target net income}}{1 - \text{tax rate}} = \frac{\$51{,}000}{(1-0.40)} = \frac{\$51{,}000}{0.60} = \$85{,}000$$

$$\begin{array}{c}\text{Quantity of output units}\\ \text{required to be sold}\end{array} = \frac{\text{Fixed costs + Target operating income}}{\text{Contribution margin per unit}} = \frac{\$129{,}200 + \$85{,}000}{\$3{,}400} = 63 \text{ cars}$$

3-22 (20–25 min.) **CVP analysis, income taxes.**

1. Variable cost percentage is $3.40 ÷ $8.50 = 40%

Let R = Revenues needed to obtain target net income

$$R - 0.40R - \$459{,}000 = \frac{\$107{,}100}{1-0.30}$$

$$0.60R = \$459{,}000 + \$153{,}000$$

$$R = \$612{,}000 \div 0.60$$

$$R = \$1{,}020{,}000$$

$$\text{or, Target revenues} = \frac{\text{Fixed costs + Target operating income}}{\text{Contribution margin percentage}}$$

$$\text{Target revenues} = \frac{\text{Fixed costs} + \dfrac{\text{Target net income}}{1 - \text{Tax rate}}}{\text{Contribution margin percentage}} = \frac{\$459{,}000 + \dfrac{\$107{,}100}{1-0.30}}{0.60} = \$1{,}020{,}000$$

Proof:		
	Revenues	$1,020,000
	Variable costs (at 40%)	408,000
	Contribution margin	612,000
	Fixed costs	459,000
	Operating income	153,000
	Income taxes (at 30%)	45,900
	Net income	$ 107,100

2.a. Customers needed to break even:

Contribution margin per customer = $8.50 – $3.40 = $5.10

Breakeven number of customers = Fixed costs ÷ Contribution margin per customer
= $459,000 ÷ $5.10 per customer
= 90,000 customers

2.b. Customers needed to earn net income of $107,100:

Total revenues ÷ Sales check per customer

$1,020,000 ÷ $8.50 = 120,000 customers

3. Using the shortcut approach:

$$\text{Change in net income} = \begin{pmatrix}\text{Change in}\\ \text{number of}\\ \text{customers}\end{pmatrix} \times \begin{pmatrix}\text{Unit}\\ \text{contribution}\\ \text{margin}\end{pmatrix} \times (1 - \text{Tax rate})$$

$$= (170{,}000 - 120{,}000) \times \$5.10 \times (1 - 0.30)$$

$$= \$255{,}000 \times 0.7 = \$178{,}500$$

$$\text{New net income} = \$178{,}500 + \$107{,}100 = \$285{,}600$$

Alternatively, with 170,000 customers,

Operating income = Number of customers × Selling price per customer
– Number of customers × Variable cost per customer – Fixed costs
= 170,000 × $8.50 – 170,000 × $3.40 – $459,000 = $408,000

Net income = Operating income × (1 – Tax rate) = $408,000 × 0.70 = $285,600

The alternative approach is:

Revenues, 170,000 × $8.50	$1,445,000
Variable costs at 40%	578,000
Contribution margin	867,000
Fixed costs	459,000
Operating income	408,000
Income tax at 30%	122,400
Net income	$ 285,600

3-23 (30 min.) **CVP analysis, sensitivity analysis.**

1. SP = $30.00 × (1 – 0.30 margin to bookstore)
= $30.00 × 0.70 = $21.00

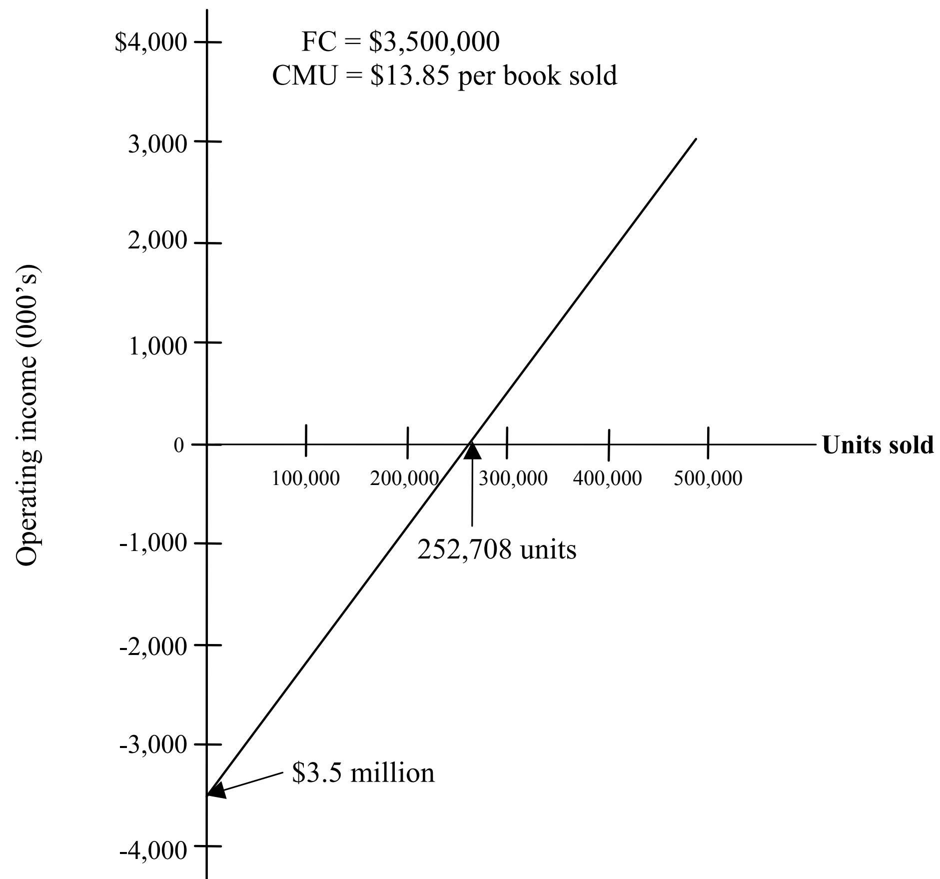
VCU = $ 4.00 variable production and marketing cost
3.15 variable author royalty cost (0.15 × $21.00)
$ 7.15

CMU = $21.00 – $7.15 = $13.85 per copy

FC = $ 500,000 fixed production and marketing cost
3,000,000 up-front payment to Washington
$3,500,000

Solution Exhibit 3-23A shows the PV graph.

SOLUTION EXHIBIT 3-23A
PV Graph for Media Publishers



2a.

$$\text{Breakeven number of units} = \frac{FC}{CMU} = \frac{\$3{,}500{,}000}{\$13.85}$$

= 252,708 copies sold (rounded up)

2b.

$$\text{Target OI} = \frac{FC + OI}{CMU}$$

$$= \frac{\$3{,}500{,}000 + \$2{,}000{,}000}{\$13.85}$$

$$= \frac{\$5{,}500{,}000}{\$13.85}$$

= 397,112 copies sold (rounded up)

3a. Decreasing the normal bookstore margin to 20% of the listed bookstore price of $30 has the following effects:

SP = $30.00 × (1 – 0.20)
= $30.00 × 0.80 = $24.00
VCU = $ 4.00 variable production and marketing cost
+ 3.60 variable author royalty cost (0.15 × $24.00)
$ 7.60

CMU = $24.00 – $7.60 = $16.40 per copy

$$\text{Breakeven number of units} = \frac{FC}{CMU} = \frac{\$3,500,000}{\$16.40}$$

= 213,415 copies sold (rounded up)

The breakeven point decreases from 252,708 copies in requirement 2 to 213,415 copies.

3b. Increasing the listed bookstore price to $40 while keeping the bookstore margin at 30% has the following effects:

SP = $40.00 × (1 – 0.30)
= $40.00 × 0.70 = $28.00
VCU = $ 4.00 variable production and marketing cost
+ 4.20 variable author royalty cost (0.15 × $28.00)
$ 8.20

CMU= $28.00 – $8.20 = $19.80 per copy

$$\text{Breakeven number of units} = \frac{\$3,500,000}{\$19.80}$$

= 176,768 copies sold (rounded up)

The breakeven point decreases from 252,708 copies in requirement 2 to 176,768 copies.

3c. The answers to requirements 3a and 3b decrease the breakeven point relative to that in requirement 2 because in each case fixed costs remain the same at $3,500,000 while the contribution margin per unit increases.

3-24 (10 min.) **CVP analysis, margin of safety.**

1. Breakeven point revenues = $\dfrac{\text{Fixed costs}}{\text{Contribution margin percentage}}$

Contribution margin percentage = $\dfrac{\$660{,}000}{\$1{,}100{,}000}$ = 0.60 or 60%

2. Contribution margin percentage = $\dfrac{\text{Selling price} - \text{Variable cost per unit}}{\text{Selling price}}$

$$0.60 = \frac{SP - \$16}{SP}$$

$$0.60\ SP = SP - \$16$$

$$0.40\ SP = \$16$$

$$SP = \$40$$

3. Breakeven sales in units = Revenues ÷ Selling price = $1,100,000 ÷ $40 = 27,500 units
Margin of safety in units = Sales in units – Breakeven sales in units
= 95,000 – 27,500 = 67,500 units

Revenues, 95,000 units × $40	$3,800,000
Breakeven revenues	1,100,000
Margin of safety	$2,700,000

3-25 (25 min.) **Operating leverage.**

1a. Let Q denote the quantity of carpets sold

Breakeven point under Option 1

$$\$500Q - \$350Q = \$5{,}000$$

$$\$150Q = \$5{,}000$$

$$Q = \$5{,}000 \div \$150 = 34 \text{ carpets (rounded up)}$$

1b. Breakeven point under Option 2

$$\$500Q - \$350Q - (0.10 \times \$500Q) = 0$$

$$100Q = 0$$

$$Q = 0$$

2. Operating income under Option 1 = $150Q – $5,000
Operating income under Option 2 = $100Q

Find Q such that $150Q – $5,000 = $100Q

$$\$50Q = \$5{,}000$$

$$Q = \$5{,}000 \div \$50 = 100 \text{ carpets}$$

Revenues = $500 × 100 carpets = $50,000

For Q = 100 carpets, operating income under both Option 1 ($150 × 100 – $5,000) and Option 2 ($100 × 100) = $10,000

For $Q > 100$, say, 101 carpets,

Option 1 gives operating income	=	$(\$150 \times 101) - \$5,000$	=	\$10,150
Option 2 gives operating income	=	$\$100 \times 101$	=	\$10,100

So Color Rugs will prefer Option 1.

For $Q < 100$, say, 99 carpets,

Option 1 gives operating income	=	$(\$150 \times 99) - \$5,000$	=	\$9,850
Option 2 gives operating income	=	$\$100 \times 99$	=	\$9,900

So Color Rugs will prefer Option 2.

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

$$= \frac{\text{Contribution margin per unit} \times \text{Quantity of carpets sold}}{\text{Operating income}}$$

Under Option 1, contribution margin per unit = \$500 – \$350, so

$$\text{Degree of operating leverage} = \frac{\$150 \times 100}{\$10,000} = 1.5$$

Under Option 2, contribution margin per unit = \$500 – \$350 – 0.10 × \$500, so

$$\text{Degree of operating leverage} = \frac{\$100 \times 100}{\$10,000} = 1.0$$

4. The calculations in requirement 3 indicate that when sales are 100 units, a percentage change in sales and contribution margin will result in 1.5 times that percentage change in operating income for Option 1, but the same percentage change in operating income for Option 2. The degree of operating leverage at a given level of sales helps managers calculate the effect of fluctuations in sales on operating incomes.

3-26 (15 min.) **CVP analysis, international cost structure differences.**

Country	Sales Price to Retail Outlets (1)	Annual Fixed Costs (2)	Variable Manufacturing Cost per Rug (3)	Variable Marketing and Distribution Cost per Rug (4)	Contribution Margin Per Rug (5)=(1)–(3)–(4)	Breakeven Units (6)=(2) ÷ (5)	Breakeven Revenues (6)×(1)	Operating Income for Budgeted Sales of 75,000 Rugs (7)=[75,000×(5)]–(2)
Singapore	$250.00	$ 9,000,000	$75.00	$25.00	$150.00	60,000	$15,000,000	$2,250,000
Brazil	$250.00	8,400,000	60.00	15.00	175.00	48,000	12,000,000	4,725,000
United States	$250.00	12,400,000	82.50	12.50	155.00	80,000	20,000,000	(775,000)
						Requirement 1	Requirement 1	Requirement 2

Brazil has the lowest breakeven point since it has both the lowest fixed costs ($8,400,000) and the lowest variable cost per unit ($75.00). Hence, for a given selling price, Brazil will always have a higher operating income (or a lower operating loss) than Singapore or the U.S.

The U.S. breakeven point is 80,000 units. Hence, with sales of only 75,000 units, it has an operating loss of $775,000.

3-27 (30 min.) **Sales mix, new and upgrade customers.**

1.

	New Customers	**Upgrade Customers**
SP	$275	$100
VCU	100	50
CMU	175	50

The 60%/40% sales mix implies that, in each bundle, 3 units are sold to new customers and 2 units are sold to upgrade customers.

Contribution margin of the bundle = 3 × $175 + 2 × $50 = $525 + $100 = $625

Breakeven point in bundles = $\frac{\$15,000,000}{\$625}$ = 24,000 bundles

Breakeven point in units is:

Sales to new customers:	24,000 bundles × 3 units per bundle	72,000 units
Sales to upgrade customers:	24,000 bundles × 2 units per bundle	48,000 units
Total number of units to breakeven (rounded)		120,000 units

Alternatively,

Let S = Number of units sold to upgrade customers

$1.5S$ = Number of units sold to new customers

Revenues – Variable costs – Fixed costs = Operating income

[$275 (1.5$S$) + 100S$] – [$100 (1.5S) + 50S$] – $15,000,000 = OI

512.5S$ – 200S$ – $15,000,000 = OI

Breakeven point is 120,000 units when OI = $0 because

312.5S$	=	$15,000,000
S	=	48,000 units sold to upgrade customers
1.5S	=	72,000 units sold to new customers
BEP	=	120,000 units

Check

Revenues ($275 × 72,000) + ($100 × 48,000)	$24,600,000
Variable costs ($100 × 72,000) + ($50 × 48,000)	9,600,000
Contribution margin	15,000,000
Fixed costs	15,000,000
Operating income	$ 0

2. When 220,000 units are sold, mix is:

Units sold to new customers (60% × 220,000)	132,000
Units sold to upgrade customers (40% × 220,000)	88,000
Revenues ($275 × 132,000) + ($100 × 88,000)	$45,100,000
Variable costs ($100 × 132,000) + ($50 × 88,000)	17,600,000
Contribution margin	27,500,000
Fixed costs	15,000,000
Operating income	$12,500,000

3a. At New 40%/Upgrade 60% mix, each bundle contains 2 units sold to new customers and 3 units sold to upgrade customers.

Contribution margin of the bundle = 2 × $175 + 3 × $50 = $350 + $150 = $500

Breakeven point in bundles = $\frac{\$15,000,000}{\$500}$ = 30,000 bundles

Breakeven point in units is:

Sales to new customers:	30,000 bundles × 2 unit per bundle	60,000 units
Sales to upgrade customers:	30,000 bundles × 3 unit per bundle	90,000 units
Total number of units to breakeven		150,000 units

Alternatively,
Let S = Number of units sold to new customers
then $1.5S$ = Number of units sold to upgrade customers

$[\$275S + \$100\,(1.5S)] - [\$100S + \$50\,(1.5S)] - \$15,000,000 = OI$

$425S - 175S$	=	$15,000,000
$250S$	=	$15,000,000
S	=	60,000 units sold to new customers
$1.5S$	=	90,000 units sold to upgrade customers
BEP	=	150,000 units

Check

Revenues ($275 × 60,000) + ($100 × 90,000)	$25,500,000
Variable costs ($100 × 60,000) + ($50 × 90,000)	10,500,000
Contribution margin	15,000,000
Fixed costs	15,000,000
Operating income	$ 0

3b. At New 80%/ Upgrade 20% mix, each bundle contains 4 units sold to new customers and 1 unit sold to upgrade customers.

Contribution margin of the bundle = 4 × $175 + 1 × $50 = $700 + $50 = $750

Breakeven point in bundles = $\frac{\$15,000,000}{\$750}$ = 20,000 bundles

Breakeven point in units is:

Sales to new customers:	20,000 bundles × 4 units per bundle	80,000 units
Sales to upgrade customers:	20,000 bundles × 1 unit per bundle	20,000 units
Total number of units to breakeven		100,000 units

Alternatively,

Let S = Number of units sold to upgrade customers
then $4S$= Number of units sold to new customers

$[\$275\,(4S) + \$100S] - [\$100\,(4S) + \$50S] - \$15{,}000{,}000 = OI$

$1{,}200S - 450S = \$15{,}000{,}000$

$750S = \$15{,}000{,}000$

S = 20,000 units sold to upgrade customers

$4S$ = 80,000 units sold to new customers

100,000 units

Check

Revenues ($275 × 80,000) + ($100 × 20,000)	$24,000,000
Variable costs ($100 × 80,000) + ($50 × 20,000)	9,000,000
Contribution margin	15,000,000
Fixed costs	15,000,000
Operating income	$ 0

3c. As Data increases its percentage of new customers, which have a higher contribution margin per unit than upgrade customers, the number of units required to break even decreases:

	New Customers	**Upgrade Customers**	**Breakeven Point**
Requirement 3(a)	40%	60%	150,000
Requirement 1	60	40	120,000
Requirement 3(b)	80	20	100,000

3-28 (30 min.) **Sales mix, three products.**

1.

	Coffee	**Bagels**
SP	\$2.50	\$3.75
VCU	1.25	1.75
CMU	\$1.25	\$2.00

The sales mix implies that each bundle consists of 4 cups of coffee and 1 bagel.

Contribution margin of the bundle = 4 × \$1.25 + 1 × \$2 = \$5.00 + \$2.00 = \$7.00

$$\text{Breakeven point in bundles} = \frac{\text{Fixed costs}}{\text{Contribution margin per bundle}} = \frac{\$7,000}{\$7.00} = 1,000 \text{ bundles}$$

Breakeven point is:
Coffee: 1,000 bundlex × 4 cups per bundle = 4,000 cups
Bagels: 1,000 bundles × 1 bagel per bundle = 1,000 bagels

Alternatively,
Let S = Number of bagels sold
$4S$ = Number of cups of coffee sold
Revenues – Variable costs – Fixed costs = Operating income
$[\$2.50(4S) + \$3.75S] – [\$1.25(4S) + \$1.75S] – \$7,000 = OI$
$\$13.75S – \$6.75S – \$7,000 = OI$
$\$7.00\ S = \$7,000$
S = 1,000 units of the sales mix
or
S = 1,000 bagels sold
$4S$ = 4,000 cups of coffee sold

Breakeven point, therefore, is 1,000 bagels and 4,000 cups of coffee when OI = 0

Check

Revenues (\$2.50 × 4,000) + (\$3.75 × 1,000)	\$13,750
Variable costs (\$1.25 × 4,000) + (\$1.75 × 1,000)	6,750
Contribution margin	7,000
Fixed costs	7,000
Operating income	\$ 0

2.

	Coffee	**Bagels**
SP	\$2.50	\$3.75
VCU	1.25	1.75
CMU	\$1.25	\$2.00

The sales mix implies that each bundle consists of 4 cups of coffee and 1 bagel.

Contribution margin of the bundle = 4 × \$1.25 + 1 × \$2 = \$5.00 + \$2.00 = \$7.00

Breakeven point in bundles

$$= \frac{\text{Fixed costs + Target operating income}}{\text{Contribution margin per bundle}} = \frac{\$7,000 + \$28,000}{\$7.00} = 5,000 \text{ bundles}$$

Breakeven point is:
Coffee: 5,000 bundles × 4 cups per bundle = 20,000 cups
Bagels: 5,000 bundles × 1 bagel per bundle = 5,000 bagels

Alternatively,
Let S = Number of bagels sold
$4S$ = Number of cups of coffee sold
Revenues – Variable costs – Fixed costs = Operating income
$[\$2.50(4S) + \$3.75S] – [\$1.25(4S) + \$1.75S] – \$7,000 = OI$
$[\$2.50(4S) + \$3.75S] – [\$1.25(4S) + \$1.75S] – \$7,000 = 28,000$
$\$13.75S – \$6.75S = 35,000$
$\$7.00\ S=\$35,000$
$S = 5,000$ units of the sales mix
or
$S =5,000$ bagels sold
$4S=20,000$ cups of coffee sold

The target number of units to reach an operating income before tax of $28,000 is 5,000 bagels and 20,000 cups of coffee.

Check

Revenues ($2.50 × 20,000) + ($3.75 × 5,000)	$68,750
Variable costs ($1.25 × 20,000) + ($1.75 × 5,000)	33,750
Contribution margin	35,000
Fixed costs	7,000
Operating income	$28,000

3.

	Coffee	Bagels	Muffins
SP	$2.50	$3.75	$3.00
VCU	1.25	1.75	0.75
CMU	$1.25	$2.00	$2.25

The sales mix implies that each bundle consists of 3 cups of coffee, 2 bagels and 1 muffin

Contribution margin of the bundle = 3 × $1.25 + 2 × $2 + 1 × $2.25
= $3.75 + $4.00 + $2.25 = $10.00

$$\text{Breakeven point in bundles} = \frac{\text{Fixed costs}}{\text{Contribution margin per bundle}} = \frac{\$7,000}{\$10.00} = 700 \text{ bundles}$$

Breakeven point is:
Coffee: 700 bundles × 3 cups per bundle = 2,100 cups
Bagels: 700 bundles × 2 bagels per bundle = 1,400 bagels
Muffins: 700 bundles × 1 muffin per bundle = 700 muffins

Alternatively,
Let S = Number of muffins sold
$2S$ = Number of bagels sold
$3S$ = Number of cups of coffee sold
Revenues – Variable costs – Fixed costs = Operating income
$[\$2.50(3S) + \$3.75(2S) + 3.00S] – [\$1.25(3S) + \$1.75(2S) + \$0.75S] – \$7,000 = OI$
$\$18.00S – \$8S – \$7,000 = OI$
$\$10.00\ S = \$7,000$
S = 700 units of the sales mix
or
S =700 muffins
$2S$=1,400 bagels
$3S$=2,100 cups of coffee

Breakeven point, therefore, is 2,100 cups of coffee 1,400 bagels, and 700 muffins when OI = 0

Check

Revenues (\$2.50 × 2,100) + (\$3.75 × 1,400) +(\$3.00 × 700)	\$12,600
Variable costs (\$1.25 × 2,100) + (\$1.75 × 1,400) +(\$0.75 × 700)	5,600
Contribution margin	7,000
Fixed costs	7,000
Operating income	\$ 0

Bobbie should definitely add muffins to her product mix because muffins have the highest contribution margin (\$2.25) of all three products. This lowers Bobbie's overall breakeven point. If the sales mix ratio above can be attained, the result is a lower breakeven revenue (\$12,600) of the options presented in the problem.

3-29 CVP, Not for profit

1.

Ticket sales per concert		$ 2,500
Variable costs per concert:		
Guest performers	$ 1,000	
Marketing and advertising	500	
Total variable costs per concert		1,500
Contribution margin per concert		$ 1,000
Fixed costs		
Salaries	$50,000	
Mortgage payments ($2,000 × 12)	24,000	
Total fixed costs		$74,000
Less donations		40,000
Net fixed costs		$34,000

$$\text{Breakeven point in units} = \frac{\text{Net fixed costs}}{\text{Contribution margin per concert}} = \frac{\$34{,}000}{\$1{,}000} = 34 \text{ concerts}$$

Check

Donations		$ 40,000
Revenue ($2,500 × 34)		85,000
Total revenue		125,000
Less variable costs		
Guest performers ($1,000 × 34)	$34,000	
Marketing and advertising ($500 × 34)	17,000	
Total variable costs		51,000
Less fixed costs		
Salaries	$50,000	
Mortgage payments	24,000	
Total fixed costs		74,000
Operating income		$ 0

2.

Ticket sales per concert		$ 2,500
Variable costs per concert:		
Guest performers	$1,000	
Marketing and advertising	500	
Total variable costs per concert		1,500
Contribution margin per concert		$ 1,000
Fixed costs		
Salaries ($50,000 + $40,000)	$90,000	
Mortgage payments ($2,000 × 12)	24,000	
Total fixed costs		$114,000
Less donations		40,000
Net fixed costs		$ 74,000

$$\text{Breakeven point in units} = \frac{\text{Net fixed costs}}{\text{Contribution margin per concert}} = \frac{\$74{,}000}{\$1{,}000} = 74 \text{ concerts}$$

Check

Donations		$ 40,000
Revenue ($2,500 × 74)		185,000
Total revenue		225,000
Less variable costs		
Guest performers ($1,000 × 74)	$74,000	
Marketing and advertising ($500 × 74)	37,000	
Total variable costs		111,000
Less fixed costs		
Salaries	$90,000	
Mortgage payments	24,000	
Total fixed costs		114,000
Operating income		$ 0

Operating Income if 60 concerts are held

Donations		$ 40,000
Revenue ($2,500 × 60)		150,000
Total revenue		190,000
Less variable costs		
Guest performers ($1,000 × 60)	$60,000	
Marketing and advertising ($500 × 60)	30,000	
Total variable costs		90,000
Less fixed costs		
Salaries	$90,000	
Mortgage payments	24,000	
Total fixed costs		114,000
Operating income (loss)		$ (14,000)

The Music Society would not be able to afford the new marketing director if the number of concerts were to increase to only 60 events. The addition of the new marketing director would require the Music Society to hold at least 74 concerts in order to breakeven. If only 60 concerts were held, the organization would lose $14,000 annually. The Music Society could look for other contributions to support the new marketing director's salary or perhaps increase the number of attendees per concert if the number of concerts could not be increased beyond 60.

3.

Ticket sales per concert		$ 2,500
Variable costs per concert:		
Guest performers	$ 1,000	
Marketing and advertising	500	
Total variable costs per concert		1,500
Contribution margin per concert		$ 1,000

Fixed costs		
Salaries ($50,000 + $40,000)	$90,000	
Mortgage payments ($2,000 × 12)	24,000	
Total fixed costs		$114,000
Deduct donations		60,000
Net fixed costs		$ 54,000

$$\text{Breakeven point in units} = \frac{\text{Net fixed costs}}{\text{Contribution margin per concert}} = \frac{\$54{,}000}{\$1{,}000} = 54 \text{ concerts}$$

Check

Donations		$ 60,000
Revenue ($2,500 × 54)		135,000
Total revenue		195,000
Less variable costs		
Guest performers ($1,000 × 54)	$54,000	
Marketing and advertising ($500 × 54)	27,000	
Total variable costs		81,000
Less fixed costs		
Salaries	$90,000	
Mortgage payments	24,000	
Total fixed costs		114,000
Operating income		$ 0

3-30 (15 min.) **Contribution margin, decision making.**

1.

Revenues		$600,000
Deduct variable costs:		
Cost of goods sold	$300,000	
Sales commissions	60,000	
Other operating costs	30,000	390,000
Contribution margin		$210,000

2. Contribution margin percentage = $\frac{\$210,000}{\$600,000}$ = 35%

3.

Incremental revenue (15% × $600,000) = $90,000	
Incremental contribution margin (35% × $90,000)	$31,500
Incremental fixed costs (advertising)	13,000
Incremental operating income	$18,500

If Mr. Lurvey spends $13,000 more on advertising, the operating income will increase by $18,500, decreasing the operating loss from $49,000 to an operating loss of $30,500.

Proof (Optional):

Revenues (115% × $600,000)		$690,000
Cost of goods sold (50% of sales)		345,000
Gross margin		345,000
Operating costs:		
Salaries and wages	$170,000	
Sales commissions (10% of sales)	69,000	
Depreciation of equipment and fixtures	20,000	
Store rent	54,000	
Advertising	13,000	
Other operating costs:		
Variable $\left(\frac{\$30,000}{\$600,000}\times\$690,000\right)$	34,500	
Fixed	15,000	375,500
Operating income		$ (30,500)

3-31 (20 min.) **Contribution margin, gross margin and margin of safety.**

1.

Mirabella Cosmetics
Operating Income Statement, June 2011

Units sold		10,000
Revenues		$100,000
Variable costs		
Variable manufacturing costs	$ 55,000	
Variable marketing costs	5,000	
Total variable costs		60,000
Contribution margin		40,000
Fixed costs		
Fixed manufacturing costs	$ 20,000	
Fixed marketing & administration costs	10,000	
Total fixed costs		30,000
Operating income		$ 10,000

2. Contribution margin per unit = $\frac{\$40{,}000}{10{,}000 \text{ units}} = \$4 \text{ per unit}$

Breakeven quantity = $\frac{\text{Fixed costs}}{\text{Contribution margin per unit}} = \frac{\$30{,}000}{\$4 \text{ per unit}} = 7{,}500 \text{ units}$

Selling price = $\frac{\text{Revenues}}{\text{Units sold}} = \frac{\$100{,}000}{10{,}000 \text{ units}} = \$10 \text{ per unit}$

Breakeven revenues = 7,500 units × $10 per unit = $75,000

Alternatively,

Contribution margin percentage = $\frac{\text{Contribution margin}}{\text{Revenues}} = \frac{\$40{,}000}{\$100{,}000} = 40\%$

Breakeven revenues = $\frac{\text{Fixed costs}}{\text{Contribution margin percentage}} = \frac{\$30{,}000}{0.40} = \$75{,}000$

3. Margin of safety (in units) = Units sold – Breakeven quantity
= 10,000 units – 7,500 units = 2,500 units

4.

Units sold	8,000
Revenues (Units sold × Selling price = 8,000 × $10)	$80,000
Contribution margin (Revenues ×CM percentage = $80,000 ×40%)	$32,000
Fixed costs	30,000
Operating income	2,000
Taxes (30% × $2,000)	600
Net income	$ 1,400

3-32 (30 min.) **Uncertainty and expected costs.**

1\.

Monthly Number of Orders	**Cost of Current System**
350,000	\$2,500,000 + \$50(350,000) = \$20,000,000
450,000	\$2,500,000 + \$50(450,000) = \$25,000,000
550,000	\$2,500,000 + \$50(550,000) = \$30,000,000
650,000	\$2,500,000 + \$50(650,000) = \$35,000,000
750,000	\$2,500,000 + \$50(750,000) = \$40,000,000

Monthly Number of Orders	**Cost of Partially Automated System**
350,000	\$10,000,000 + \$40(350,000) = \$24,000,000
450,000	\$10,000,000 + \$40(450,000) = \$28,000,000
550,000	\$10,000,000 + \$40(550,000) = \$32,000,000
650,000	\$10,000,000 + \$40(650,000) = \$36,000,000
750,000	\$10,000,000 + \$40(750,000) = \$40,000,000

Monthly Number of Orders	**Cost of Fully Automated System**
350,000	\$20,000,000 + \$25(350,000) = \$28,750,000
450,000	\$20,000,000 + \$25(450,000) = \$31,250,000
550,000	\$20,000,000 + \$25(550,000) = \$33,750,000
650,000	\$20,000,000 + \$25(650,000) = \$36,250,000
750,000	\$20,000,000 + \$25(750,000) = \$38,750,000

2\. Current System Expected Cost:

\$20,000,000 × 0.15	=	\$ 3,000,000
25,000,000 × 0.20	=	5,000,000
30,000,000 × 0.35	=	10,500,000
35,000,000 × 0.20	=	7,000,000
40,000,000 × 0.10	=	4,000,000
		\$29,500,000

Partially Automated System Expected Cost:

\$24,000,000 × 0.15	=	\$ 3,600,000
28,000,000 × 0.20	=	5,600,000
32,000,000 × 0.35	=	11,200,000
36,000,000 × 0.20	=	7,200,000
40,000,000 × 0.10	=	4,000,000
		\$31,600,000

Fully Automated System Expected Cost:

\$28,750,000 × 0.15	=	\$ 4,312,500
31,250,000 × 0.20	=	6,250,000
33,750,000 × 0.35	=	11,812,500
36,250,000 × 0.20	=	7,250,000
38,750,000 × 0.10	=	3,875,000
		\$33,500,000

3. Foodmart should consider the impact of the different systems on its relationship with suppliers. The interface with Foodmart's system may require that suppliers also update their systems. This could cause some suppliers to raise the cost of their merchandise. It could force other suppliers to drop out of Foodmart's supply chain because the cost of the system change would be prohibitive. Foodmart may also want to consider other factors such as the reliability of different systems and the effect on employee morale if employees have to be laid off as it automates its systems.

3-33 (15–20 min.) **CVP analysis, service firm**.

1.

Revenue per package	$5,000
Variable cost per package	3,700
Contribution margin per package	$1,300

Breakeven (packages) = Fixed costs ÷ Contribution margin per package

$$= \frac{\$520,000}{\$1,300 \text{ per package}} = 400 \text{ tour packages}$$

2.

$$\text{Contribution margin ratio} = \frac{\text{Contribution margin per package}}{\text{Selling price}} = \frac{\$1,300}{\$5,000} = 26\%$$

Revenue to achieve target income = (Fixed costs + target OI) ÷ Contribution margin ratio

$$= \frac{\$520,000 + \$91,000}{0.26} = \$2,350,000, \text{ or}$$

$$\text{Number of tour packages to earn \$91,000 operating income} = \frac{\$520,000 + \$91,000}{\$1,300} = 470 \text{ tour packages}$$

Revenues to earn $91,000 OI = 470 tour packages × $5,000 = $2,350,000.

3. Fixed costs = $520,000 + $32,000 = $552,000

$$\text{Breakeven (packages)} = \frac{\text{Fixed costs}}{\text{Contribution margin per package}}$$

$$\text{Contribution margin per package} = \frac{\text{Fixed costs}}{\text{Breakeven (packages)}}$$

$$= \frac{\$552,000}{400 \text{ tour packages}} = \$1,380 \text{ per tour package}$$

Desired variable cost per tour package = $5,000 – $1,380 = $3,620

Because the current variable cost per unit is $3,700, the unit variable cost will need to be reduced by $80 to achieve the breakeven point calculated in requirement 1.

Alternate Method: If fixed cost increases by $32,000, then total variable costs must be reduced by $32,000 to keep the breakeven point of 400 tour packages.

Therefore, the variable cost per unit reduction = $32,000 ÷ 400 = $80 per tour package.

3-34 (30 min.) **CVP, target operating income, service firm.**

1.

Revenue per child	$580
Variable costs per child	230
Contribution margin per child	$350

$$\text{Breakeven quantity} = \frac{\text{Fixed costs}}{\text{Contribution margin per child}}$$

$$= \frac{\$5{,}600}{\$350} = 16 \text{ children}$$

2.

$$\text{Target quantity} = \frac{\text{Fixed costs} + \text{Target operating income}}{\text{Contribution margin per child}}$$

$$= \frac{\$5{,}600 + \$10{,}500}{\$350} = 46 \text{ children}$$

3.

Increase in rent ($3,150 – $2,150)	$1,000
Field trips	1,300
Total increase in fixed costs	$2,300
Divide by the number of children enrolled	÷ 46
Increase in fee per child	$ 50

Therefore, the fee per child will increase from $580 to $630.

Alternatively,

$$\text{New contribution margin per child} = \frac{\$5{,}600 + \$2{,}300 + \$10{,}500}{46} = \$400$$

New fee per child = Variable costs per child + New contribution margin per child
= $230 + $400 = $630

3-35 (20–25 min.) **CVP analysis.**

1.

Selling price		$300
Variable costs per unit:		
Production costs	$120	
Shipping and handling	5	125
Contribution margin per unit (CMU)		$175

$$\text{Breakeven point in units} = \frac{\text{Fixed costs}}{\text{Contribution margin per unit}} = \frac{\$1{,}260{,}000}{\$175} = 7{,}200 \text{ units}$$

Margin of safety (units) = 10,000 – 7,200 = 2,800 units

2. Since fixed costs remain the same, any incremental increase in sales will increase contribution margin and operating income dollar for dollar.

Increase in units sales = 10% × 10,000 = 1,000
Incremental contribution margin = $175 × 1,000 = $175,000

Therefore, the increase in operating income will be equal to $175,000.
Technology Solutions's operating income in 2011 would be $490,000 + $175,000 = $665,000.

3.

Selling price		$300
Variable costs:		
Production costs $120 × 130%	$156	
Shipping and handling ($5 – ($5×0.20))	4	160
Contribution margin per unit		$140

$$\text{Target sales in units} = \frac{FC + TOI}{CMU} = \frac{\$1{,}260{,}000 + \$490{,}000}{\$140} = 12{,}500 \text{ units}$$

Target sales in dollars = $300 × 12,500 = $3,750,000

3-36 (30–40 min.) **CVP analysis, income taxes.**

1. $\text{Revenues} - \text{Variable costs} - \text{Fixed costs} = \dfrac{\text{Target net income}}{1 - \text{Tax rate}}$

Let X = Net income for 2011

$$20{,}000(\$25.00) - 20{,}000(\$13.75) - \$135{,}000 = \frac{X}{1-0.40}$$
$$\$500{,}000 - \$275{,}000 - \$135{,}000 = \frac{X}{0.60}$$
$$\$300{,}000 - \$165{,}000 - \$81{,}000 = X$$
$$X = \$54{,}000$$

Alternatively,
Operating income = Revenues – Variable costs – Fixed costs
= \$500,000 – \$275,000 – \$135,000 = \$90,000
Income taxes = 0.40 × \$90,000 = \$36,000
Net income = Operating income – Income taxes
= \$90,000 – \$36,000 = \$54,000

2. Let Q = Number of units to break even
\$25.00Q – \$13.75Q – \$135,000 = 0
Q = \$135,000 ÷ \$11.25 = 12,000 units

3. Let X = Net income for 2012

$$22{,}000(\$25.00) - 22{,}000(\$13.75) - (\$135{,}000 + \$11{,}250) = \frac{X}{1-0.40}$$
$$\$550{,}000 - \$302{,}500 - \$146{,}250 = \frac{X}{0.60}$$
$$\$101{,}250 = \frac{X}{0.60}$$
$$X = \$60{,}750$$

4. Let Q = Number of units to break even with new fixed costs of \$146,250
\$25.00Q – \$13.75Q – \$146,250 = 0
Q = \$146,250 ÷ \$11.25 = 13,000 units
Breakeven revenues = 13,000 × \$25.00 = \$325,000

5. Let S = Required sales units to equal 2011 net income

$$\$25.00S - \$13.75S - \$146{,}250 = \frac{\$54{,}000}{0.60}$$
\$11.25S = \$236,250
S = 21,000 units
Revenues = 21,000 units × \$25 = \$525,000

6. Let A = Amount spent for advertising in 2012

$$\$550{,}000 - \$302{,}500 - (\$135{,}000 + A) = \frac{\$60{,}000}{0.60}$$
$$\$550{,}000 - \$302{,}500 - \$135{,}000 - A = \$100{,}000$$
$$\$550{,}000 - \$537{,}500 = A$$
$$A = \$12{,}500$$

3-37 (25 min.) **CVP, sensitivity analysis**.

Contribution margin per pair of shoes = \$60 – \$25 = \$35
Fixed costs = \$100,000
Units sold = Total sales ÷ Selling price = \$300,000 ÷ \$60 per pair= 5,000 pairs of shoes

1. Variable costs decrease by 20%; Fixed costs increase by 15%

Sales revenues 5,000 × \$60	\$300,000
Variable costs 5,000 × \$25 × (1 – 0.20)	100,000
Contribution margin	200,000
Fixed costs \$100,000 x 1.15	115,000
Operating income	\$ 85,000

2. Increase advertising (fixed costs) by \$30,000; Increase sales 20%

Sales revenues 5,000 × 1.20 × \$60.00	\$360,000
Variable costs 5,000 × 1.20 × \$25.00	150,000
Contribution margin	210,000
Fixed costs (\$100,000 + \$30,000)	130,000
Operating income	\$ 80,000

3. Increase selling price by \$10.00; Sales decrease 10%; Variable costs increase by \$7

Sales revenues 5,000 × 0.90 × (\$60 + \$10)	\$315,000
Variable costs 5,000 × 0.90 × (\$25 + \$7)	144,000
Contribution margin	171,000
Fixed costs	100,000
Operating income	\$ 71,000

4. Double fixed costs; Increase sales by 60%

Sales revenues 5,000 × 1.60 × \$60	\$480,000
Variable costs 5,000 × 1.60 × \$25	200,000
Contribution margin	280,000
Fixed costs \$100,000 × 2	200,000
Operating income	\$ 80,000

Alternative 1 yields the highest operating income. Choosing alternative 1 will give Brown a 13.33% increase in operating income [(\$85,000 – \$75,000)/\$75,000 = 13.33%], which is less than the company's 25% targeted increase. Alternatives 2 and 4 also generate more operating income for Brown, but they too do not meet Brown's target of 25% increase in operating income. Alternative 3 actually results in lower operating income than under Brown's current cost structure. There is no reason, however, for Brown to think of these alternatives as being mutually exclusive. For example, Brown can combine actions 1 and 2, automate the machining process and advertise. This will result in a 26.67% increase in operating income as follows:

Sales revenue 5,000 × 1.20 × $60	$360,000
Variable costs 5,000 × 1.20 × $25 × (1 – 0.20)	120,000
Contribution margin	240,000
Fixed costs $100,000 × 1.15 + $30,000	145,000
Operating income	$ 95,000

The point of this problem is that managers always need to consider broader rather than narrower alternatives to meet ambitious or stretch goals.

3-38 (20–30 min.) **CVP analysis, shoe stores.**

1. CMU (SP – VCU = $30 – $21)	$ 9.00
a. Breakeven units (FC ÷ CMU = $360,000 ÷ $9 per unit)	40,000
b. Breakeven revenues	
(Breakeven units × SP = 40,000 units × $30 per unit)	$1,200,000

2. Pairs sold	35,000
Revenues, 35,000 × $30	$1,050,000
Total cost of shoes, 35,000 × $19.50	682,500
Total sales commissions, 35,000 × $1.50	52,500
Total variable costs	735,000
Contribution margin	315,000
Fixed costs	360,000
Operating income (loss)	$ (45,000)

3. Unit variable data (per pair of shoes)	
Selling price	$ 30.00
Cost of shoes	19.50
Sales commissions	0
Variable cost per unit	$ 19.50
Annual fixed costs	
Rent	$ 60,000
Salaries, $200,000 + $81,000	281,000
Advertising	80,000
Other fixed costs	20,000
Total fixed costs	$ 441,000

CMU, $30 – $19.50	$ 10.50
a. Breakeven units, $441,000 ÷ $10.50 per unit	42,000
b. Breakeven revenues, 42,000 units × $30 per unit	$1,260,000

4. Unit variable data (per pair of shoes)

Selling price	$ 30.00
Cost of shoes	19.50
Sales commissions	1.80
Variable cost per unit	$ 21.30
Total fixed costs	$ 360,000
CMU, $30 – $21.30	$ 8.70
a. Break even units = $360,000 ÷ $8.70 per unit	41,380 (rounded up)
b. Break even revenues = 41,380 units × $30 per unit	$1,241,400

5.

Pairs sold	50,000
Revenues (50,000 pairs × $30 per pair)	$1,500,000
Total cost of shoes (50,000 pairs × $19.50 per pair)	$ 975,000
Sales commissions on first 40,000 pairs (40,000 pairs × $1.50 per pair)	60,000
Sales commissions on additional 10,000 pairs [10,000 pairs × ($1.50 + $0.30 per pair)]	18,000
Total variable costs	$1,053,000
Contribution margin	$ 447,000
Fixed costs	360,000
Operating income	$ 87,000

Alternative approach:

Breakeven point in units = 40,000 pairs
Store manager receives commission of $0.30 on 10,000 (50,000 – 40,000) pairs.
Contribution margin per pair beyond breakeven point of 10,000 pairs =
$8.70 ($30 – $21 – $0.30) per pair.
Operating income = 10,000 pairs × $8.70 contribution margin per pair = $87,000.

3-39 (30 min.) **CVP analysis, shoe stores (continuation of 3-38).**

	Salaries + Commission Plan				Higher Fixed Salaries Only				
No. of units sold (1)	**CM per Unit (2)**	**CM (3)=(1)×(2)**	**Fixed Costs (4)**	**Operating Income (5)=(3)–(4)**	**CM per Unit (6)**	**CM (7)=(1)×(6)**	**Fixed Costs (8)**	**Operating Income (9)=(7)–(8)**	**Difference in favor of higher-fixed-salary-only (10)=(9)–(5)**
40,000	$9.00	$360,000	$360,000	0	$10.50	$420,000	$441,000	$ (21,000)	$(21,000)
42,000	9.00	378,000	360,000	18,000	10.50	441,000	441,000	0	(18,000)
44,000	9.00	396,000	360,000	36,000	10.50	462,000	441,000	21,000	(15,000)
46,000	9.00	414,000	360,000	54,000	10.50	483,000	441,000	42,000	(12,000)
48,000	9.00	432,000	360,000	72,000	10.50	504,000	441,000	63,000	(9,000)
50,000	9.00	450,000	360,000	90,000	10.50	525,000	441,000	84,000	(6,000)
52,000	9.00	468,000	360,000	108,000	10.50	546,000	441,000	105,000	(3,000)
54,000	9.00	486,000	360,000	126,000	10.50	567,000	441,000	126,000	0
56,000	9.00	504,000	360,000	144,000	10.50	588,000	441,000	147,000	3,000
58,000	9.00	522,000	360,000	162,000	10.50	609,000	441,000	168,000	6,000
60,000	9.00	540,000	360,000	180,000	10.50	630,000	441,000	189,000	9,000
62,000	9.00	558,000	360,000	198,000	10.50	651,000	441,000	210,000	12,000
64,000	9.00	576,000	360,000	216,000	10.50	672,000	441,000	231,000	15,000
66,000	9.00	594,000	360,000	234,000	10.50	693,000	441,000	252,000	18,000

1. See preceding table. The new store will have the same operating income under either compensation plan when the volume of sales is 54,000 pairs of shoes. This can also be calculated as the unit sales level at which both compensation plans result in the same total costs:

Let Q = unit sales level at which total costs are same for both plans

$$\$19.50Q + \$360{,}000 + \$81{,}000 = \$21Q + \$360{,}000$$
$$\$1.50\,Q = \$81{,}000$$
$$Q = 54{,}000 \text{ pairs}$$

2. When sales volume is above 54,000 pairs, the higher-fixed-salaries plan results in lower costs and higher operating incomes than the salary-plus-commission plan. So, for an expected volume of 55,000 pairs, the owner would be inclined to choose the higher-fixed-salaries-only plan. But it is likely that sales volume itself is determined by the nature of the compensation plan. The salary-plus-commission plan provides a greater motivation to the salespeople, and it may well be that for the same amount of money paid to salespeople, the salary-plus-commission plan generates a higher volume of sales than the fixed-salary plan.

3. Let TQ = Target number of units

For the salary-only plan,

$$\$30.00TQ - \$19.50TQ - \$441{,}000 = \$168{,}000$$
$$\$10.50TQ = \$609{,}000$$
$$TQ = \$609{,}000 \div \$10.50$$
$$TQ = 58{,}000 \text{ units}$$

For the salary-plus-commission plan,

$$\$30.00TQ - \$21.00TQ - \$360{,}000 = \$168{,}000$$
$$\$9.00TQ = \$528{,}000$$
$$TQ = \$528{,}000 \div \$9.00$$
$$TQ = 58{,}667 \text{ units (rounded up)}$$

The decision regarding the salary plan depends heavily on predictions of demand. For instance, the salary plan offers the same operating income at 58,000 units as the commission plan offers at 58,667 units.

4.

WalkRite Shoe Company
Operating Income Statement, 2011

Revenues (48,000 pairs ×$30) + (2,000 pairs ×$18)	$1,476,000
Cost of shoes, 50,000 pairs × $19.50	975,000
Commissions = Revenues ×5% = $1,476,000 × 0.05	73,800
Contribution margin	427,200
Fixed costs	360,000
Operating income	$ 67,200

3-40 (40 min.) **Alternative cost structures, uncertainty, and sensitivity analysis.**

1. Contribution margin per page assuming current fixed leasing agreement = \$0.15 – \$0.03 – \$0.04 = \$0.08 per page

   Fixed costs = \$1,000

   $$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution margin per page}} = \frac{\$1,000}{\$0.08 \text{ per page}} = 12,500 \text{ pages}$$

   Contribution margin per page assuming \$10 per 500 page commission agreement = \$0.15–\$0.02[a] – \$0.03 – \$.04 = \$0.06 per page

   Fixed costs = \$0

   $$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution margin per page}} = \frac{\$0}{\$0.06 \text{ per page}} = 0 \text{ pages}$$

   (i.e., Stylewise makes a profit no matter how few pages it sells)

   [a]\$10/500 pages = \$0.02 per page

2. Let x denote the number of pages Stylewise must sell for it to be indifferent between the fixed leasing agreement and commission based agreement.
   To calculate x we solve the following equation.

   $\$0.15x - \$0.03x - \$0.04x - \$1,000 = \$0.15x - \$0.02x - \$0.03x - \$.04x$
   $\$0.08x - \$1,000 = \$0.06x$
   $\$0.02x = \$1,000$
   $x = \$1,000 \div \$0.02 = 50,000$ pages

   For sales between 0 to 50,000 pages, Stylewise prefers the commission based agreement because in this range, $\$0.06x > \$0.08x - \$1,000$. For sales greater than 50,000 pages, Stylewise prefers the fixed leasing agreement because in this range, $\$0.08x - \$1,000 > \$.06x$.

3. Fixed leasing agreement

Pages Sold (1)	Revenue (2)	Variable Costs (3)	Fixed Costs (4)	Operating Income (Loss) (5)=(2)–(3)–(4)	Probability (6)	Expected Operating Income (7)=(5)×(6)
20,000	20,000×\$.15=\$ 3,000	20,000×\$.07=\$1,400	\$1,000	\$ 600	0.20	\$ 120
40,000	40,000×\$.15=\$ 6,000	40,000×\$.07=\$2,800	\$1,000	\$2,200	0.20	440
60,000	60,000×\$.15=\$ 9,000	60,000×\$.07=\$4,200	\$1,000	\$3,800	0.20	760
80,000	80,000×\$.15=\$12,000	80,000×\$.07=\$5,600	\$1,000	\$5,400	0.20	1,080
100,000	100,000×\$.15=\$15,000	100,000×\$.07=\$7,000	\$1,000	\$7,000	0.20	1,400
Expected value of fixed leasing agreement						\$3,800

Commission-based leasing agreement:

Pages Sold (1)	Revenue (2)	Variable Costs (3)	Operating Income (4)=(2)–(3)	Probability (5)	Expected Operating Income (6)=(4)×(5)
20,000	20,000×$.15=$ 3,000	20,000×$.09=$1,800	$1,200	0.20	$ 240
40,000	40,000×$.15=$ 6,000	40,000×$.09=$3,600	$2,400	0.20	480
60,000	60,000×$.15=$ 9,000	60,000×$.09=$5,400	$3,600	0.20	720
80,000	80,000×$.15=$12,000	80,000×$.09=$7,200	$4,800	0.20	960
100,000	100,000×$.15=$15,000	100,000×$.09=$9,000	$6,000	0.20	1,200
Expected value of commission based agreement					$3,600

Stylewise should choose the fixed cost leasing agreement because the expected value is higher than under the commission-based leasing agreement. The range of sales is high enough to make the fixed leasing agreement more attractive.

3-41 (20-30 min.) **CVP, alternative cost structures.**

1. Variable cost per computer = \$100 + (\$15 × 10) + \$50 = \$300
   Contribution margin per computer = Selling price –Variable cost per computer
   = \$500 – \$300 = \$200
   Breakeven point = Fixed costs ÷ Contribution margin per computer
   = \$4,000 ÷ \$200 = 20 computers (per month)

2. $$\text{Target number of computers} = \frac{\text{Fixed costs + Target operating income}}{\text{Contribution margin per computer}}$$

   $$= \frac{\$4{,}000 + \$5{,}000}{\$200} = 45 \text{ computers}$$

3. Contribution margin per computer = Selling price – Variable cost per computer
   = \$500 – \$200 – \$50 = \$250
   Fixed costs = \$4,000
   $$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution margin per computer}} = \frac{\$4{,}000}{\$250} = 16 \text{ computers}$$

4. Let x be the number of computers for which PC Planet is indifferent between paying a monthly rental fee for the retail space and paying a 20% commission on sales. PC Planet will be indifferent when the profits under the two alternatives are equal.

$$\$500x - \$300x - \$4{,}000 = \$500x - \$300x - \$500\,(0.20)\,x$$
$$\$200x - \$4{,}000 = \$100x$$
$$\$100x = \$4{,}000$$
$$x = 40 \text{ computers}$$

For sales between 0 and 40 computers, PC Planet prefers to pay the 20% commission because in this range, $\$100x > \$200x - \$4{,}000$. For sales greater than 40 computers, the company prefers to pay the monthly fixed rent of \$4,000 because $\$200x - \$4{,}000 > \$100x$

3-42 (30 min.) **CVP analysis, income taxes, sensitivity.**

1a.To breakeven, Agro Engine Company must sell 1,200 units. This amount represents the point where revenues equal total costs.
Let Q denote the quantity of engines sold.

Revenue	=	Variable costs + Fixed costs
$3,000Q	=	$500Q + $3,000,000
$2,500Q	=	$3,000,000
Q	=	1,200 units

Breakeven can also be calculated using contribution margin per unit.
Contribution margin per unit = Selling price – Variable cost per unit = $3,000 – $500 = $2,500

Breakeven = Fixed Costs ÷ Contribution margin per unit
= $3,000,000 ÷ $2,500
= 1,200 units

1b. To achieve its net income objective, Agro Engine Company must sell 2,000 units. This amount represents the point where revenues equal total costs plus the corresponding operating income objective to achieve net income of $1,500,000.

Revenue = Variable costs + Fixed costs + [Net income ÷ (1 – Tax rate)]
$3,000Q = $500Q + $3,000,000 + [$1,500,000 ÷ (1 – 0.25)]
$3,000Q = $500Q + $3,000,000 + $2,000,000
Q = 2,000 units

2. To achieve its net income objective, Agro Engine Company should select alternative c, where fixed costs are reduced by 20% and selling price is reduced by 10% resulting in 1,700 additional units being sold through the end of the year. This alternative results in the highest net income and is the only alternative that equals or exceeds the company's net income objective of $1,500,000. Calculations for the three alternatives are shown below.

Alternative a
Revenues = ($3,000 × 300) + ($2,400[a] × 2,000) = $5,700,000
Variable costs = $500 × 2,300[b] = $1,150,000
Operating income = $5,700,000 – $1,150,000 – $3,000,000 = $1,550,000
Net income = $1,550,000 × (1 – 0.25) = $1,162,500

[a]$3,000 – ($3,000 × 0.20) = ; [b]300 units + 2,000 units.

Alternative b

Revenues = $(\$3,000 \times 300) + (\$2,750^{c} \times 1,800) = \$5,850,000$

Variable costs = $(\$500 \times 300) + (\$450^{d} \times 1,800) = \$960,000$

Operating income = $\$5,850,000 - \$960,000 - \$3,000,000 = \$1,890,000$

Net income = $\$1,890,000 \times (1 - 0.25) = \$1,417,500$

[c]$3,000 – $250; [d]$450.

Alternative c

Revenues = $(\$3,000 \times 300) + (\$2,700^{e} \times 1,700) = \$5,490,000$

Variable costs = $\$500 \times 2000^{f} = \$1,000,000$

Operating income = $\$5,490,000 - \$1,000,000 - \$2,400,000^{g} = \$2,090,000$

Net income = $\$2,090,000 \times (1 - 0.25) = \$1,567,500$

[e]$3,000 – (0.10 × $3,000) = $3,000 – $300; [f]300units + 1,700 units;
[g]$3,000,000 – (0.20 × $3,000,000)

3-43 (30 min.) **Choosing between compensation plans, operating leverage.**

1. We can recast Marston's income statement to emphasize contribution margin, and then use it to compute the required CVP parameters.

Marston Corporation
Income Statement
For the Year Ended December 31, 2011

	Using Sales Agents		**Using Own Sales Force**	
Revenues		$26,000,000		$26,000,000
Variable Costs				
Cost of goods sold—variable	$11,700,000		$11,700,000	
Marketing commissions	4,680,000	16,380,000	2,600,000	14,300,000
Contribution margin		9,620,000		11,700,000
Fixed Costs				
Cost of goods sold—fixed	2,870,000		2,870,000	
Marketing—fixed	3,420,000	6,290,000	5,500,000	8,370,000
Operating income		$ 3,330,000		$ 3,330,000
Contribution margin percentage ($9,620,000 ÷ 26,000,000; $11,700,000 ÷ $26,000,000)		37%		45%
Breakeven revenues ($6,290,000 ÷ 0.37; $8,370,000 ÷ 0.45)		$17,000,000		$18,600,000
Degree of operating leverage ($9,620,000 ÷ $3,330,000; $11,700,000 ÷ $3,330,000)		2.89		3.51

2. The calculations indicate that at sales of $26,000,000, a percentage change in sales and contribution margin will result in 2.89 times that percentage change in operating income if Marston continues to use sales agents and 3.51 times that percentage change in operating income if Marston employs its own sales staff. The higher contribution margin per dollar of sales and higher fixed costs gives Marston more operating leverage, that is, greater benefits (increases in operating income) if revenues increase but greater risks (decreases in operating income) if revenues decrease. Marston also needs to consider the skill levels and incentives under the two alternatives. Sales agents have more incentive compensation and hence may be more motivated to increase sales. On the other hand, Marston's own sales force may be more knowledgeable and skilled in selling the company's products. That is, the sales volume itself will be affected by who sells and by the nature of the compensation plan.

3. Variable costs of marketing = 15% of Revenues
Fixed marketing costs = $5,500,000

$$\text{Operating income} = \text{Revenues} - \begin{matrix}\text{Variable}\\\text{manuf. costs}\end{matrix} - \begin{matrix}\text{Fixed}\\\text{manuf. costs}\end{matrix} - \begin{matrix}\text{Variable}\\\text{marketing}\\\text{costs}\end{matrix} - \begin{matrix}\text{Fixed}\\\text{marketing}\\\text{costs}\end{matrix}$$

Denote the revenues required to earn $3,330,000 of operating income by R, then

$R - 0.45R - \$2,870,000 - 0.15R - \$5,500,000 = \$3,330,000$

$$R - 0.45R - 0.15R = \$3,330,000 + \$2,870,000 + \$5,500,000$$
$$0.40R = \$11,700,000$$
$$R = \$11,700,000 \div 0.40 = \$29,250,000$$

3-44 (15–25 min.) **Sales mix, three products.**

1. Sales of A, B, and C are in ratio 20,000 : 100,000 : 80,000. So for every 1 unit of A, 5 (100,000 ÷ 20,000) units of B are sold, and 4 (80,000 ÷ 20,000) units of C are sold.

Contribution margin of the bundle = 1 × \$3 + 5 × \$2 + 4 × \$1 = \$3 + \$10 + \$4 = \$17

$$\text{Breakeven point in bundles} = \frac{\$255,000}{\$17} = 15,000 \text{ bundles}$$

Breakeven point in units is:

Product A:	15,000 bundles × 1 unit per bundle	15,000 units
Product B:	15,000 bundles × 5 units per bundle	75,000 units
Product C:	15,000 bundles × 4 units per bundle	60,000 units
Total number of units to breakeven		150,000 units

Alternatively,

Let Q = Number of units of A to break even
5Q = Number of units of B to break even
4Q = Number of units of C to break even

Contribution margin – Fixed costs = Zero operating income

\$3Q + \$2(5Q) + \$1(4Q) – \$255,000	=	0
\$17Q	=	\$255,000
Q	=	15,000 (\$255,000 ÷ \$17) units of A
5Q	=	75,000 units of B
4Q	=	60,000 units of C
Total	=	150,000 units

2. Contribution margin:

A: 20,000 × \$3	\$ 60,000	
B: 100,000 × \$2	200,000	
C: 80,000 × \$1	80,000	
Contribution margin		\$340,000
Fixed costs		255,000
Operating income		\$ 85,000

3. Contribution margin

A: 20,000 × $3	$ 60,000	
B: 80,000 × $2	160,000	
C: 100,000 × $1	100,000	
Contribution margin		$320,000
Fixed costs		255,000
Operating income		$ 65,000

Sales of A, B, and C are in ratio 20,000 : 80,000 : 100,000. So for every 1 unit of A, 4 (80,000 ÷ 20,000) units of B and 5 (100,000 ÷ 20,000) units of C are sold.

Contribution margin of the bundle = 1 × $3 + 4 × $2 + 5 × $1 = $3 + $8 + $5 = $16

Breakeven point in bundles = $\frac{\$255,000}{\$16}$ = 15,938 bundles (rounded up)

Breakeven point in units is:

Product A:	15,938 bundles × 1 unit per bundle	15,938 units
Product B:	15,938 bundles × 4 units per bundle	63,752 units
Product C:	15,938 bundles × 5 units per bundle	79,690 units
Total number of units to breakeven		159,380 units

Alternatively,

Let Q = Number of units of A to break even
4Q = Number of units of B to break even
5Q = Number of units of C to break even

Contribution margin – Fixed costs = Breakeven point

$3Q + $2(4Q) + $1(5Q) – $255,000 = 0
$16Q = $255,000
Q = 15,938 ($255,000 ÷ $16) units of A (rounded up)
4Q = 63,752 units of B
5Q = 79,690 units of C
Total = 159,380 units

Breakeven point increases because the new mix contains less of the higher contribution margin per unit, product B, and more of the lower contribution margin per unit, product C.

3-45 (40 min.) **Multi-product CVP and decision making.**

1. Faucet filter:

Selling price	$80
Variable cost per unit	20
Contribution margin per unit	$60

Pitcher-cum-filter:

Selling price	$90
Variable cost per unit	25
Contribution margin per unit	$65

Each bundle contains 2 faucet models and 3 pitcher models.

So contribution margin of a bundle = 2×$60 + 3×$65 = $315

$$\text{Breakeven point in bundles} = \frac{\text{Fixed costs}}{\text{Contribution margin per bundle}} = \frac{\$945,000}{\$315} = 3,000 \text{ bundles}$$

Breakeven point in units of faucet models and pitcher models is:

Faucet models: 3,000 bundles×2 units per bundle	=	6,000 units
Pitcher models: 3,000 bundles×3 units per bundle	=	9,000 units
Total number of units to breakeven		15,000 units

Breakeven point in dollars for faucet models and pitcher models is:

Faucet models: 6,000 units×$80 per unit	=	$ 480,000
Pitcher models: 9,000 units×$90 per unit	=	810,000
Breakeven revenues		$1,290,000

Alternatively, weighted average contribution margin per unit = $\frac{(2\times\$60) + (3\times\$65)}{5} = \$63$

Breakeven point = $\frac{\$945,000}{\$63} = 15,000$ units

Faucet filter: $\frac{2}{5} \times 15,000$ units = 6,000 units

Pitcher-cum-filter: $\frac{3}{5} \times 15,000$ units $= 9,000$ units

Breakeven point in dollars

Faucet filter: 6,000 units×$80 per unit = $480,000

Pitcher-cum-filter: 9,000 units×$90 per unit = $810,000

2. Faucet filter:

Selling price	$80
Variable cost per unit	15
Contribution margin per unit	$65

Pitcher-cum-filter:

Selling price	\$90
Variable cost per unit	16
Contribution margin per unit	\$74

Each bundle contains 2 faucet models and 3 pitcher models.

So contribution margin of a bundle = 2×\$65 + 3×\$74 = \$352

$$\text{Breakeven point in bundles} = \frac{\text{Fixed costs}}{\text{Contribution margin per bundle}} = \frac{\$945,000+\$181,400}{\$352} = 3,200 \text{ bundles}$$

Breakeven point in units of faucet models and pitcher models is:

Faucet models: 3,200 bundles×2 units per bundle =	6,400 units
Pitcher models: 3,200 bundles×3 units per bundle =	9,600 units
Total number of units to breakeven	16,000 units

Breakeven point in dollars for faucet models and pitcher models is:

Faucet models: 6,400 bundles×\$80 per unit =	\$ 512,000
Pitcher models: 9,600 bundles×\$90 per unit =	864,000
Breakeven revenues	\$1,376,000

$$\text{Alternatively, weighted average contribution margin per unit} = \frac{(2\times\$65) + (3\times\$74)}{5} = \$70.40$$

$$\text{Breakeven point} = \frac{\$945,000 + \$181,400}{\$70.40} = 16,000 \text{ units}$$

$$\text{Faucet filter: } \frac{2}{5} \times 16,000 \text{ units} = 6,400 \text{ units}$$

$$\text{Pitcher-cum-filter: } \frac{3}{5} \times 16,000 \text{ units} = 9,600 \text{ units}$$

Breakeven point in dollars:
Faucet filter: 6,400 units×\$80 per unit = \$512,000
Pitcher-cum-filter: 9,600 units×\$90 per unit = \$864,000

3. Let x be the number of bundles for Pure Water Products to be indifferent between the old and new production equipment.

Operating income using old equipment = \$315 x – \$945,000

Operating income using new equipment = \$352 x – \$945,000 – \$181,400

At point of indifference:
\$315 x – \$945,000 = \$352 x – \$1,126,400
\$352 x – \$315 x = \$1,126,400 – \$945,000
\$37 x = \$181,400
x = \$181,400 ÷ \$37 = 4,902.7 bundles
= 4,903 bundles (rounded)

Faucet models = 4,903 bundles×2 units per bundle =	9,806	units
Pitcher models = 4,903 bundles×3 units per bundle =	14,709	units
Total number of units	24,515	units

Let x be the number of bundles,

When total sales are less than 24,515 units (4,903 bundles), $\$315x - \$945{,}000 > \$352x - \$1{,}126{,}400$, so Pure Water Products is better off with the old equipment.

When total sales are greater than 24,515 units (4,903 bundles), $\$352x - \$1{,}126{,}400 > \$315x - \$945{,}000$, so Pure Water Products is better off buying the new equipment.

At total sales of 30,000 units (6,000 bundles), Pure Water Products should buy the new production equipment.

Check
$352×6,000 – $1,126,400 = $985,600 is greater than $315×6,000 –$945,000 = $945,000.

3-46 (20–25 min.) **Sales mix, two products.**

1. Sales of standard and deluxe carriers are in the ratio of 187,500 : 62,500. So for every 1 unit of deluxe, 3 (187,500 ÷ 62,500) units of standard are sold.

Contribution margin of the bundle = 3 × $10 + 1 × $20 = $30 + $20 = $50

$$\text{Breakeven point in bundles} = \frac{\$2,250,000}{\$50} = 45,000 \text{ bundles}$$

Breakeven point in units is:

Standard carrier:	45,000 bundles × 3 units per bundle	135,000 units
Deluxe carrier:	45,000 bundles × 1 unit per bundle	45,000 units
Total number of units to breakeven		180,000 units

Alternatively,
Let Q = Number of units of Deluxe carrier to break even
3Q = Number of units of Standard carrier to break even

Revenues – Variable costs – Fixed costs = Zero operating income

$$
\begin{aligned}
\$28(3Q) + \$50Q - \$18(3Q) - \$30Q - \$2{,}250{,}000 &= 0 \\
\$84Q + \$50Q - \$54Q - \$30Q &= \$2{,}250{,}000 \\
\$50Q &= \$2{,}250{,}000 \\
Q &= 45{,}000 \text{ units of Deluxe} \\
3Q &= 135{,}000 \text{ units of Standard}
\end{aligned}
$$

The breakeven point is 135,000 Standard units plus 45,000 Deluxe units, a total of 180,000 units.

2a. Unit contribution margins are: Standard: $28 – $18 = $10; Deluxe: $50 – $30 = $20
If only Standard carriers were sold, the breakeven point would be:
$2,250,000 ÷ $10 = 225,000 units.

2b. If only Deluxe carriers were sold, the breakeven point would be:
$2,250,000 ÷ $20 = 112,500 units

3. Operating income = Contribution margin of Standard + Contribution margin of Deluxe - Fixed costs
= 200,000($10) + 50,000($20) – $2,250,000
= $2,000,000 + $1,000,000 – $2,250,000
= $750,000

Sales of standard and deluxe carriers are in the ratio of 200,000 : 50,000. So for every 1 unit of deluxe, 4 (200,000 ÷ 50,000) units of standard are sold.

Contribution margin of the bundle = 4 × $10 + 1 × $20 = $40 + $20 = $60

Breakeven point in bundles = $\frac{\$2,250,000}{\$60}$ = 37,500 bundles

Breakeven point in units is:

Standard carrier:	37,500 bundles × 4 units per bundle	150,000 units
Deluxe carrier:	37,500 bundles × 1 unit per bundle	37,500 units
Total number of units to breakeven		187,500 units

Alternatively,
Let Q = Number of units of Deluxe product to break even
4Q = Number of units of Standard product to break even

$28(4Q) + $50Q – $18(4Q) – $30Q – $2,250,000 = 0
$112Q + $50Q – $72Q – $30Q = $2,250,000
$60Q = $2,250,000
Q = 37,500 units of Deluxe
4Q = 150,000 units of Standard

The breakeven point is 150,000 Standard +37,500 Deluxe, a total of 187,500 units.

The major lesson of this problem is that changes in the sales mix change breakeven points and operating incomes. In this example, the budgeted and actual total sales in number of units were identical, but the proportion of the product having the higher contribution margin declined. Operating income suffered, falling from $875,000 to $750,000. Moreover, the breakeven point rose from 180,000 to 187,500 units.

3-47 (20 min.) **Gross margin and contribution margin**.

1.

Ticket sales ($24 × 525 attendees)		$12,600
Variable cost of dinner ($12[a] × 525 attendees)	$6,300	
Variable invitations and paperwork ($1[b] × 525)	525	6,825
Contribution margin		5,775
Fixed cost of dinner	9,000	
Fixed cost of invitations and paperwork	1,975	10,975
Operating profit (loss)		$ (5,200)

[a] $6,300/525 attendees = $12/attendee
[b] $525/525 attendees = $1/attendee

2.

Ticket sales ($24 × 1,050 attendees)		$25,200
Variable cost of dinner ($12 × 1,050 attendees)	$12,600	
Variable invitations and paperwork ($1 × 1,050)	1,050	13,650
Contribution margin		11,550
Fixed cost of dinner	9,000	
Fixed cost of invitations and paperwork	1,975	10,975
Operating profit (loss)		$ 575

3-48 (30 min.) **Ethics, CVP analysis.**

1. Contribution margin percentage

$$= \frac{\text{Revenues} - \text{Variable costs}}{\text{Revenues}}$$

$$= \frac{\$5{,}000{,}000 - \$3{,}000{,}000}{\$5{,}000{,}000}$$

$$= \frac{\$2{,}000{,}000}{\$5{,}000{,}000} = 40\%$$

Breakeven revenues

$$= \frac{\text{Fixed costs}}{\text{Contribution margin percentage}}$$

$$= \frac{\$2{,}160{,}000}{0.40} = \$5{,}400{,}000$$

2. If variable costs are 52% of revenues, contribution margin percentage equals 48% (100% – 52%)

Breakeven revenues

$$= \frac{\text{Fixed costs}}{\text{Contribution margin percentage}}$$

$$= \frac{\$2{,}160{,}000}{0.48} = \$4{,}500{,}000$$

3.

Revenues	$5,000,000
Variable costs (0.52 × $5,000,000)	2,600,000
Fixed costs	2,160,000
Operating income	$ 240,000

4. Incorrect reporting of environmental costs with the goal of continuing operations is unethical. In assessing the situation, the specific "Standards of Ethical Conduct for Management Accountants" (described in Exhibit 1-7) that the management accountant should consider are listed below.

Competence
Clear reports using relevant and reliable information should be prepared. Preparing reports on the basis of incorrect environmental costs to make the company's performance look better than it is violates competence standards. It is unethical for Bush not to report environmental costs to make the plant's performance look good.

Integrity
The management accountant has a responsibility to avoid actual or apparent conflicts of interest and advise all appropriate parties of any potential conflict. Bush may be tempted to report lower environmental costs to please Lemond and Woodall and save the jobs of his colleagues. This action, however, violates the responsibility for integrity. The Standards of Ethical Conduct require the management accountant to communicate favorable as well as unfavorable information.

Credibility
The management accountant's Standards of Ethical Conduct require that information should be fairly and objectively communicated and that all relevant information should be disclosed. From a management accountant's standpoint, underreporting environmental costs to make performance look good would violate the standard of objectivity.

Bush should indicate to Lemond that estimates of environmental costs and liabilities should be included in the analysis. If Lemond still insists on modifying the numbers and reporting lower environmental costs, Bush should raise the matter with one of Lemond's superiors. If after taking all these steps, there is continued pressure to understate environmental costs, Bush should consider resigning from the company and not engage in unethical behavior.

3-49 (35 min.) **Deciding where to produce.**

	Peoria		Moline	
Selling price		$150.00		$150.00
Variable cost per unit				
Manufacturing	$72.00		$88.00	
Marketing and distribution	14.00	86.00	14.00	102.00
Contribution margin per unit (CMU)		64.00		48.00
Fixed costs per unit				
Manufacturing	30.00		15.00	
Marketing and distribution	19.00	49.00	14.50	29.50
Operating income per unit		$ 15.00		$ 18.50
CMU of normal production (as shown above)		$64		$48
CMU of overtime production ($64 – $3; $48 – $8)		61		40

1.

	Peoria		Moline	
Annual fixed costs = Fixed cost per unit × Daily production rate × Normal annual capacity ($49 ×400 units × 240 days; $29.50 × 320 units × 240 days)	$4,704,000		$2,265,600	
Breakeven volume = FC ÷ CMU of normal production ($4,704,000 ÷ $64; $2,265,600 ÷ 48)	73,500	units	47,200	units

2.

	Peoria		Moline
Units produced and sold	96,000		96,000
Normal annual volume (units) (400 × 240; 320 × 240)	96,000		76,800
Units over normal volume (needing overtime)	0		19,200
CM from normal production units (normal annual volume × CMU normal production) (96,000 × $64; 76,800 × 48)	$6,144,000		$3,686,400
CM from overtime production units (0; 19,200 × $40)	0		768,000
Total contribution margin	6,144,000		4,454,400
Total fixed costs	4,704,000		2,265,600
Operating income	$1,440,000		$2,188,800
Total operating income		$3,628,800	

3. The optimal production plan is to produce 120,000 units at the Peoria plant and 72,000 units at the Moline plant. The full capacity of the Peoria plant, 120,000 units (400 units × 300 days), should be used because the contribution from these units is higher at all levels of production than is the contribution from units produced at the Moline plant.

Contribution margin per plant:	
Peoria, 96,000 × $64	$ 6,144,000
Peoria 24,000 × ($64 – $3)	1,464,000
Moline, 72,000 × $48	3,456,000
Total contribution margin	11,064,000
Deduct total fixed costs	6,969,600
Operating income	$ 4,094,400

The contribution margin is higher when 120,000 units are produced at the Peoria plant and 72,000 units at the Moline plant. As a result, operating income will also be higher in this case since total fixed costs for the division remain unchanged regardless of the quantity produced at each plant.

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