

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):

$$\text{Operating income} = \text{Total revenues from operations} - \frac{\text{Costs of goods sold and operating costs (excluding income taxes)}}{\quad}$$

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:

$$\text{Net income} = \text{Operating income} - \text{Income taxes}$$

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.

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

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\% \times \$1,500 = \90 per ticket
 $VCU = \$43$ per ticket
 $CMU = \$90 - \$43 = \$47$ per ticket
 $FC = \$23,500$ a month

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

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

$$= \frac{\$40,500}{\$47 \text{ per ticket}}$$
$$= 862 \text{ tickets (rounded up)}$$

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

$$Q = \frac{FC}{CMU} = \frac{\$23,500}{\$50 \text{ per ticket}}$$
$$= 470 \text{ tickets}$$

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

$$= \frac{\$40,500}{\$50 \text{ per ticket}}$$
$$= 810 \text{ tickets}$$

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

$$Q = \frac{FC}{CMU} = \frac{\$23,500}{\$20 \text{ per ticket}}$$
$$= 1,175 \text{ tickets}$$

$$\begin{aligned}
 3b. \quad Q &= \frac{FC + TOI}{CMU} = \frac{\$23,500 + \$17,000}{\$20 \text{ per ticket}} \\
 &= \frac{\$40,500}{\$20 \text{ per ticket}} \\
 &= 2,025 \text{ tickets}
 \end{aligned}$$

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:

$$\begin{aligned}
 SP &= \$65 (\$60 + \$5) \text{ per ticket} \\
 VCU &= \$40 \text{ per ticket} \\
 CMU &= \$65 - \$40 = \$25 \text{ per ticket} \\
 FC &= \$23,500 \text{ a month}
 \end{aligned}$$

$$\begin{aligned}
 Q &= \frac{FC}{CMU} = \frac{\$23,500}{\$25 \text{ per ticket}} \\
 &= 940 \text{ tickets}
 \end{aligned}$$

$$\begin{aligned}
 4b. \quad Q &= \frac{FC + TOI}{CMU} = \frac{\$23,500 + \$17,000}{\$25 \text{ per ticket}} \\
 &= \frac{\$40,500}{\$25 \text{ per ticket}} \\
 &= 1,620 \text{ tickets}
 \end{aligned}$$

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

^Gstands 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.
$$[\text{Units sold} (\text{Selling price} - \text{Variable costs})] - \text{Fixed costs} = \text{Operating income}$$

$$[5,000,000 (\$0.50 - \$0.30)] - \$900,000 = \$100,000$$

1b.
$$\text{Fixed costs} \div \text{Contribution margin per unit} = \text{Breakeven units}$$

$$\$900,000 \div [(\$0.50 - \$0.30)] = 4,500,000 \text{ units}$$

$$\text{Breakeven units} \times \text{Selling price} = \text{Breakeven revenues}$$

$$4,500,000 \text{ units} \times \$0.50 \text{ per unit} = \$2,250,000$$

or,

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

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

$$\text{Fixed costs} \div \text{Contribution margin ratio} = \text{Breakeven revenues}$$

$$\$900,000 \div 0.40 = \$2,250,000$$

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.
$$\$900,000 (1.1) \div (\$0.50 - \$0.30) = 4,950,000 \text{ units}$$

6.
$$(\$900,000 + \$20,000) \div (\$0.55 - \$0.30) = 3,680,000 \text{ units}$$

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

- $$\begin{aligned} \text{Monthly fixed costs} &= \$48,200 + \$68,000 + \$13,000 = \$129,200 \\ \text{Contribution margin per unit} &= \$27,000 - \$23,000 - \$600 = \$3,400 \\ \text{Breakeven units per month} &= \frac{\text{Monthly fixed costs}}{\text{Contribution margin per unit}} = \frac{\$129,200}{\$3,400 \text{ per car}} = 38 \text{ cars} \end{aligned}$$
- $$\begin{aligned} \text{Tax rate} &40\% \\ \text{Target net income} &\$51,000 \\ \text{Target operating income} &= \frac{\text{Target net income}}{1 - \text{tax rate}} = \frac{\$51,000}{(1 - 0.40)} = \frac{\$51,000}{0.60} = \$85,000 \\ \text{Quantity of output units required to be sold} &= \frac{\text{Fixed costs} + \text{Target operating income}}{\text{Contribution margin per unit}} = \frac{\$129,200 + \$85,000}{\$3,400} = 63 \text{ cars} \end{aligned}$$

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

- Variable cost percentage is $\$3.40 \div \$8.50 = 40\%$

Let R = Revenues needed to obtain target net income

$$\begin{aligned} R - 0.40R - \$459,000 &= \frac{\$107,100}{1 - 0.30} \\ 0.60R &= \$459,000 + \$153,000 \\ R &= \$612,000 \div 0.60 \\ R &= \$1,020,000 \end{aligned}$$

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

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

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

- Customers needed to break even:

$$\text{Contribution margin per customer} = \$8.50 - \$3.40 = \$5.10$$

$$\begin{aligned} \text{Breakeven number of customers} &= \text{Fixed costs} \div \text{Contribution margin per customer} \\ &= \$459,000 \div \$5.10 \text{ per customer} \\ &= 90,000 \text{ customers} \end{aligned}$$

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

Total revenues ÷ Sales check per customer

$$\$1,020,000 \div \$8.50 = 120,000 \text{ customers}$$

3. Using the shortcut approach:

$$\begin{aligned} \text{Change in net income} &= \left(\text{Change in number of customers} \right) \times \left(\text{Unit contribution margin} \right) \times (1 - \text{Tax rate}) \\ &= (170,000 - 120,000) \times \$5.10 \times (1 - 0.30) \\ &= \$255,000 \times 0.7 = \$178,500 \\ \text{New net income} &= \$178,500 + \$107,100 = \$285,600 \end{aligned}$$

Alternatively, with 170,000 customers,

$$\begin{aligned} \text{Operating income} &= \text{Number of customers} \times \text{Selling price per customer} \\ &\quad - \text{Number of customers} \times \text{Variable cost per customer} - \text{Fixed costs} \\ &= 170,000 \times \$8.50 - 170,000 \times \$3.40 - \$459,000 = \$408,000 \end{aligned}$$

$$\text{Net income} = \text{Operating income} \times (1 - \text{Tax rate}) = \$408,000 \times 0.70 = \$285,600$$

The alternative approach is:

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

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

$$\begin{aligned} 1. \quad \text{SP} &= \$30.00 \times (1 - 0.30 \text{ margin to bookstore}) \\ &= \$30.00 \times 0.70 = \$21.00 \end{aligned}$$

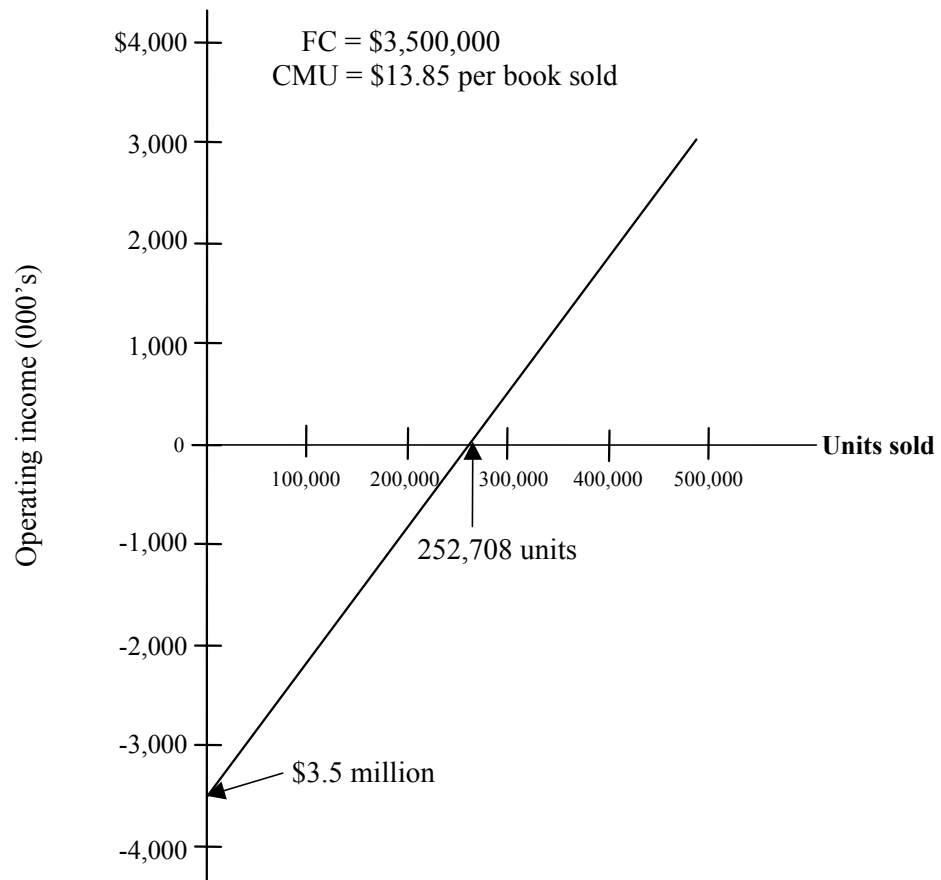
$$\begin{aligned} \text{VCU} &= \$4.00 \text{ variable production and marketing cost} \\ &\quad \underline{3.15 \text{ variable author royalty cost } (0.15 \times \$21.00)} \\ &= \underline{\underline{\$7.15}} \end{aligned}$$

$$\begin{aligned} \text{CMU} &= \$21.00 - \$7.15 = \$13.85 \text{ per copy} \\ \text{FC} &= \$500,000 \text{ fixed production and marketing cost} \\ &\quad \underline{3,000,000 \text{ up-front payment to Washington}} \\ &= \underline{\underline{\$3,500,000}} \end{aligned}$$

Solution Exhibit 3-23A shows the PV graph.

SOLUTION EXHIBIT 3-23A

PV Graph for Media Publishers



2a.

$$\begin{aligned}\text{Breakeven number of units} &= \frac{\text{FC}}{\text{CMU}} \\ &= \frac{\$3,500,000}{\$13.85} \\ &= 252,708 \text{ copies sold (rounded up)}\end{aligned}$$

2b.

$$\begin{aligned}\text{Target OI} &= \frac{\text{FC} + \text{OI}}{\text{CMU}} \\ &= \frac{\$3,500,000 + \$2,000,000}{\$13.85} \\ &= \frac{\$5,500,000}{\$13.85} \\ &= 397,112 \text{ copies sold (rounded up)}\end{aligned}$$

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

$$\begin{aligned} \text{SP} &= \$30.00 \times (1 - 0.20) \\ &= \$30.00 \times 0.80 = \$24.00 \\ \text{VCU} &= \$ 4.00 \text{ variable production and marketing cost} \\ &\quad + \underline{3.60} \text{ variable author royalty cost } (0.15 \times \$24.00) \\ &\quad \underline{\$ 7.60} \end{aligned}$$

$$\text{CMU} = \$24.00 - \$7.60 = \$16.40 \text{ per copy}$$

$$\begin{aligned} \text{Breakeven} &= \frac{\text{FC}}{\text{CMU}} \\ \text{number of units} &= \frac{\$3,500,000}{\$16.40} \\ &= 213,415 \text{ copies sold (rounded up)} \end{aligned}$$

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:

$$\begin{aligned} \text{SP} &= \$40.00 \times (1 - 0.30) \\ &= \$40.00 \times 0.70 = \$28.00 \\ \text{VCU} &= \$ 4.00 \text{ variable production and marketing cost} \\ &\quad + \underline{4.20} \text{ variable author royalty cost } (0.15 \times \$28.00) \\ &\quad \underline{\$ 8.20} \end{aligned}$$

$$\text{CMU} = \$28.00 - \$8.20 = \$19.80 \text{ per copy}$$

$$\begin{aligned} \text{Breakeven} &= \frac{\$3,500,000}{\$19.80} \\ \text{number of units} &= 176,768 \text{ copies sold (rounded up)} \end{aligned}$$

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

$$\text{Contribution margin percentage} = \frac{\$660,000}{\$1,100,000} = 0.60 \text{ or } 60\%$$
2. Contribution margin percentage = $\frac{\text{Selling price} - \text{Variable cost per unit}}{\text{Selling price}}$

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

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

$$0.40 \text{ SP} = \$16$$

$$\text{SP} = \$40$$
3. Breakeven sales in units = Revenues \div Selling price = $\$1,100,000 \div \$40 = 27,500$ units
 Margin of safety in units = Sales in units – Breakeven sales in units
 $= 95,000 - 27,500 = 67,500$ units

Revenues, 95,000 units \times \$40	\$3,800,000
Breakeven revenues	<u>1,100,000</u>
Margin of safety	<u>\$2,700,000</u>

3-25 (25 min.) Operating leverage.

- 1a. Let Q denote the quantity of carpets sold

Breakeven point under Option 1

$$\begin{aligned} \$500Q - \$350Q &= \$5,000 \\ \$150Q &= \$5,000 \\ Q &= \$5,000 \div \$150 = 34 \text{ carpets (rounded up)} \end{aligned}$$

- 1b. Breakeven point under Option 2

$$\begin{aligned} \$500Q - \$350Q - (0.10 \times \$500Q) &= 0 \\ 100Q &= 0 \\ Q &= 0 \end{aligned}$$

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

$$\begin{aligned} \text{Find } Q \text{ such that } \$150Q - \$5,000 &= \$100Q \\ \$50Q &= \$5,000 \end{aligned}$$

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

$$\text{Revenues} = \$500 \times 100 \text{ carpets} = \$50,000$$

For Q = 100 carpets, operating income under both Option 1 ($\$150 \times 100 - \$5,000$) and Option 2 ($\$100 \times 100$) = \$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. 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

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

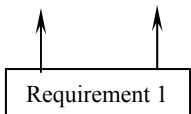
Under Option 2, contribution margin per unit = $\$500 - \$350 - 0.10 \times \$500$, so

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

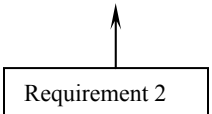
4. The calculations in requirement 3 indicate that when sales are 100 units, a percentage change in sales and contribution margin will result in 1.5 times that percentage change in operating income for Option 1, but the same percentage change in operating income for Option 2. The degree of operating 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 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 = $3 \times \$175 + 2 \times \$50 = \$525 + \$100 = \$625$

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

Breakeven point in units is:

Sales to new customers:	24,000 bundles \times 3 units per bundle	72,000 units
Sales to upgrade customers:	24,000 bundles \times 2 units per bundle	<u>48,000 units</u>
Total number of units to breakeven (rounded)		<u>120,000 units</u>

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

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

$\$512.5S - \$200S - \$15,000,000 = OI$

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 $(\$275 \times 72,000) + (\$100 \times 48,000)$	\$24,600,000
Variable costs $(\$100 \times 72,000) + (\$50 \times 48,000)$	<u>9,600,000</u>
Contribution margin	15,000,000
Fixed costs	<u>15,000,000</u>
Operating income	<u>\$ 0</u>

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)	<u>17,600,000</u>
Contribution margin	27,500,000
Fixed costs	<u>15,000,000</u>
Operating income	<u>\$12,500,000</u>

- 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 = $2 \times \$175 + 3 \times \$50 = \$350 + \$150 = \$500$

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	<u>90,000 units</u>
Total number of units to breakeven		<u>150,000 units</u>

Alternatively,

Let S = Number of units sold to new customers

then $1.5S$ = Number of units sold to upgrade customers

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

$$425S - 175S = \$15,000,000$$

$$250S = \$15,000,000$$

$$S = 60,000 \text{ units sold to new customers}$$

$$1.5S = \underline{90,000} \text{ units sold to upgrade customers}$$

$$\text{BEP} = \underline{150,000} \text{ units}$$

Check

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

- 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 = $4 \times \$175 + 1 \times \$50 = \$700 + \$50 = \$750$

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	<u>20,000 units</u>
Total number of units to breakeven		<u>100,000 units</u>

Alternatively,

Let S = Number of units sold to upgrade customers

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

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

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

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

$$S = 20,000 \text{ units sold to upgrade customers}$$

$$4S = \underline{80,000} \text{ units sold to new customers}$$

$$\underline{100,000} \text{ units}$$

Check

Revenues $(\$275 \times 80,000) + (\$100 \times 20,000)$ \$24,000,000

Variable costs $(\$100 \times 80,000) + (\$50 \times 20,000)$ 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	<u>1.25</u>	<u>1.75</u>
	CMU	<u>\$1.25</u>	<u>\$2.00</u>

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

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

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: $1,000 \text{ bundles} \times 4 \text{ cups per bundle} = 4,000 \text{ cups}$

Bagels: $1,000 \text{ bundles} \times 1 \text{ bagel per bundle} = 1,000 \text{ bagels}$

Alternatively,

Let S = Number of bagels sold

$4S$ = Number of cups of coffee sold

Revenues – Variable costs – Fixed costs = Operating income

$[\$2.50(4S) + \$3.75S] - [\$1.25(4S) + \$1.75S] - \$7,000 = \text{OI}$

$\$13.75S - \$6.75S - \$7,000 = \text{OI}$

$\$7.00 S = \$7,000$

$S = 1,000$ 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 $\text{OI} = 0$

Check

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

2.		Coffee	Bagels
	SP	\$2.50	\$3.75
	VCU	<u>1.25</u>	<u>1.75</u>
	CMU	<u>\$1.25</u>	<u>\$2.00</u>

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

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

Breakeven point in bundles

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

Breakeven point is:

Coffee: 5,000 bundles \times 4 cups per bundle = 20,000 cups

Bagels: 5,000 bundles \times 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

$[\$2.50(4S) + \$3.75S] - [\$1.25(4S) + \$1.75S] - \$7,000 = \text{OI}$

$[\$2.50(4S) + \$3.75S] - [\$1.25(4S) + \$1.75S] - \$7,000 = 28,000$

$\$13.75S - \$6.75S = 35,000$

$\$7.00 S = \$35,000$

$S = 5,000$ 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 $(\$2.50 \times 20,000) + (\$3.75 \times 5,000)$	\$68,750
Variable costs $(\$1.25 \times 20,000) + (\$1.75 \times 5,000)$	<u>33,750</u>
Contribution margin	35,000
Fixed costs	<u>7,000</u>
Operating income	<u><u>\$28,000</u></u>

3.

	Coffee	Bagels	Muffins
SP	\$2.50	\$3.75	\$3.00
VCU	<u>1.25</u>	<u>1.75</u>	<u>0.75</u>
CMU	<u><u>\$1.25</u></u>	<u><u>\$2.00</u></u>	<u><u>\$2.25</u></u>

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

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

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 \times 3 cups per bundle = 2,100 cups

Bagels: 700 bundles \times 2 bagels per bundle = 1,400 bagels

Muffins: 700 bundles \times 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

$$[\$2.50(3S) + \$3.75(2S) + \$3.00S] - [\$1.25(3S) + \$1.75(2S) + \$0.75S] - \$7,000 = \text{OI}$$

$$\$18.00S - \$8S - \$7,000 = \text{OI}$$

$$\$10.00S = \$7,000$$

$$S = 700 \text{ units of the sales mix}$$

or

$$S = 700 \text{ muffins}$$

$$2S = 1,400 \text{ bagels}$$

$$3S = 2,100 \text{ cups of coffee}$$

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

Check

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

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	<u>500</u>	
Total variable costs per concert		<u>1,500</u>
Contribution margin per concert		<u>\$ 1,000</u>
Fixed costs		
Salaries	\$50,000	
Mortgage payments (\$2,000 × 12)	<u>24,000</u>	
Total fixed costs		\$74,000
Less donations		<u>40,000</u>
Net fixed costs		<u>\$34,000</u>

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

Check

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

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

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

Check

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

Operating Income if 60 concerts are held

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

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	<u>500</u>	
Total variable costs per concert		<u>1,500</u>
Contribution margin per concert		<u>\$ 1,000</u>

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

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

Check

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

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	<u>30,000</u>	<u>390,000</u>
	Contribution margin		<u>\$210,000</u>

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

3.	Incremental revenue ($15\% \times \$600,000$) = \$90,000	
	Incremental contribution margin	
	($35\% \times \$90,000$)	\$31,500
	Incremental fixed costs (advertising)	<u>13,000</u>
	Incremental operating income	<u>\$18,500</u>

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 ($115\% \times \$600,000$)	\$690,000
Cost of goods sold (50% of sales)	<u>345,000</u>
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	<u>15,000</u>	<u>375,500</u>
Operating income		<u>\$ (30,500)</u>

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

1.

**Mirabella Cosmetics
Operating Income Statement, June 2011**

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

2. Contribution margin per unit = $\frac{\$40,000}{10,000 \text{ units}} = \4 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 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	<u>8,000</u>
Revenues (Units sold × Selling price = 8,000 × \$10)	<u>\$80,000</u>
Contribution margin (Revenues × CM percentage = \$80,000 × 40%)	\$32,000
Fixed costs	<u>30,000</u>
Operating income	2,000
Taxes (30% × \$2,000)	<u>600</u>
Net income	<u>\$ 1,400</u>

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:

$\$20,000,000 \times 0.15$	$=$	$\$ 3,000,000$
$25,000,000 \times 0.20$	$=$	$5,000,000$
$30,000,000 \times 0.35$	$=$	$10,500,000$
$35,000,000 \times 0.20$	$=$	$7,000,000$
$40,000,000 \times 0.10$	$=$	$4,000,000$
		<u>$\\$29,500,000$</u>

Partially Automated System Expected Cost:

$\$24,000,000 \times 0.15$	$=$	$\$ 3,600,000$
$28,000,000 \times 0.20$	$=$	$5,600,000$
$32,000,000 \times 0.35$	$=$	$11,200,000$
$36,000,000 \times 0.20$	$=$	$7,200,000$
$40,000,000 \times 0.10$	$=$	$4,000,000$
		<u>$\\$31,600,000$</u>

Fully Automated System Expected Cost:

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

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	<u>3,700</u>
	Contribution margin per package	<u>\$1,300</u>

$$\begin{aligned}\text{Breakeven (packages)} &= \text{Fixed costs} \div \text{Contribution margin per package} \\ &= \frac{\$520,000}{\$1,300 \text{ per package}} = 400 \text{ tour packages}\end{aligned}$$

$$2. \quad \text{Contribution margin ratio} = \frac{\text{Contribution margin per package}}{\text{Selling price}} = \frac{\$1,300}{\$5,000} = 26\%$$

$$\begin{aligned}\text{Revenue to achieve target income} &= (\text{Fixed costs} + \text{target OI}) \div \text{Contribution margin ratio} \\ &= \frac{\$520,000 + \$91,000}{0.26} = \$2,350,000, \text{ or}\end{aligned}$$

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

$$\text{Revenues to earn } \$91,000 \text{ OI} = 470 \text{ tour packages} \times \$5,000 = \$2,350,000.$$

$$3. \quad \text{Fixed costs} = \$520,000 + \$32,000 = \$552,000$$

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

$$\begin{aligned}\text{Contribution margin per package} &= \frac{\text{Fixed costs}}{\text{Breakeven (packages)}} \\ &= \frac{\$552,000}{400 \text{ tour packages}} = \$1,380 \text{ per tour package}\end{aligned}$$

$$\text{Desired variable cost per tour package} = \$5,000 - \$1,380 = \$3,620$$

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.

$$\text{Therefore, the variable cost per unit reduction} = \$32,000 \div 400 = \$80 \text{ per tour package.}$$

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

1.	Revenue per child	\$580
	Variable costs per child	<u>230</u>
	Contribution margin per child	<u>\$350</u>

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

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

$$2. \quad \text{Target quantity} = \frac{\text{Fixed costs} + \text{Target operating income}}{\text{Contribution margin per child}}$$

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

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

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

Alternatively,

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

$$\begin{aligned} \text{New fee per child} &= \text{Variable costs per child} + \text{New contribution margin per child} \\ &= \$230 + \$400 = \$630 \end{aligned}$$

3-35 (20–25 min.) CVP analysis.

1.	Selling price		\$300
	Variable costs per unit:		
	Production costs	\$120	
	Shipping and handling	<u>5</u>	<u>125</u>
	Contribution margin per unit (CMU)		<u>\$175</u>

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

$$\text{Margin of safety (units)} = 10,000 - 7,200 = 2,800 \text{ units}$$

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

$$\text{Increase in units sales} = 10\% \times 10,000 = 1,000$$

$$\text{Incremental contribution margin} = \$175 \times 1,000 = \$175,000$$

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 $\$120 \times 130\%$	\$156	
	Shipping and handling $(\$5 - (\$5 \times 0.20))$	<u>4</u>	<u>160</u>
	Contribution margin per unit		<u>\$140</u>

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

$$\text{Target sales in dollars} = \$300 \times 12,500 = \$3,750,000$$

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

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

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,

$$\begin{aligned} \text{Operating income} &= \text{Revenues} - \text{Variable costs} - \text{Fixed costs} \\ &= \$500,000 - \$275,000 - \$135,000 = \$90,000 \end{aligned}$$

$$\text{Income taxes} = 0.40 \times \$90,000 = \$36,000$$

$$\begin{aligned} \text{Net income} &= \text{Operating income} - \text{Income taxes} \\ &= \$90,000 - \$36,000 = \$54,000 \end{aligned}$$

$$2. \quad \text{Let } Q = \text{Number of units to break even}$$

$$\$25.00Q - \$13.75Q - \$135,000 = 0$$

$$Q = \$135,000 \div \$11.25 = 12,000 \text{ units}$$

$$3. \quad \text{Let } X = \text{Net income for 2012}$$

$$22,000(\$25.00) - 22,000(\$13.75) - (\$135,000 + \$11,250) = \frac{X}{1 - 0.40}$$

$$\$550,000 - \$302,500 - \$146,250 = \frac{X}{0.60}$$

$$\$101,250 = \frac{X}{0.60}$$

$$X = \$60,750$$

$$4. \quad \text{Let } Q = \text{Number of units to break even with new fixed costs of } \$146,250$$

$$\$25.00Q - \$13.75Q - \$146,250 = 0$$

$$Q = \$146,250 \div \$11.25 = 13,000 \text{ units}$$

$$\text{Breakeven revenues} = 13,000 \times \$25.00 = \$325,000$$

$$5. \quad \text{Let } S = \text{Required sales units to equal 2011 net income}$$

$$\$25.00S - \$13.75S - \$146,250 = \frac{\$54,000}{0.60}$$

$$\$11.25S = \$236,250$$

$$S = 21,000 \text{ units}$$

$$\text{Revenues} = 21,000 \text{ units} \times \$25 = \$525,000$$

$$6. \quad \text{Let } A = \text{Amount spent for advertising in 2012}$$

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

$$\$550,000 - \$302,500 - \$135,000 - A = \$100,000$$

$$\$550,000 - \$537,500 = A$$

$$A = \$12,500$$

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

Contribution margin per pair of shoes = $\$60 - \$25 = \$35$

Fixed costs = $\$100,000$

Units sold = Total sales \div Selling price = $\$300,000 \div \60 per pair = 5,000 pairs of shoes

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

Sales revenues $5,000 \times \$60$	\$300,000
Variable costs $5,000 \times \$25 \times (1 - 0.20)$	<u>100,000</u>
Contribution margin	200,000
Fixed costs $\$100,000 \times 1.15$	<u>115,000</u>
Operating income	<u>\$ 85,000</u>

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

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

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

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

4. Double fixed costs; Increase sales by 60%

Sales revenues $5,000 \times 1.60 \times \60	\$480,000
Variable costs $5,000 \times 1.60 \times \25	200,000
Contribution margin	280,000
Fixed costs $\$100,000 \times 2$	<u>200,000</u>
Operating income	<u>\$ 80,000</u>

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 \times 1.20 \times \60	\$360,000
Variable costs	$5,000 \times 1.20 \times \$25 \times (1 - 0.20)$	<u>120,000</u>
Contribution margin		240,000
Fixed costs	$\$100,000 \times 1.15 + \$30,000$	<u>145,000</u>
Operating income		<u>\$ 95,000</u>

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	<u>35,000</u>
Revenues, 35,000 × \$30	<u>\$1,050,000</u>
Total cost of shoes, 35,000 × \$19.50	682,500
Total sales commissions, 35,000 × \$1.50	<u>52,500</u>
Total variable costs	<u>735,000</u>
Contribution margin	315,000
Fixed costs	<u>360,000</u>
Operating income (loss)	<u>\$ (45,000)</u>
3. Unit variable data (per pair of shoes)	
Selling price	<u>\$ 30.00</u>
Cost of shoes	19.50
Sales commissions	<u>0</u>
Variable cost per unit	<u>\$ 19.50</u>
Annual fixed costs	
Rent	\$ 60,000
Salaries, \$200,000 + \$81,000	281,000
Advertising	80,000
Other fixed costs	<u>20,000</u>
Total fixed costs	<u>\$ 441,000</u>
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	<u>\$ 30.00</u>
Cost of shoes	19.50
Sales commissions	<u>1.80</u>
Variable cost per unit	<u>\$ 21.30</u>
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

	<u>50,000</u>
Revenues (50,000 pairs × \$30 per pair)	<u>\$1,500,000</u>
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)]	<u>18,000</u>
Total variable costs	<u>\$1,053,000</u>
Contribution margin	\$ 447,000
Fixed costs	<u>360,000</u>
Operating income	<u>\$ 87,000</u>

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).

No. of units sold (1)	Salaries + Commission Plan				Higher Fixed Salaries Only				Difference in favor of higher-fixed- salary-only (10)=(9)–(5)
	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)	
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

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

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,

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

For the salary-plus-commission plan,

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

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	<u>73,800</u>
Contribution margin	427,200
Fixed costs	<u>360,000</u>
Operating income	<u><u>\$ 67,200</u></u>

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 = $\$0.15 - \$0.02^a - \$0.03 - \$0.04 = \$0.06$ 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.

$$\$0.15x - \$0.03x - \$0.04x - \$1,000 = \$0.15x - \$0.02x - \$0.03x - \$0.04x$$

$$\$0.08x - \$1,000 = \$0.06x$$

$$\$0.02x = \$1,000$$

$$x = \$1,000 \div \$0.02 = 50,000 \text{ pages}$$

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, $\$0.08x - \$1,000 > \$0.06x$.

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	$20,000 \times \$0.15 = \$3,000$	$20,000 \times \$0.07 = \$1,400$	\$1,000	\$ 600	0.20	\$ 120
40,000	$40,000 \times \$0.15 = \$6,000$	$40,000 \times \$0.07 = \$2,800$	\$1,000	\$2,200	0.20	440
60,000	$60,000 \times \$0.15 = \$9,000$	$60,000 \times \$0.07 = \$4,200$	\$1,000	\$3,800	0.20	760
80,000	$80,000 \times \$0.15 = \$12,000$	$80,000 \times \$0.07 = \$5,600$	\$1,000	\$5,400	0.20	1,080
100,000	$100,000 \times \$0.15 = \$15,000$	$100,000 \times \$0.07 = \$7,000$	\$1,000	\$7,000	0.20	1,400
Expected value of fixed leasing agreement						<u>\$3,800</u>

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					<u>\$3,600</u>

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 \times 10) + \$50 = \300
Contribution margin per computer = Selling price – Variable cost per computer
= $\$500 - \$300 = \$200$

$$\text{Breakeven point} = \text{Fixed costs} \div \text{Contribution margin per computer} \\ = \$4,000 \div \$200 = 20 \text{ computers (per month)}$$

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

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

3. Contribution margin per computer = Selling price – Variable cost per computer
= $\$500 - \$200 - \$50 = \250

$$\text{Fixed costs} = \$4,000$$

$$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution margin per computer}} = \frac{\$4,000}{\$250} = 16 \text{ computers}$$

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.

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

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.

$$\begin{aligned}\text{Revenue} &= \text{Variable costs} + \text{Fixed costs} \\ \$3,000Q &= \$500Q + \$3,000,000 \\ \$2,500Q &= \$3,000,000 \\ Q &= 1,200 \text{ units}\end{aligned}$$

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

$$\begin{aligned}\text{Breakeven} &= \text{Fixed Costs} \div \text{Contribution margin per unit} \\ &= \$3,000,000 \div \$2,500 \\ &= 1,200 \text{ units}\end{aligned}$$

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.

$$\begin{aligned}\text{Revenue} &= \text{Variable costs} + \text{Fixed costs} + [\text{Net income} \div (1 - \text{Tax rate})] \\ \$3,000Q &= \$500Q + \$3,000,000 + [\$1,500,000 \div (1 - 0.25)] \\ \$3,000Q &= \$500Q + \$3,000,000 + \$2,000,000 \\ Q &= 2,000 \text{ units}\end{aligned}$$

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

$$\begin{aligned}\text{Revenues} &= (\$3,000 \times 300) + (\$2,400^a \times 2,000) = \$5,700,000 \\ \text{Variable costs} &= \$500 \times 2,300^b = \$1,150,000 \\ \text{Operating income} &= \$5,700,000 - \$1,150,000 - \$3,000,000 = \$1,550,000 \\ \text{Net income} &= \$1,550,000 \times (1 - 0.25) = \$1,162,500\end{aligned}$$

^a\$3,000 – (\$3,000 × 0.20) = ; ^b300 units + 2,000 units.

Alternative b

$$\begin{aligned}\text{Revenues} &= (\$3,000 \times 300) + (\$2,750^c \times 1,800) = \$5,850,000 \\ \text{Variable costs} &= (\$500 \times 300) + (\$450^d \times 1,800) = \$960,000 \\ \text{Operating income} &= \$5,850,000 - \$960,000 - \$3,000,000 = \$1,890,000 \\ \text{Net income} &= \$1,890,000 \times (1 - 0.25) = \$1,417,500\end{aligned}$$

^c\$3,000 – \$250; ^d\$450.

Alternative c

$$\begin{aligned}\text{Revenues} &= (\$3,000 \times 300) + (\$2,700^e \times 1,700) = \$5,490,000 \\ \text{Variable costs} &= \$500 \times 2000^f = \$1,000,000 \\ \text{Operating income} &= \$5,490,000 - \$1,000,000 - \$2,400,000^g = \$2,090,000 \\ \text{Net income} &= \$2,090,000 \times (1 - 0.25) = \$1,567,500\end{aligned}$$

^e\$3,000 – (0.10 × \$3,000) = \$3,000 – \$300; ^f300units + 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	<u>4,680,000</u>	<u>16,380,000</u>	<u>2,600,000</u>	<u>14,300,000</u>
Contribution margin		9,620,000		11,700,000
Fixed Costs				
Cost of goods sold—fixed	2,870,000		2,870,000	
Marketing—fixed	<u>3,420,000</u>	<u>6,290,000</u>	<u>5,500,000</u>	<u>8,370,000</u>
Operating income		<u>\$ 3,330,000</u>		<u>\$ 3,330,000</u>
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

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

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

$$\begin{aligned}
 R - 0.45R - \$2,870,000 - 0.15R - \$5,500,000 &= \$3,330,000 \\
 R - 0.45R - 0.15R &= \$3,330,000 + \$2,870,000 + \$5,500,000 \\
 0.40R &= \$11,700,000 \\
 R &= \$11,700,000 \div 0.40 = \$29,250,000
 \end{aligned}$$

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

Breakeven point in bundles = $\frac{\$255,000}{\$17} = 15,000$ 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	<u>60,000 units</u>
Total number of units to breakeven		<u>150,000 units</u>

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

$$\begin{aligned}
 \$3Q + \$2(5Q) + \$1(4Q) - \$255,000 &= 0 \\
 \$17Q &= \$255,000 \\
 Q &= 15,000 (\$255,000 \div \$17) \text{ units of A} \\
 5Q &= 75,000 \text{ units of B} \\
 4Q &= \underline{60,000} \text{ units of C} \\
 \text{Total} &= \underline{150,000} \text{ units}
 \end{aligned}$$

2. Contribution margin:

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

3. Contribution margin

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

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	<u>79,690 units</u>
Total number of units to breakeven		<u>159,380 units</u>

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

$$\$3Q + \$2(4Q) + \$1(5Q) - \$255,000 = 0$$

$$\$16Q = \$255,000$$

$$Q = 15,938 (\$255,000 \div \$16) \text{ units of A (rounded up)}$$

$$4Q = 63,752 \text{ units of B}$$

$$5Q = \underline{79,690} \text{ units of C}$$

$$\text{Total} = \underline{159,380} \text{ units}$$

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	<u>20</u>
Contribution margin per unit	<u>\$60</u>

Pitcher-cum-filter:

Selling price	\$90
Variable cost per unit	<u>25</u>
Contribution margin per unit	<u>\$65</u>

Each bundle contains 2 faucet models and 3 pitcher models.

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

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

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

Faucet models: $3,000 \text{ bundles} \times 2 \text{ units per bundle} = 6,000 \text{ units}$ Pitcher models: $3,000 \text{ bundles} \times 3 \text{ units per bundle} = \underline{9,000} \text{ units}$ Total number of units to breakeven 15,000 units

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

Faucet models: $6,000 \text{ units} \times \$80 \text{ per unit} = \$480,000$ Pitcher models: $9,000 \text{ units} \times \$90 \text{ per unit} = \underline{810,000}$ Breakeven revenues \$1,290,000

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

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

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

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

Breakeven point in dollars

Faucet filter: $6,000 \text{ units} \times \$80 \text{ per unit} = \$480,000$ Pitcher-cum-filter: $9,000 \text{ units} \times \$90 \text{ per unit} = \$810,000$

2. Faucet filter:

Selling price	\$80
Variable cost per unit	<u>15</u>
Contribution margin per unit	<u>\$65</u>

Pitcher-cum-filter:	
Selling price	\$90
Variable cost per unit	<u>16</u>
Contribution margin per unit	<u>\$74</u>

Each bundle contains 2 faucet models and 3 pitcher models.

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

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

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

Faucet models: $3,200 \text{ bundles} \times 2 \text{ units per bundle} = 6,400 \text{ units}$

Pitcher models: $3,200 \text{ bundles} \times 3 \text{ units per bundle} = \underline{9,600 \text{ units}}$

Total number of units to breakeven 16,000 units

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

Faucet models: $6,400 \text{ bundles} \times \$80 \text{ per unit} = \$ 512,000$

Pitcher models: $9,600 \text{ bundles} \times \$90 \text{ per unit} = \underline{864,000}$

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: $6,400 \text{ units} \times \$80 \text{ per unit} = \$512,000$

Pitcher-cum-filter: $9,600 \text{ units} \times \$90 \text{ per unit} = \$864,000$

- 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 = $\$315x - \$945,000$

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

At point of indifference:

$$\$315x - \$945,000 = \$352x - \$1,126,400$$

$$\$352x - \$315x = \$1,126,400 - \$945,000$$

$$\$37x = \$181,400$$

$$\begin{aligned} x &= \$181,400 \div \$37 = 4,902.7 \text{ bundles} \\ &= 4,903 \text{ bundles (rounded)} \end{aligned}$$

Faucet models = 4,903 bundles \times 2 units per bundle = 9,806 units
 Pitcher models = 4,903 bundles \times 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

$\$352 \times 6,000 - \$1,126,400 = \$985,600$ is greater than $\$315 \times 6,000 - \$945,000 = \$945,000$.

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

- 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 \div 62,500) units of standard are sold.

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

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

Breakeven point in units is:

Standard carrier:	45,000 bundles \times 3 units per bundle	135,000 units
Deluxe carrier:	45,000 bundles \times 1 unit per bundle	<u>45,000</u> units
Total number of units to breakeven		<u>180,000</u> 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:
 $\$2,250,000 \div \$10 = 225,000$ units.
- 2b. If only Deluxe carriers were sold, the breakeven point would be:
 $\$2,250,000 \div \$20 = 112,500$ 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 \div 50,000) units of standard are sold.

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

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

Breakeven point in units is:

Standard carrier:	37,500 bundles \times 4 units per bundle	150,000 units
Deluxe carrier:	37,500 bundles \times 1 unit per bundle	<u>37,500 units</u>
Total number of units to breakeven		<u>187,500 units</u>

Alternatively,

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

$$\begin{aligned}
 \$28(4Q) + \$50Q - \$18(4Q) - \$30Q - \$2,250,000 &= 0 \\
 \$112Q + \$50Q - \$72Q - \$30Q &= \$2,250,000 \\
 \$60Q &= \$2,250,000 \\
 Q &= 37,500 \text{ units of Deluxe} \\
 4Q &= 150,000 \text{ units of Standard}
 \end{aligned}$$

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 ($\$24 \times 525$ attendees)		\$12,600
	Variable cost of dinner ($\$12^a \times 525$ attendees)	\$6,300	
	Variable invitations and paperwork ($\$1^b \times 525$)	<u>525</u>	<u>6,825</u>
	Contribution margin		5,775
	Fixed cost of dinner	9,000	
	Fixed cost of invitations and paperwork	<u>1,975</u>	<u>10,975</u>
	Operating profit (loss)		<u>\$ (5,200)</u>

^a $\$6,300/525$ attendees = $\$12/\text{attendee}$

^b $\$525/525$ attendees = $\$1/\text{attendee}$

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

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

$$\begin{aligned}
 1. \quad \text{Contribution margin percentage} &= \frac{\text{Revenues} - \text{Variable costs}}{\text{Revenues}} \\
 &= \frac{\$5,000,000 - \$3,000,000}{\$5,000,000} \\
 &= \frac{\$2,000,000}{\$5,000,000} = 40\% \\
 \text{Breakeven revenues} &= \frac{\text{Fixed costs}}{\text{Contribution margin percentage}} \\
 &= \frac{\$2,160,000}{0.40} = \$5,400,000
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Breakeven revenues} &= \frac{\text{Fixed costs}}{\text{Contribution margin percentage}} \\
 &= \frac{\$2,160,000}{0.48} = \$4,500,000
 \end{aligned}$$

3.	Revenues	\$5,000,000
	Variable costs ($0.52 \times \$5,000,000$)	2,600,000
	Fixed costs	<u>2,160,000</u>
	Operating income	<u>\$ 240,000</u>

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	<u>14.00</u>	<u>86.00</u>	<u>14.00</u>	<u>102.00</u>
Contribution margin per unit (CMU)		64.00		48.00
Fixed costs per unit				
Manufacturing	30.00		15.00	
Marketing and distribution	<u>19.00</u>	<u>49.00</u>	<u>14.50</u>	<u>29.50</u>
Operating income per unit		<u>\$ 15.00</u>		<u>\$ 18.50</u>
CMU of normal production (as shown above)		\$64		\$48
CMU of overtime production (\$64 – \$3; \$48 – \$8)		61		40

1.

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

\$4,704,000	\$2,265,600
73,500 units	47,200 units

2.

Units produced and sold	96,000	96,000
Normal annual volume (units) (400 × 240; 320 × 240)	<u>96,000</u>	<u>76,800</u>
Units over normal volume (needing overtime)	<u>0</u>	<u>19,200</u>
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)	<u>0</u>	<u>768,000</u>
Total contribution margin	6,144,000	4,454,400
Total fixed costs	<u>4,704,000</u>	<u>2,265,600</u>
Operating income	<u>\$1,440,000</u>	<u>\$2,188,800</u>
Total operating income	▲ \$3,628,800	▲ \$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, $96,000 \times \$64$	\$ 6,144,000
Peoria $24,000 \times (\$64 - \$3)$	1,464,000
Moline, $72,000 \times \$48$	<u>3,456,000</u>
Total contribution margin	11,064,000
Deduct total fixed costs	<u>6,969,600</u>
Operating income	<u>\$ 4,094,400</u>

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.