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):

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

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:

\[
\text{Net income} = \text{Operating income} - \text{Income taxes}
\]

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.
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.

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.

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.

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.

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.

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.

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.

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.**

<table>
<thead>
<tr>
<th></th>
<th>Revenues ($2,000)</th>
<th>Variable Costs ($500)</th>
<th>Fixed Costs ($300)</th>
<th>Total Costs ($800)</th>
<th>Operating Income ($1,200)</th>
<th>Contribution Margin ($1,500)</th>
<th>Contribution Margin %</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>$2,000</td>
<td>$500</td>
<td>$300</td>
<td>$800</td>
<td>$1,200</td>
<td>$1,500</td>
<td>75.0%</td>
</tr>
<tr>
<td>b.</td>
<td>2,000</td>
<td>1,500</td>
<td>300</td>
<td>1,800</td>
<td>200</td>
<td>500</td>
<td>25.0%</td>
</tr>
<tr>
<td>c.</td>
<td>1,000</td>
<td>700</td>
<td>300</td>
<td>1,000</td>
<td>0</td>
<td>300</td>
<td>30.0%</td>
</tr>
<tr>
<td>d.</td>
<td>1,500</td>
<td>900</td>
<td>300</td>
<td>1,200</td>
<td>300</td>
<td>600</td>
<td>40.0%</td>
</tr>
</tbody>
</table>

**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

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

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

    \[
    Q = \frac{FC}{CMU} = \frac{$23,500}{$20 \text{ per ticket}}
    \]
    \[
    = 1,175 \text{ tickets}
    \]
3b. \[ Q = \frac{FC + TOI}{CMU} = \frac{\$23,500 + \$17,000}{\$20 \text{ per ticket}} \]

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

\[ = 2,025 \text{ tickets} \]

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

<table>
<thead>
<tr>
<th></th>
<th>6% Commission (Requirement 2)</th>
<th>Fixed Commission of $60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakeven point</td>
<td>470</td>
<td>1,175</td>
</tr>
<tr>
<td>Attain OI of $10,000</td>
<td>810</td>
<td>2,025</td>
</tr>
</tbody>
</table>

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:

\[ SP = \$65 \text{ ($60 + $5) per ticket} \]

\[ VCU = \$40 \text{ per ticket} \]

\[ CMU = \$65 - \$40 = \$25 \text{ per ticket} \]

\[ FC = \$23,500 \text{ a month} \]

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

\[ = 940 \text{ tickets} \]

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

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

\[ = 1,620 \text{ tickets} \]

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.

<table>
<thead>
<tr>
<th></th>
<th>Revenues</th>
<th>Variable Costs</th>
<th>Contribution Margin</th>
<th>Fixed Costs</th>
<th>Budgeted Operating Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orig.</td>
<td>$10,000,000&lt;sup&gt;G&lt;/sup&gt;</td>
<td>$8,000,000&lt;sup&gt;G&lt;/sup&gt;</td>
<td>$2,000,000</td>
<td>$1,800,000&lt;sup&gt;G&lt;/sup&gt;</td>
<td>$200,000</td>
</tr>
<tr>
<td>1.</td>
<td>10,000,000</td>
<td>7,800,000</td>
<td>2,200,000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1,800,000</td>
<td>400,000</td>
</tr>
<tr>
<td>2.</td>
<td>10,000,000</td>
<td>8,200,000</td>
<td>1,800,000&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1,800,000</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>10,000,000</td>
<td>8,000,000</td>
<td>2,000,000</td>
<td>1,890,000&lt;sup&gt;c&lt;/sup&gt;</td>
<td>110,000</td>
</tr>
<tr>
<td>4.</td>
<td>10,000,000</td>
<td>8,000,000</td>
<td>2,000,000</td>
<td>1,710,000&lt;sup&gt;d&lt;/sup&gt;</td>
<td>290,000</td>
</tr>
<tr>
<td>5.</td>
<td>10,800,000&lt;sup&gt;e&lt;/sup&gt;</td>
<td>8,640,000&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2,160,000</td>
<td>1,800,000</td>
<td>360,000</td>
</tr>
<tr>
<td>6.</td>
<td>9,200,000&lt;sup&gt;g&lt;/sup&gt;</td>
<td>7,360,000&lt;sup&gt;h&lt;/sup&gt;</td>
<td>1,840,000</td>
<td>1,800,000</td>
<td>40,000</td>
</tr>
<tr>
<td>7.</td>
<td>11,000,000&lt;sup&gt;i&lt;/sup&gt;</td>
<td>8,800,000&lt;sup&gt;j&lt;/sup&gt;</td>
<td>2,200,000</td>
<td>1,980,000&lt;sup&gt;k&lt;/sup&gt;</td>
<td>220,000</td>
</tr>
<tr>
<td>8.</td>
<td>10,000,000</td>
<td>7,600,000&lt;sup&gt;l&lt;/sup&gt;</td>
<td>2,400,000</td>
<td>1,890,000&lt;sup&gt;m&lt;/sup&gt;</td>
<td>510,000</td>
</tr>
</tbody>
</table>

<sup>G</sup>stands for given.

<sup>a</sup>$2,000,000 \times 1.10; \quad <sup>b</sup>$2,000,000 \times 0.90; \quad <sup>c</sup>$1,800,000 \times 1.05; \quad <sup>d</sup>$1,800,000 \times 0.95; \quad <sup>e</sup>$10,000,000 \times 1.08; \quad <sup>f</sup>$8,000,000 \times 1.08; \quad <sup>g</sup>$10,000,000 \times 0.92; \quad <sup>h</sup>$8,000,000 \times 0.92; \quad <sup>i</sup>$10,000,000 \times 1.10; \quad <sup>j</sup>$8,000,000 \times 1.10; \quad <sup>k</sup>$1,800,000 \times 1.10; \quad <sup>l</sup>$8,000,000 \times 0.95; \quad <sup>m</sup>$1,800,000 \times 1.05

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

1a. \[[\text{Units sold} \times (\text{Selling price} - \text{Variable costs})] - \text{Fixed costs}\] = \text{Operating income}  
\[[5,000,000 \times ($0.50 - $0.30)] - $900,000\] = $100,000

1b. \text{Fixed costs} ÷ \text{Contribution margin per unit} \quad = \text{Breakeven units}  
$900,000 ÷ [(($0.50 - $0.30)] = 4,500,000 units  
\text{Breakeven units} \times \text{Selling price} = \text{Breakeven revenues}  
4,500,000 units \times $0.50 \text{per unit} = $2,250,000

or,

\[
\text{Contribution margin ratio} = \frac{\text{Selling price} - \text{Variable costs}}{\text{Selling price}} = \frac{$0.50 - $0.30}{$0.50} = 0.40
\]

\[
\text{Fixed costs} ÷ \text{Contribution margin ratio} = \text{Breakeven revenues}  
$900,000 ÷ 0.40 = $2,250,000
\]

2. \[5,000,000 \times ($0.50 - $0.34) - $900,000\] = $ (100,000)

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

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

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

6. \((900,000 + 20,000) \times ($0.55 - $0.30) = 3,680,000 units

---

3-6
1. Monthly fixed costs = $48,200 + $68,000 + $13,000 = $129,200
   Contribution margin per unit = $27,000 – $23,000 – $600 = $3,400
   Breakeven units per month = \[
   \frac{\text{Monthly fixed costs}}{\text{Contribution margin per unit}} = \frac{129,200}{3,400} = 38 \text{ cars}
   \]

2. Tax rate 40%
   Target net income $51,000
   Target operating income = \[
   \frac{\text{Target net income}}{1 - \text{tax rate}} = \frac{51,000}{1 - 0.40} = \frac{51,000}{0.60} = 85,000
   \]
   Quantity of output units required to be sold = \[
   \frac{\text{Fixed costs} + \text{Target operating income}}{\text{Contribution margin per unit}} = \frac{129,200 + 85,000}{3,400} = 63 \text{ cars}
   \]

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
   \[
   R - 0.40R = 459,000 = \frac{107,100}{1 - 0.30} \\
   0.60R = 459,000 + 153,000 \\
   R = 612,000 ÷ 0.60 \\
   R = 1,020,000
   \]
   or, Target revenues \[
   \frac{\text{Fixed costs} + \text{Target operating income}}{\text{Contribution margin percentage}} = \frac{459,000 + 107,100}{1 - 0.30} = \frac{566,100}{0.60} = 1,020,000
   \]

   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 = $459,000 ÷ $5.10 per customer
   = 90,000 customers
2.b. Customers needed to earn net income of $107,100:
   \[ \text{Total revenues ÷ Sales check per customer} \]
   \[ \frac{1,020,000}{8.50} = 120,000 \text{ customers} \]

3. Using the shortcut approach:

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

Alternatively, with 170,000 customers,

\[
\begin{align*}
\text{Operating income} & = \text{Number of customers} \times \text{Selling price per customer} \\
& \quad - \text{Number of customers} \times \text{Variable cost per customer} - \text{Fixed costs} \\
& = 170,000 \times 8.50 - 170,000 \times 3.40 - 459,000 = 408,000 \\
\text{Net income} & = \text{Operating income} \times (1 - \text{Tax rate}) = 408,000 \times 0.7 = 285,600
\end{align*}
\]

The alternative approach is:

\[
\begin{align*}
\text{Revenues, 170,000} \times 8.50 & = 1,445,000 \\
\text{Variable costs at 40%} & = 578,000 \\
\text{Contribution margin} & = 867,000 \\
\text{Fixed costs} & = 459,000 \\
\text{Operating income} & = 408,000 \\
\text{Income tax at 30%} & = 122,400 \\
\text{Net income} & = 285,600
\end{align*}
\]

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

1. \[ \text{SP} = 30.00 \times (1 - 0.30 \text{ margin to bookstore}) \]
   \[ = 30.00 \times 0.70 = 21.00 \]

   \[ \text{VCU} = 4.00 \text{ variable production and marketing cost} \]
   \[ 3.15 \text{ variable author royalty cost (0.15 \times 21.00)} \]
   \[ 7.15 \]
   \[ \text{CMU} = 21.00 - 7.15 = 13.85 \text{ per copy} \]
   \[ \text{FC} = 500,000 \text{ fixed production and marketing cost} \]
   \[ 3,000,000 \text{ up-front payment to Washington} \]
   \[ 3,500,000 \]
Solution Exhibit 3-23A shows the PV graph.

**SOLUTION EXHIBIT 3-23A**
PV Graph for Media Publishers

2a. Breakeven number of units

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

2b. Target OI

\[
\text{Target OI} = \frac{FC + OI}{CMU} = \frac{$3,500,000 + $2,000,000}{13.85} = \frac{$5,500,000}{13.85} = 397,112 \text{ copies sold (rounded up)}
\]
3a. Decreasing the normal bookstore margin to 20% of the listed bookstore price of $30 has the following effects:

\[
\begin{align*}
\text{SP} & = 30.00 \times (1 - 0.20) \\
& = 30.00 \times 0.80 = 24.00 \\
\text{VCU} & = $4.00 \text{ variable production and marketing cost} \\
& + 3.60 \text{ variable author royalty cost (0.15 \times$24.00)} \\
& = $7.60 \\
\text{CMU} & = 24.00 - 7.60 = 16.40 \text{ per copy}
\end{align*}
\]

The breakeven number of units is:

\[
\frac{\text{FC}}{\text{CMU}} = \frac{3,500,000}{16.40} = 213,415 \text{ copies sold (rounded up)}
\]

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:

\[
\begin{align*}
\text{SP} & = 40.00 \times (1 - 0.30) \\
& = 40.00 \times 0.70 = 28.00 \\
\text{VCU} & = $4.00 \text{ variable production and marketing cost} \\
& + 4.20 \text{ variable author royalty cost (0.15 \times$28.00)} \\
& = $8.20 \\
\text{CMU} & = 28.00 - 8.20 = 19.80 \text{ per copy}
\end{align*}
\]

The breakeven number of units is:

\[
\frac{\text{FC}}{\text{CMU}} = \frac{3,500,000}{19.80} = 176,768 \text{ copies sold (rounded up)}
\]

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 = \( \frac{\text{Fixed costs}}{\text{Contribution margin percentage}} \)
   
   Contribution margin percentage = \( \frac{\$660,000}{\$1,100,000} \) = 0.60 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 ÷ Selling price = \( \frac{\$1,100,000}{\$40} \) = 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
   
   \[
   \$500Q - 350Q = 5,000
   \]
   
   \[
   \$150Q = 5,000
   \]
   
   \[
   Q = 5,000 ÷ 150 = 34 \text{ carpets (rounded up)}
   \]

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

   \[
   50Q = 5,000
   \]
   
   \[
   Q = 5,000 ÷ 50 = 100 \text{ carpets}
   \]
   
   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
   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
   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.**

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

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 = 48,000 units
- Total number of units to breakeven (rounded) = 120,000 units

Alternatively,

Let \(S\) = Number of units sold to upgrade customers
Let \(1.5S\) = 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

\[ \$312.5S = \$15,000,000 \]
\[ S = 48,000 \text{ units sold to upgrade customers} \]
\[ 1.5S = \frac{72,000}{24} \text{ units sold to new customers} \]
BEP = 120,000 units

*Check*

Revenues \((\$275 \times 72,000) + (\$100 \times 48,000)\) \(\$24,600,000\)
Variable costs \((\$100 \times 72,000) + (\$50 \times 48,000)\) \(\$9,600,000\)
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 1.5\( S \) = Number of units sold to upgrade customers

\[
\begin{align*}
[$275S + $100 (1.5S)] & − [$100S + $50 (1.5S)] − $15,000,000 = OI \\
425S − 175S & = $15,000,000 \\
250S & = $15,000,000 \\
S & = 60,000 \text{ units sold to new customers} \\
1.5S & = 90,000 \text{ units sold to upgrade customers} \\
\text{BEP} & = 150,000 \text{ units}
\end{align*}
\]

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

3-15
Alternatively,

Let \( S \) = Number of units sold to upgrade customers
then \( 4S \) = Number of units sold to new customers

\[
\begin{align*}
[275 (4S) + 100S] - [100 (4S) + 50S] - 15,000,000 &= OI \\
1,200S - 450S &= 15,000,000 \\
750S &= 15,000,000 \\
S &= \frac{20,000}{750} = 20,000 \text{ units sold to upgrade customers} \\
4S &= \frac{80,000}{750} = 80,000 \text{ units sold to new customers} \\
&= 100,000 \text{ units}
\end{align*}
\]

**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:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>New Customers</th>
<th>Upgrade Customers</th>
<th>Breakeven Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>3(a)</td>
<td>40%</td>
<td>60%</td>
<td>150,000</td>
</tr>
<tr>
<td>1</td>
<td>60%</td>
<td>40%</td>
<td>120,000</td>
</tr>
<tr>
<td>3(b)</td>
<td>80%</td>
<td>20%</td>
<td>100,000</td>
</tr>
</tbody>
</table>
### 3-28  (30 min.)  **Sales mix, three products.**

1. | Coffee | Bagels |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>$2.50</td>
</tr>
<tr>
<td>VCU</td>
<td>1.25</td>
</tr>
<tr>
<td>CMU</td>
<td>$1.25</td>
</tr>
</tbody>
</table>

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 bundles \(\times 4\) cups per bundle = 4,000 cups
- Bagels: 1,000 bundles \(\times 1\) 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
\[
[$2.50(4S) + $3.75S] - [\$1.25(4S) + $1.75S] - $7,000 = OI
\]
\[
\$13.75S - \$6.75S - $7,000 = OI
\]
\[
\$7.00 S = $7,000
\]
\[
S = 1,000 \text{ units of the sales mix}
\]

or
\[
S = 1,000 \text{ bagels sold}
\]
\[
4S = 4,000 \text{ cups of coffee sold}
\]

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

**Check**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>$13,750</td>
</tr>
<tr>
<td>Variable costs</td>
<td>$6,750</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$7,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$7,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$0</td>
</tr>
</tbody>
</table>

2. | Coffee | Bagels |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>$2.50</td>
</tr>
<tr>
<td>VCU</td>
<td>1.25</td>
</tr>
<tr>
<td>CMU</td>
<td>$1.25</td>
</tr>
</tbody>
</table>

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
\[
\text{Breakeven point is:}\nonumber
\text{Coffee: } 5,000 \text{ bundles} \times 4 \text{ cups per bundle} = 20,000 \text{ cups} \\
\text{Bagels: } 5,000 \text{ bundles} \times 1 \text{ bagel per bundle} = 5,000 \text{ bagels}
\]

Alternatively,

Let \( S \) = Number of bagels sold

\[
4S = \text{Number of cups of coffee sold}
\]

Revenues – Variable costs – Fixed costs = Operating income

\[
\begin{align*}
&\left[ 2.50(4S) + 3.75S \right] - \left[ 1.25(4S) + 1.75S \right] - 7,000 = \text{OI} \\
&\left[ 2.50(4S) + 3.75S \right] - \left[ 1.25(4S) + 1.75S \right] - 7,000 = 28,000 \\
&13.75S - 6.75S = 35,000 \\
&7.00 S = 35,000 \\
&S = 5,000 \text{ units of the sales mix} \\
&\text{or} \\
&S = 5,000 \text{ bagels sold} \\
&4S = 20,000 \text{ cups of coffee sold}
\end{align*}
\]

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

\[
\begin{align*}
\text{Revenues} &= (2.50 \times 20,000) + (3.75 \times 5,000) = 68,750 \\
\text{Variable costs} &= (1.25 \times 20,000) + (1.75 \times 5,000) = 33,750 \\
\text{Contribution margin} &= 35,000 \\
\text{Fixed costs} &= 7,000 \\
\text{Operating income} &= 28,000
\end{align*}
\]

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

<table>
<thead>
<tr>
<th></th>
<th>Coffee</th>
<th>Bagels</th>
<th>Muffins</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>$2.50</td>
<td>$3.75</td>
<td>$3.00</td>
</tr>
<tr>
<td>VCU</td>
<td>1.25</td>
<td>1.75</td>
<td>0.75</td>
</tr>
<tr>
<td>CMU</td>
<td>$1.25</td>
<td>$2.00</td>
<td>$2.25</td>
</tr>
</tbody>
</table>

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 bundles

Breakeven point is:

Coffee: 700 bundles \times 3 \text{ cups per bundle} = 2,100 \text{ cups} \\
Bagels: 700 bundles \times 2 \text{ bagels per bundle} = 1,400 \text{ bagels} \\
Muffins: 700 bundles \times 1 \text{ muffin per bundle} = 700 \text{ 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

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>$12,600</td>
</tr>
<tr>
<td>Variable costs</td>
<td>5,600</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>7,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>7,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$0</td>
</tr>
</tbody>
</table>

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

   Breakeven point in units = \( \frac{\text{Net fixed costs}}{\text{Contribution margin per concert}} \) = $34,000 = 34 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
Breakeven point in units = \( \frac{\text{Net fixed costs}}{\text{Contribution margin per concert}} = \frac{\$74,000}{\$1,000} = 74 \text{ concerts} \)

**Check**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donations</td>
<td>$40,000</td>
</tr>
<tr>
<td>Revenue ($2,500 \times 74)</td>
<td>185,000</td>
</tr>
<tr>
<td>Total revenue</td>
<td>225,000</td>
</tr>
</tbody>
</table>

Less variable costs
- Guest performers ($1,000 \times 74) $74,000
- Marketing and advertising ($500 \times 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**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donations</td>
<td>$40,000</td>
</tr>
<tr>
<td>Revenue ($2,500 \times 60)</td>
<td>150,000</td>
</tr>
<tr>
<td>Total revenue</td>
<td>190,000</td>
</tr>
</tbody>
</table>

Less variable costs
- Guest performers ($1,000 \times 60) $60,000
- Marketing and advertising ($500 \times 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 break even. 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

Breakeven point in units = \( \frac{\text{Net fixed costs}}{\text{Contribution margin per concert}} \) = $54,000 \( \div \) $1,000 = 54 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
   Contribution margin $210,000

2. Contribution margin percentage = $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 = $40,000 / 10,000 units = $4 per unit
   Breakeven quantity = Fixed costs / Contribution margin per unit = $30,000 / $4 per unit = 7,500 units
   Selling price = Revenues / Units sold = $100,000 / 10,000 units = $10 per unit
   Breakeven revenues = 7,500 units × $10 per unit = $75,000

   Alternatively,
   Contribution margin percentage = Contribution margin / Revenues = $40,000 / $100,000 = 40%
   Breakeven revenues = Fixed costs / Contribution margin percentage = $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) = \[
   \frac{\text{Fixed costs}}{\text{Contribution margin per package}} = \frac{$520,000}{\$1,300} = 400 \text{ tour packages}
   \]

2. **Contribution margin ratio =**  
   \[
   \frac{\$1,300}{\$5,000} = 26\%
   \]

   Revenue to achieve target income = (Fixed costs + target OI) ÷ Contribution margin ratio  
   \[
   = \frac{$520,000 + $91,000}{0.26} = $2,350,000, \text{ or}
   \]

   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 =**  
   \[
   $520,000 + $32,000 = $552,000
   \]

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

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

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

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

2. 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 \div 46
Increase in fee per child $ 50

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

Alternatively,

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
CVP analysis.

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

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

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

   Target sales in dollars = $300 × 12,500 = $3,750,000
3-36  (30–40 min.)  **CVP analysis, income taxes.**

1. **Revenues – Variable costs – Fixed costs = Target net income / (1 – Tax rate)**

   Let X = Net income for 2011
   
   \[
   \begin{align*}
   20,000(\$25.00) - 20,000(\$13.75) - \$135,000 &= \frac{X}{1 - 0.40} \\
   \$500,000 - \$275,000 - \$135,000 &= \frac{X}{0.60} \\
   \$300,000 - \$165,000 - \$81,000 &= X
   \\
   X &= \$54,000
   \end{align*}
   \]

   Alternatively,
   
   Operating income = Revenues – Variable costs – Fixed costs
   
   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
   
   \[
   \begin{align*}
   22,000(\$25.00) - 22,000(\$13.75) - (\$135,000 + \$11,250) &= \frac{X}{1 - 0.40} \\
   \$550,000 - \$302,500 - \$146,250 &= \frac{X}{0.60} \\
   \$101,250 &= \frac{X}{0.60}
   \\
   X &= \$60,750
   \end{align*}
   \]

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 = $325,000

5. Let S = Required sales units to equal 2011 net income
   
   \[
   \begin{align*}
   $25.00S - $13.75S - $146,250 &= \frac{\$54,000}{0.60} \\
   $11.25S &= \$236,250 \\
   S &= 21,000 units
   \\
   Revenues &= 21,000 units \times $25 = $525,000
   \end{align*}
   \]

6. Let A = Amount spent for advertising in 2012
   
   \[
   \begin{align*}
   $550,000 - $302,500 - (\$135,000 + A) &= \frac{\$60,000}{0.60} \\
   \$550,000 - $302,500 - $135,000 - A &= \$100,000 \\
   \$550,000 - $537,500 &= A
   \\
   A &= $12,500
   \end{align*}
   \]

3-29
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 × 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)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$30.00</td>
</tr>
<tr>
<td>Cost of shoes</td>
<td>19.50</td>
</tr>
<tr>
<td>Sales commissions</td>
<td>1.80</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>$21.30</td>
</tr>
<tr>
<td>Total fixed costs</td>
<td>$360,000</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues (50,000 pairs × $30 per pair)</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Total cost of shoes (50,000 pairs × $19.50 per pair)</td>
<td>$975,000</td>
</tr>
<tr>
<td>Sales commissions on first 40,000 pairs (40,000 pairs × $1.50 per pair) 60,000</td>
<td></td>
</tr>
<tr>
<td>Sales commissions on additional 10,000 pairs [10,000 pairs × ($1.50 + $0.30 per pair)] 18,000</td>
<td></td>
</tr>
<tr>
<td>Total variable costs</td>
<td>$1,053,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$447,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$360,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$87,000</td>
</tr>
</tbody>
</table>

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.
### CVP analysis, shoe stores (continuation of 3-38).

<table>
<thead>
<tr>
<th>No. of units sold (1)</th>
<th>Salaries + Commission Plan</th>
<th>Higher Fixed Salaries Only</th>
<th>Difference in favor of higher-fixed-salary-only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CM per Unit (2)</td>
<td>CM (3)=$(1)\times(2)$</td>
<td>Fixed Costs (4)</td>
</tr>
<tr>
<td>40,000</td>
<td>$9.00</td>
<td>$360,000</td>
<td>$360,000</td>
</tr>
<tr>
<td>42,000</td>
<td>9.00</td>
<td>378,000</td>
<td>360,000</td>
</tr>
<tr>
<td>44,000</td>
<td>9.00</td>
<td>396,000</td>
<td>360,000</td>
</tr>
<tr>
<td>46,000</td>
<td>9.00</td>
<td>414,000</td>
<td>360,000</td>
</tr>
<tr>
<td>48,000</td>
<td>9.00</td>
<td>432,000</td>
<td>360,000</td>
</tr>
<tr>
<td>50,000</td>
<td>9.00</td>
<td>450,000</td>
<td>360,000</td>
</tr>
<tr>
<td>52,000</td>
<td>9.00</td>
<td>468,000</td>
<td>360,000</td>
</tr>
<tr>
<td>54,000</td>
<td>9.00</td>
<td>486,000</td>
<td>360,000</td>
</tr>
<tr>
<td>56,000</td>
<td>9.00</td>
<td>504,000</td>
<td>360,000</td>
</tr>
<tr>
<td>58,000</td>
<td>9.00</td>
<td>522,000</td>
<td>360,000</td>
</tr>
<tr>
<td>60,000</td>
<td>9.00</td>
<td>540,000</td>
<td>360,000</td>
</tr>
<tr>
<td>62,000</td>
<td>9.00</td>
<td>558,000</td>
<td>360,000</td>
</tr>
<tr>
<td>64,000</td>
<td>9.00</td>
<td>576,000</td>
<td>360,000</td>
</tr>
<tr>
<td>66,000</td>
<td>9.00</td>
<td>594,000</td>
<td>360,000</td>
</tr>
</tbody>
</table>
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

\[
\begin{align*}
19.50Q + 360,000 + 81,000 &= 21Q + 360,000 \\
1.50 Q &= 81,000 \\
Q &= 54,000 \text{ pairs}
\end{align*}
\]

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,

\[
\begin{align*}
30.00TQ - 19.50TQ - 441,000 &= 168,000 \\
10.50TQ &= 609,000 \\
TQ &= 609,000 ÷ 10.50 \\
TQ &= 58,000 \text{ units}
\end{align*}
\]

For the salary-plus-commission plan,

\[
\begin{align*}
30.00TQ - 21.00TQ - 360,000 &= 168,000 \\
9.00TQ &= 528,000 \\
TQ &= 528,000 ÷ 9.00 \\
TQ &= 58,667 \text{ units (rounded up)}
\end{align*}
\]

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**

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues (48,000 pairs × $30) + (2,000 pairs × $18)</td>
<td>$1,476,000</td>
</tr>
<tr>
<td>Cost of shoes, 50,000 pairs × $19.50</td>
<td>$975,000</td>
</tr>
<tr>
<td>Commissions = Revenues × 5% = $1,476,000 × 0.05</td>
<td>$73,800</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$427,200</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$360,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$67,200</td>
</tr>
</tbody>
</table>
Alternative cost structures, uncertainty, and sensitivity analysis.

1. Contribution margin per page assuming current fixed leasing agreement

\[ \text{Fixed costs} = $1,000 \]

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

Contribution margin per page assuming $10 per 500 page commission agreement

\[ \text{Fixed costs} = $0 \]

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

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

$10/500 \text{ pages} = $0.02/\text{page}$

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.

\[ 0.15x - 0.03x - 0.04x - 1,000 = 0.15x - 0.02x - 0.03x - 0.04x \]
\[ 0.08x - 1,000 = 0.06x \]
\[ 0.02x = 1,000 \]
\[ x = 1,000 / 0.02 = 50,000 \text{ pages} \]

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

<table>
<thead>
<tr>
<th>Pages Sold (1)</th>
<th>Revenue (2)</th>
<th>Variable Costs (3)</th>
<th>Fixed Costs (4)</th>
<th>Operating Income (Loss) (5)=(2)–(3)–(4)</th>
<th>Probability (6)</th>
<th>Expected Operating Income (7)=(5)×(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,000</td>
<td>$20,000×$.15=$3,000</td>
<td>$20,000×$.07=$1,400</td>
<td>$1,000</td>
<td>$600</td>
<td>0.20</td>
<td>$120</td>
</tr>
<tr>
<td>40,000</td>
<td>$40,000×$.15=$6,000</td>
<td>$40,000×$.07=$2,800</td>
<td>$1,000</td>
<td>$2,200</td>
<td>0.20</td>
<td>440</td>
</tr>
<tr>
<td>60,000</td>
<td>$60,000×$.15=$9,000</td>
<td>$60,000×$.07=$4,200</td>
<td>$1,000</td>
<td>$3,800</td>
<td>0.20</td>
<td>760</td>
</tr>
<tr>
<td>80,000</td>
<td>$80,000×$.15=$12,000</td>
<td>$80,000×$.07=$5,600</td>
<td>$1,000</td>
<td>$5,400</td>
<td>0.20</td>
<td>1,080</td>
</tr>
<tr>
<td>100,000</td>
<td>$100,000×$.15=$15,000</td>
<td>$100,000×$.07=$7,000</td>
<td>$1,000</td>
<td>$7,000</td>
<td>0.20</td>
<td>1,400</td>
</tr>
</tbody>
</table>

Expected value of fixed leasing agreement $3,800
Commission-based leasing agreement:

<table>
<thead>
<tr>
<th>Pages Sold (1)</th>
<th>Revenue (2)</th>
<th>Variable Costs (3)</th>
<th>Operating Income (4)=(2)−(3)</th>
<th>Probability (5)</th>
<th>Expected Operating Income (6)=(4)×(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,000</td>
<td>20,000×$.15=$ 3,000</td>
<td>20,000×$.09=$1,800</td>
<td>$1,200</td>
<td>0.20</td>
<td>$ 240</td>
</tr>
<tr>
<td>40,000</td>
<td>40,000×$.15=$ 6,000</td>
<td>40,000×$.09=$3,600</td>
<td>$2,400</td>
<td>0.20</td>
<td>480</td>
</tr>
<tr>
<td>60,000</td>
<td>60,000×$.15=$ 9,000</td>
<td>60,000×$.09=$5,400</td>
<td>$3,600</td>
<td>0.20</td>
<td>720</td>
</tr>
<tr>
<td>80,000</td>
<td>80,000×$.15=$12,000</td>
<td>80,000×$.09=$7,200</td>
<td>$4,800</td>
<td>0.20</td>
<td>960</td>
</tr>
<tr>
<td>100,000</td>
<td>100,000×$.15=$15,000</td>
<td>100,000×$.09=$9,000</td>
<td>$6,000</td>
<td>0.20</td>
<td>1,200</td>
</tr>
</tbody>
</table>

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 \times 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. Target number of computers = \frac{Fixed costs + Target operating income}{Contribution margin per computer}
   = \frac{$4,000 + $5,000}{$200} = 45 computers

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

\[
\begin{align*}
500x - 300x - 4000 &= 500x - 300x - 500(0.20)x \\
200x - 4000 &= 100x \\
100x &= 4000 \\
x &= 40 \text{ computers}
\end{align*}
\]

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 $200x – 4,000 > 100x$
1a. To break even, 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

\[3,000Q = 500Q + 3,000,000\]

\[2,500Q = 3,000,000\]

\[Q = 1,200\text{ units}\]

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

\[
\text{Breakeven} = \frac{\text{Fixed Costs}}{\text{Contribution margin per unit}}
\]

\[= \frac{3,000,000}{2,500} = 1,200\text{ units}\]

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)]

\[3,000Q = 500Q + 3,000,000 + \left[\frac{1,500,000}{1 - 0.25}\right]\]

\[3,000Q = 500Q + 3,000,000 + 2,000,000\]

\[Q = 2,000\text{ units}\]

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 = \((3,000 \times 300) + (2,400^a \times 2,000) = 5,700,000\)

Variable costs = \(500 \times 2,300^b = 1,150,000\)

Operating income = \(5,700,000 - 1,150,000 - 3,000,000 = 1,550,000\)

Net income = \(1,550,000 \times (1 - 0.25) = 1,162,500\)

\(^a3,000 - (3,000 \times 0.20) = ; \quad ^b300 \text{ units} + 2,000 \text{ units}.\)
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 \times $3,000) = $3,000 – $300; ^f300 units + 1,700 units;
^g$3,000,000 − (0.20 \times $3,000,000)
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.

<table>
<thead>
<tr>
<th>Marston Corporation</th>
<th>Using Sales Agents</th>
<th>Using Own Sales Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Statement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For the Year Ended</td>
<td></td>
<td></td>
</tr>
<tr>
<td>December 31, 2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenues</td>
<td>$26,000,000</td>
<td>$26,000,000</td>
</tr>
<tr>
<td>Variable Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of goods sold—variable</td>
<td>$11,700,000</td>
<td>$11,700,000</td>
</tr>
<tr>
<td>Marketing commissions</td>
<td>4,680,000</td>
<td>16,380,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>9,620,000</td>
<td>11,700,000</td>
</tr>
<tr>
<td>Fixed Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of goods sold—fixed</td>
<td>2,870,000</td>
<td>2,870,000</td>
</tr>
<tr>
<td>Marketing—fixed</td>
<td>3,420,000</td>
<td>6,290,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$3,330,000</td>
<td>$3,330,000</td>
</tr>
</tbody>
</table>

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

Operating income = Revenues − Variable manuf. costs − Fixed manuf. costs − Variable marketing costs − Fixed marketing costs

Denote the revenues required to earn $3,330,000 of operating income by R, then
$$R - 0.45R - 2,870,000 - 0.15R - 5,500,000 = 3,330,000$$
$$R - 0.45R - 0.15R = 3,330,000 + 2,870,000 + 5,500,000$$
$$0.40R = 11,700,000$$
$$R = 11,700,000 / 0.40 = 29,250,000$$

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 = \(1 \times 3 + 5 \times 2 + 4 \times 1 = 3 + 10 + 4 = 17\) 
   Breakeven point in bundles = \(\frac{255,000}{17} = 15,000\) bundles 
   Breakeven point in units is:
   - Product A: 15,000 bundles \(\times 1\) unit per bundle = 15,000 units 
   - Product B: 15,000 bundles \(\times 5\) units per bundle = 75,000 units 
   - Product C: 15,000 bundles \(\times 4\) 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 

   \(3Q + 2(5Q) + 1(4Q) - 255,000 = 0\) 
   \(3Q + 10Q + 4Q - 255,000 = 0\) 
   \(17Q = 255,000\) 
   \(Q = 15,000\) \((255,000 ÷ 17)\) units of A 
   \(5Q = 75,000\) units of B 
   \(4Q = 60,000\) units of C 
   Total = 150,000 units 

2. Contribution margin:
   - A: \(20,000 \times 3\) = $60,000 
   - B: \(100,000 \times 2\) = $200,000 
   - C: \(80,000 \times 1\) = $80,000 
   Contribution margin = $340,000 
   Fixed costs = $255,000 
   Operating income = $85,000
3. Contribution margin

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A:</td>
<td>20,000 × $3</td>
<td>$ 60,000</td>
</tr>
<tr>
<td>B:</td>
<td>80,000 × $2</td>
<td>160,000</td>
</tr>
<tr>
<td>C:</td>
<td>100,000 × $1</td>
<td>100,000</td>
</tr>
</tbody>
</table>

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 = $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
4$Q$ = Number of units of B to break even
5$Q$ = 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)

4$Q = 63,752$ units of B

5$Q = 79,690$ 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$x60 + 3$x65 = $315

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

   Breakeven point in units of faucet models and pitcher models is:
   Faucet models: 3,000 bundles\times2 units per bundle = 6,000 units
   Pitcher models: 3,000 bundles\times3 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\times$80 per unit = $480,000
   Pitcher models: 9,000 units\times$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: \(\frac{2}{5}\times15,000\) units = 6,000 units

   Pitcher-cum-filter: \(\frac{3}{5}\times15,000\) units = 9,000 units

   Breakeven point in dollars
   Faucet filter: 6,000 units\times$80 per unit = $480,000
   Pitcher-cum-filter: 9,000 units\times$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

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

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

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

\[
\text{Check} \quad 352 \times 6,000 - 1,126,400 = 985,600 \text{ is greater than } 315 \times 6,000 - 945,000 = 945,000.
\]

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.

\[
\text{Contribution margin of the bundle} = 3 \times 10 + 1 \times 20 = 30 + 20 = 50
\]

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

\[
\text{Breakeven point in units is:}
\text{Standard carrier:} \quad 45,000 \text{ bundles} \times 3 \text{ units per bundle} \quad 135,000 \text{ units}
\text{Deluxe carrier:} \quad 45,000 \text{ bundles} \times 1 \text{ unit per bundle} \quad 45,000 \text{ units}
\text{Total number of units to breakeven} \quad 180,000 \text{ units}
\]

Alternatively,

Let \( Q \) = Number of units of Deluxe carrier to break even
3\( Q \) = Number of units of Standard carrier to break even

\[
\text{Revenues – Variable costs – Fixed costs} = \text{Zero operating income}
\]

\[
28(3Q) + 50Q - 18(3Q) - 30Q - 2,250,000 = 0
\]

\[
84Q + 50Q - 54Q - 30Q = 2,250,000
\]

\[
50Q = 2,250,000
\]

\[
Q = 45,000 \text{ units of Deluxe}
3Q = 135,000 \text{ units of Standard}
\]

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

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

   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.
(20 min.) Gross margin and contribution margin.

1. 

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket sales ($24 \times 525$ attendees)</td>
<td></td>
<td>$12,600</td>
</tr>
<tr>
<td>Variable cost of dinner ($12^{a} \times 525$ attendees)</td>
<td></td>
<td>$6,300</td>
</tr>
<tr>
<td>Variable invitations and paperwork ($1^{b} \times 525$)</td>
<td></td>
<td>$525</td>
</tr>
<tr>
<td>Contribution margin</td>
<td></td>
<td>$6,825</td>
</tr>
<tr>
<td>Fixed cost of dinner</td>
<td></td>
<td>$9,000</td>
</tr>
<tr>
<td>Fixed cost of invitations and paperwork</td>
<td></td>
<td>$1,975</td>
</tr>
<tr>
<td>Operating profit (loss)</td>
<td></td>
<td>$5,775</td>
</tr>
</tbody>
</table>

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

2. 

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket sales ($24 \times 1,050$ attendees)</td>
<td></td>
<td>$25,200</td>
</tr>
<tr>
<td>Variable cost of dinner ($12 \times 1,050$ attendees)</td>
<td></td>
<td>$12,600</td>
</tr>
<tr>
<td>Variable invitations and paperwork ($1 \times 1,050$)</td>
<td></td>
<td>$1,050</td>
</tr>
<tr>
<td>Contribution margin</td>
<td></td>
<td>$13,650</td>
</tr>
<tr>
<td>Fixed cost of dinner</td>
<td></td>
<td>$9,000</td>
</tr>
<tr>
<td>Fixed cost of invitations and paperwork</td>
<td></td>
<td>$1,975</td>
</tr>
<tr>
<td>Operating profit (loss)</td>
<td></td>
<td>$11,550</td>
</tr>
</tbody>
</table>

(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. 

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>Variable costs (0.52 \times $5,000,000)</td>
<td>2,600,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>2,160,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$240,000</td>
</tr>
</tbody>
</table>
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 Lemand 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 Lemand that estimates of environmental costs and liabilities should be included in the analysis. If Lemand still insists on modifying the numbers and reporting lower environmental costs, Bush should raise the matter with one of Lemand’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.**

<table>
<thead>
<tr>
<th></th>
<th>Peoria</th>
<th>Moline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$150.00</td>
<td>$150.00</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>$72.00</td>
<td>$88.00</td>
</tr>
<tr>
<td>Marketing and distribution</td>
<td>14.00</td>
<td>102.00</td>
</tr>
<tr>
<td>Contribution margin per unit (CMU)</td>
<td>64.00</td>
<td>48.00</td>
</tr>
<tr>
<td>Fixed costs per unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>30.00</td>
<td>15.00</td>
</tr>
<tr>
<td>Marketing and distribution</td>
<td>19.00</td>
<td>29.50</td>
</tr>
<tr>
<td>Operating income per unit</td>
<td>$15.00</td>
<td>$18.50</td>
</tr>
</tbody>
</table>

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
   $(49 \times 400 \text{ units} \times 240 \text{ days};$
   $29.50 \times 320 \text{ units} \times 240 \text{ days})$
   $4,704,000$   $2,265,600$

   Breakeven volume = FC ÷ CMU of normal production $(4,704,000 ÷ 64; 2,265,600 ÷ 48)$
   73,500 units   47,200 units

2.  Units produced and sold  96,000  96,000

   Normal annual volume (units)
   $(400 \times 240; 320 \times 240)$
   96,000   76,800

   Units over normal volume (needing overtime)  0   19,200

   CM from normal production units (normal annual volume × CMU normal production)
   $(96,000 \times 64; 76,800 \times 48)$
   $6,144,000$   $3,686,400$

   CM from overtime production units
   $(0; 19,200 \times 40)$
   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:

<table>
<thead>
<tr>
<th>Plant</th>
<th>Units</th>
<th>Unit Price</th>
<th>Contribution Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peoria</td>
<td>96,000</td>
<td>$64</td>
<td>$6,144,000</td>
</tr>
<tr>
<td>Peoria</td>
<td>24,000</td>
<td>($64 – $3)</td>
<td>1,464,000</td>
</tr>
<tr>
<td>Moline</td>
<td>72,000</td>
<td>$48</td>
<td>3,456,000</td>
</tr>
</tbody>
</table>

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.