CMA Accelerated Program

MANAGEMENT ACCOUNTING

MODULE 4
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9. Cost-Volume-Profit Analysis

Learning Objectives

After completing this chapter, you will:

1. Understand the role of cost volume profit analysis
2. Be able to apply cost volume profit analysis in both single product and multi-product settings
3. Be able to adapt and use cost volume profit analysis to evaluate the profit effect of management initiatives such as advertising and re-engineering
4. Understand and be able to adapt cost volume profit tools to more complex, spreadsheet-based models

The Cost Volume Profit Model

CVP Analysis in the News

The automaker (Chrysler) can break even by selling one million cars annually in the US and make $1 billion for every additional 100,000 vehicles, two people familiar with its finances have said.


The basic cost volume profit (CVP) model makes the following important assumptions:

1. The volume of sales does not affect product price.
2. The volume of product does not affect variable cost per unit.
3. All costs are either variable or fixed.
4. All production is sold.

With these assumptions, we can use the profit equation to develop the CVP relationship.

Let:

- \( P \) = price per unit
- \( V \) = variable cost per unit
- \( F \) = total fixed cost
- \( x \) = number of units produced and sold
- \( OI \) = operating income

Revenues - costs = operating income

\[ Px - Vx - F = OI \]

\[ x (P - V) - F = OI \]
Accountants call price per unit minus variable cost per unit (P – V) the contribution margin per unit. The contribution margin per unit is the dollar amount that each unit made and sold contributes to covering fixed costs and provides a profit. We can now write the above equation as:

\[ x \times CM - F = OI \]

\[ x = \frac{\text{fixed costs} + \text{operating income}}{\text{contribution margin per unit}} \]

For convenience, we will refer to this equation as the units CVP equation. What the units CVP equation does is it allows the decision maker to identify the number of units \( x \) that must be made and sold to cover fixed costs and provide a target profit. Or, put another way, it predicts the profit (or loss) resulting from a given level of unit sales.

Using the Units Cost Volume Profit Model

The following is an example illustrating the use of the units CVP model. Russell Company sells a product that has a price of $4 per unit, variable manufacturing costs of $2 per unit and selling costs of $.50 per unit. Russell Company has fixed manufacturing costs of $125,000 and fixed general, selling and administrative expenses of $25,000. Assume management has two questions:

1. How many units does Russell Company have to sell to breakeven?
2. How many units does Russell Company have to sell to earn a pre-tax profit of $100,000?

The total variable cost of the company’s product is $2.50 ($2 + $.50). Therefore, the contribution margin per unit is $1.50 ($4 - $2.50). The company’s total fixed cost is $150,000. Breakeven means zero profit, so putting this data in the units CVP equation we have:

\[ x = \frac{150,000}{1.50} = 100,000 \text{ units} \]

The following equation computes the unit sales needed to generate a target profit of $100,000

\[ X = \frac{(100,000 + 150,000)}{1.50} = 166,667 \text{ units} \]

We will follow the convention in these notes that when a target quantity is computed, it will be rounded up, when necessary, to calculate the solution.

A measure that management accountants often find useful as a means of expressing financial risk is the margin of safety measure. The margin of safety is computed as follows:

\[ \text{Margin of safety} = \text{expected units} - \text{breakeven units} \]

Or as the margin of safety percentage:

\[ \text{Margin of safety percentage} = \frac{(\text{expected units} - \text{breakeven units})}{\text{expected units}} \]
Assume in the above example management believes the company will sell 150,000 units, the margin of safety is 150,000 - 100,000 = 50,000 units. The margin of safety percentage is 33% [(150,000 - 100,000) / 150,000]. The margin of safety percentage measure says that sales would have to drop at least 33% from expected levels before losses would occur.

**Developing and Using the Revenue Cost Volume Profit Model**

Often decision makers prefer that the required levels to achieve breakeven or a target profit be stated in revenue terms. We can easily adapt the units CVP model to adopt the revenue perspective.

Return to the units CVP equation. Note that we can convert this equation to a revenue equation by multiplying both sides of the equation by price per unit. We now have:

\[
\text{Revenue} = \text{Px} = \text{P(operating income + fixed costs)}
\]

CM per unit

Dividing the top and the bottom of the right hand side of the equation, we have:

\[
\text{Revenue} = (\text{operating income + fixed costs}) / (\text{CM/unit / P})
\]

Management accountants call the ratio of contribution margin per unit divided by price per unit the contribution margin ratio. The contribution margin ratio reflects the proportion of each sales dollar that goes toward covering fixed costs and providing a profit.

So, we have the following equation, which we will call the revenue CVP equation:

\[
\text{Revenue} = (\text{operating income + fixed costs}) / \text{CM ratio}
\]

Returning to the Russell Company example, we can compute the product’s contribution margin ratio as follows:

\[
\$1.50 / 4 = 37.5%
\]

We can now answer the following questions expressed in revenue terms for the above product:

1. What sales revenue must Russell Company achieve to breakeven?

2. What sales revenue must Russell Company achieve to earn a profit of $100,000?

Question one can be answered with the following calculation:

\[
\$150,000 / .375 = \$400,000
\]

Question two can be answered with the following calculation:

\[
(\$150,000 + 100,000) / .375 = \$666,667
\]
The Cost Volume Profit Chart

Often, management accountants find it useful to express the CVP relationship in a CVP chart. The CVP chart for the product described above would look as follows:

The advantage of the CVP chart is it provides a visual representation of units, revenues, costs and profits, which often help communicate these relationships more effectively.

Taxes and the CVP Equations

Returning to the basic profit equation, we have:

\[
\text{After tax profit} = (\text{revenue} - \text{variable cost} - \text{fixed cost}) \times (1 - \text{tax rate})
\]

or, using the notation, we developed above:

\[
\text{After tax profit} = ((P - V)x - f) \times (1 - \text{tax rate})
\]

rearranging, and recalling that \((p - v)\) is the unit contribution margin, we get the following unit CFP equation adapted for taxes:

\[
x = \left(\frac{\text{after tax profit}}{1 - t}\right) + \frac{\text{fixed costs}}{\text{CM per unit}}
\]

and following the same procedure we used above, we can develop the following sales CVP equation:

\[
\text{Revenue} = \left(\frac{\text{after tax profit}}{1 - t}\right) + \frac{\text{fixed costs}}{\text{CM ratio}}
\]
Returning to Russell Company, assume the company faces a tax rate of 30%, how many units must Russell Company sell to earn a post-tax profit of $100,000?

We have, in units:

\[
\frac{(100,000 / .7) + 150,000}{1.5} = 195,339 \text{ units}
\]
or, in revenue:

\[
\frac{(100,000 / .7) + 150,000}{.375} = 780,953
\]

Exploiting the Profit Equation

The profit equation provides, in effect, a financial model of the organization. Manipulating the profit equation allows management to undertake analyses to predict the effect of proposed decisions, a process called what-if analysis.

Assume, given the data noted above, Russell Company management expects unit sales of 160,000 for the upcoming period. The marketing manager believes that a 5% price decrease and a $25,000 advertising budget will increase sales to 175,000 units. Are these changes desirable?

We use incremental analysis to calculate the incremental income of the proposed change as follows:

<table>
<thead>
<tr>
<th></th>
<th>Before: 160,000 units x $1.50</th>
<th>After: 175,000 x $1.30*</th>
<th>Incremental contribution margin</th>
<th>Advertising costs</th>
<th>Incremental income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total contribution margin</td>
<td>$240,000</td>
<td>227,500</td>
<td>12,500</td>
<td>25,000</td>
<td>($12,500)</td>
</tr>
</tbody>
</table>

* Sales price decrease = decrease in CM/Unit = $4 x 5% = $0.20
  New CM/unit = $1.50 - .20 = $1.30

Modelling Uncertainty

Even with limited computational power, decision makers were able to incorporate probabilistic concepts into CVP analysis. Again, the applications required considerable simplification.

For example, return to the original Russell Company example and assume demand in the forthcoming period is uncertain and has been estimated at between 80,000 and 180,000, with all units on this interval equally likely. In effect, sales have been estimated as following a uniform distribution.
Recall that breakeven sales were computed as 100,000 units. The probability of at least breaking even given this uniform distribution is computed as follows:

\[
\text{Probability} = \frac{\text{upper limit} - \text{breakeven quantity}}{\text{upper limit} - \text{lower limit}} = \frac{180,000 - 100,000}{180,000 - 80,000} = 80\%
\]

As an exercise you should verify that the probability that Russell Company will earn $100,000 or more is 13.3%.

Similar statements could be developed for any other standard distribution whose properties are well known such as the normal distribution.

**Multi-Product**

Most of what we have discussed in this chapter was well known to, and practiced by, both managers and accountants in the early 1900s. In fact, there is evidence to suggest that CVP analysis was originally developed by managers and not accountants. This approach was, therefore, developed at a time when there were no calculators, let alone computers. For this reason assumptions needed to be made to make the analysis tractable. This is why assumptions like constant prices, variable costs and fixed costs were so important.

So, when decision makers decided they wanted to adapt the CVP models described above to multi-product organizations, they needed to make another assumption to make the CVP model work. The assumption made was as total sales levels increased or decreased, each product’s proportion of total sales would remain constant.

An example best illustrates the approach and the insights of multi-product CVP analysis.

Brant Consulting design costing and transfer pricing systems for its clients. The following is a summary of volume, revenue and cost expectations for the upcoming year:

<table>
<thead>
<tr>
<th>Item</th>
<th>Costing Projects</th>
<th>Transfer Pricing Projects</th>
<th>Firm Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number Per Job</td>
<td>50 Total</td>
<td>75 Per Job</td>
</tr>
<tr>
<td>Revenue</td>
<td>$10,000</td>
<td>$500,000</td>
<td>$15,000</td>
</tr>
<tr>
<td>Variable cost</td>
<td>4,500</td>
<td>225,000</td>
<td>11,500</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$5,500</td>
<td>$275,000</td>
<td>$3,500</td>
</tr>
<tr>
<td>Fixed cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>$5,500</td>
<td>$275,000</td>
<td>$3,500</td>
</tr>
</tbody>
</table>

The solution to the problem comprises of combining units in a 'bundle' based on their sales mix. In this case, the sales mix is 50 costing projects (CP) and 75 transfer pricing projects (TPP). At its lowest common denominator, we can say the sales mix is 2:3 (CP:TPP).
We then create a product bundle containing two CP and three TPP and calculate the contribution margin generated by that bundle:

\[(2 \times \$5,500) + (3 \times \$3,500) = 21,500\]

The number of bundles needed to be sold to breakeven are:

\[\frac{\$475,000}{21,500} = 22.1\]

We then break out the bundles into the individual products:

- Costing projects: 22.1 bundles \(\times\) 2 = 45
- Transfer pricing projects: 22.1 bundles \(\times\) 3 = 67

The unit sales Brant Consulting needs to achieve an operating income of $60,000 is:

\[\frac{(\$475,000 + 60,000)}{21,500} = 24.88\]

Breaking out the bundles into the individual products:

- Costing projects: 24.88 bundles \(\times\) 2 = 50
- Transfer pricing projects: 24.88 bundles \(\times\) 3 = 75

**Spreadsheets**

Today, with powerful computers and electronic spreadsheets, business modelling is done on computers. However, the basic modelling insights developed in CVP analysis underlies the financial models implemented on computers.
Problems with Solutions

Multiple Choice Questions

1. Spencer Company expects to sell 60,000 units of Product B next year. Variable production costs are $4 per unit and variable selling costs are 10% of the selling price. Fixed costs are $115,000 per year and the company desires an after-tax profit of $30,000 next year. The company's tax rate is 40%. Based on this information, the unit selling price next year should be:
   a) $7.00  
   b) $10.75  
   c) $7.50  
   d) $6.75  
   e) None of the above

2. Operating income is shown on a cost-volume-profit chart where the:
   a) Total variable cost line exceeds the total fixed cost line  
   b) Total cost line exceeds the total sales revenue line  
   c) Total sales revenue line exceeds the total fixed cost line  
   d) Total sales revenue line exceeds the total cost line  
   e) Total cost line intersects the total sales revenue line

3. The following information relates to a new product an organization plans to introduce:
   Selling price $80 per unit  
   Variable selling cost $5 per unit  
   Direct materials $25 per unit  
   Direct labour $10 per unit  
   Variable overhead $20 per unit  
   Fixed overhead $140,000 per year  
   Fixed selling expense $60,000 per year

   How many units of this product must be sold each year to breakeven?
   a) 2,500  
   b) 10,000  
   c) 7,000  
   d) 8,000  
   e) 4,444
4. Which of the following statements is consistent with the conventional cost-volume-profit model?
   a) All costs can be divided into fixed and variable elements
   b) Costs and sales revenues are linear over a relevant range
   c) Variable costs remain constant on a unit basis
   d) All of the above
   e) b) and c) only

5. Monnex Corp. sells three designs of all-weather vehicle tires: Radial, All Terrain and Super Pro. The following represents the sales and cost information budgeted for 1997:

<table>
<thead>
<tr>
<th></th>
<th>Radial</th>
<th>All Terrain</th>
<th>Super Pro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales price per unit</td>
<td>$50</td>
<td>$100</td>
<td>$200</td>
</tr>
<tr>
<td>Costs per unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>25</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>Direct labour</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Fixed overhead*</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Gross margin per unit</td>
<td>-$5</td>
<td>$20</td>
<td>$100</td>
</tr>
</tbody>
</table>

* Fixed overhead per unit is based on the 1996 sales of 5,000 Radial tires, 20,000 All Terrain tires and 10,000 Super Pro tires.

Fixed administration costs total $150,000 in the 1997 budget. Assuming the 1996 sales mix continues, what is the breakeven volume of Radial tires?
   a) Monnex Corp. cannot breakeven
   b) 6,500 units
   c) 351 units
   d) 7,338 units
   e) 1,049 units
The following information pertains to items 6 – 9:

Tic Toc Ltd. produces two types of clocks: a digital model and an analog model. Budgeted sales for next year are:

<table>
<thead>
<tr>
<th>Sales volume</th>
<th>Digital</th>
<th>Analog</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume</td>
<td>8,000 units</td>
<td>12,000 units</td>
<td>20,000 units</td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$180,000</td>
<td>$140,000</td>
<td>$320,000</td>
</tr>
</tbody>
</table>

Total variable manufacturing costs, which are joint costs, are estimated to amount to $160,000 next year and variable selling costs are estimated to amount to 5% of sales. Budgeted fixed costs for next year are $80,000 for manufacturing overhead and $24,000 for selling and administration. All manufacturing costs are allocated to the two models on the basis of sales revenue. The company’s effective tax rate is 30%.

6. The budgeted contribution margin percentage of sales is:
   a) 45% for both models
   b) 59.4% for the digital model and 26.4% for the analog model
   c) 25% for both models
   d) 50% for both models
   e) 12.5% for both models

7. Assuming the budgeted contribution margin percentage is 40% of sales for both models, the desired total sales required to be raised by Tic Toc Ltd. to earn an after-tax income of $70,000 is:
   a) $354,286
   b) $453,333
   c) $487,500
   d) $510,000
   e) $582,857

8. Assuming the budgeted dollar sales mix is maintained during the year and the contribution margin percentage of sales is 30% for the digital model and 50% for the analog model, how many units of each model must Tic Toc Ltd. sell during the year to make a contribution margin of $164,000?
   a) Digital model – 15,449 units; Analog model – 10,332 units
   b) Digital model – 13,667 units; Analog model – 12,300 units
   c) Digital model – 10,581 units; Analog model – 15,871 units
   d) Digital model – 9,762 units; Analog model – 14,643 units
   e) Digital model – 9,719 units; Analog model – 16,869 units
9. Assume the budgeted dollar sales mix and the budgeted sales volume for each model is maintained for next year. Also, assume the budgeted contribution margin is 40% of sales for both models and total fixed costs amount to $105,000 for next year.

What is the minimum unit price for each model that should be set to earn a 7% after-tax return on sales next year?

a) Digital model – $17.50/unit; Analog model – $17.50/unit
b) Digital model – $18.46/unit; Analog model – $9.57/unit
c) Digital model – $20.51/unit; Analog model – $10.64/unit
d) Digital model – $22.37/unit; Analog model – $11.60/unit
e) Digital model – $24.61/unit; Analog model – $12.76/unit

10. When you undertake long-range cost-volume-profit analysis, step cost functions with multiple steps may be treated as variable costs if:

a) The range over which production volumes vary is wide
b) The range over which production volumes vary is narrow
c) The operating leverage is high
d) The relevant range is fixed
e) None of the above
The following information pertains to Questions 11 – 13:

Joie Inc. produces Product X. Each unit of the product requires two hours of direct labour, two kilograms of Material A and one kilogram of Material B. The company has a production capacity of 30,000 units of Product X per year, but its current production and sales are 25,000 units per year. For the current year, costs and revenues are:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price per unit of Product X</td>
<td>$13.50</td>
</tr>
<tr>
<td>Direct labour cost per hour</td>
<td>$15.00</td>
</tr>
<tr>
<td>Material A cost per kilogram</td>
<td>$.80</td>
</tr>
<tr>
<td>Material B cost per kilogram</td>
<td>$2.40</td>
</tr>
<tr>
<td>Fixed factory overhead</td>
<td>$50,000</td>
</tr>
<tr>
<td>Variable selling and administration costs</td>
<td>$12,500</td>
</tr>
<tr>
<td>All other fixed expenses</td>
<td>$37,500</td>
</tr>
</tbody>
</table>

11. At the current level of production, the contribution margin per unit of Product X is:
   a) $6.50
   b) $4.50
   c) $6.80
   d) $4.00
   e) $6.00

12. At the current level of production, the gross margin per unit of Product X is:
   a) $6.00
   b) $4.50
   c) $4.83
   d) $3.00
   e) $4.00

13. Assume that variable production costs for next year will be $8 per unit of Product X and that all other costs will be the same as for the current year. If the selling price remains at $13.50 per unit, the breakeven volume for next year would be
   a) 17,500.
   b) 10,000.
   c) 18,182.
   d) 15,909.
   e) 10,294.
14. Which of the following statements is true with regard to the profit-volume chart, where profit represents the vertical axis and sales volume represents the horizontal axis?

a) The slope of the profit line is affected by the product’s total fixed costs.
b) The slope of the profit line is not affected by the product’s selling price.
c) The slope of the profit line remains unchanged as the variable cost per unit decreases, assuming the selling price and total fixed costs remain unaffected.
d) The slope of the profit line is the product’s contribution margin per unit.
e) None of the above.
Problem 1

Return to the CVP analysis in the news text box at the beginning of this chapter. Draw the CVP chart for Chrysler using the information provided for car sales between 700,000 and 1,200,000 units per year.

Problem 2

Russell Company manufactures a plastic novelty item. The revenue per unit is $2.50 and the variable manufacturing cost is $0.75 per unit. Variable selling and distribution costs are $0.05 per unit. The fixed manufacturing and selling and administrative costs for this product amount to $250,000 and $90,000, respectively.

Required: (consider each question separately)

a. What is the breakeven quantity in units?

b. What revenue is required to earn a target pre-tax profit of $200,000?

c. If the company tax rate is 30%, what is the required revenue to earn a target post-tax profit of $100,000?

d. At a sales level of $700,000, what is the degree of operating leverage?

e. If management estimates the margin of safety percentage as 20%, what is its expected level of sales in units?

f. Russell Company has signed a contract to deliver 210,000 units of this product at a price of $2.50 per unit. Total incremental fixed costs associated with this contract will be $370,000. Variable selling and distribution costs will be zero. However, variable manufacturing costs can vary between $0.70 and $0.85 per unit with all values on this interval equally likely. What is the probability of at least breaking even on this contract?

Problem 3

Burford Ball Company (BBC) manufactures soccer balls, which sell for $30 apiece and have direct materials cost of $12 each. The BBC production manager is considering acquiring a new computer-controlled sewing machine that sews together the 32 panels comprising the ball. The current cost per ball to sew the panels together is $5.50 and reflects the wage paid to a seamstress operating a manually controlled machine. The computer-controlled machine would reduce the cost to $4 per ball by reducing the required operator time.

The manufacturer of the new machine has offered to rent the machine to BBC for $75,000 per year.

a. What volume of annual production is required to make this machine attractive to BBC?

b. If BBC believes annual sales are uniformly distributed on the interval between 40,000 and 70,000 units, what is the probability that acquiring this machine will increase profits at BBC?
Problem 4

Drombo Quality Safes (DQS) manufactures and sells three models of safes: home, office and banker.

The following is a summary of the three products and DQS' fixed costs:

<table>
<thead>
<tr>
<th></th>
<th>Home</th>
<th>Office</th>
<th>Bank</th>
<th>DQS Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units sold</td>
<td>8,000</td>
<td>4,000</td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>$600</td>
<td>$1,800</td>
<td>$5,400</td>
<td>$900,000</td>
</tr>
<tr>
<td>Variable cost</td>
<td>$2,800,000</td>
<td>$5,000,000</td>
<td>$12,000,000</td>
<td>$19,800,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$250</td>
<td>$2,200</td>
<td>$4,200</td>
<td>$8,400,000</td>
</tr>
</tbody>
</table>

Assume the sales mix remains constant in answering the following problems.

a. What is the breakeven level of sales?

b. What level of unit sales is required to earn a target income that is 20% of sales?

Problem 5

Refer to the data in Problem 4. The marketing manager wants to increase the sales of the bank product. The marketing manager believes a price cut of 10% accompanied by an advertising campaign of $100,000 to support the bank product will increase its sales. What is the minimum unit sales increase of the bank product that would be required to make this proposal financially attractive?

Problem 6

Return to the data in Problem 4. The purchasing agent has announced that steel prices will increase in the current year. The effect will be to increase all variable costs by 12%.

a. If the current sales mix and quantities remain the same, what must DQS charge for each of its products to achieve the $900,000 originally planned?

b. Explain why the required price increase for each product is not 12%
Problem 7

The Scotland Jammers hockey club is considering offering Bud Kelly a hockey contract. As a star player, Kelly expects to be well paid. The general manager at Scotland Jammers believes the team will have to pay Kelly a bonus of $2,000,000 when he signs his contract and an annual salary of $5,000,000 per year. Kelly is demanding a five year contract.

The team plays 35 games a year. On average, the Jammers receive $75 per ticket for home games and sell $20 of food and merchandise to each customer. The variable cost per customer averages approximately $40.

Current ticket sales average about 15,000 per game and signing Kelly is expected to increase average ticket sales to 17,000 per game, which is the arena’s capacity.

Required:

a. What would this contract’s effect be on total five year income ignoring the time value of money?

b. The general manager believes that simply focusing on regular season games understates Kelly’s value to the club. On average, the Jammers play six home playoff games each year, which are all sold out. However, the general manager believes the number will increase to eight playoff games per year. Given this information, what is this contract’s effect on income?

Problem 8

Ayr Manufacturing pays taxes of 20% on all pre-tax income under $200,000. For pre-tax income above $200,000, the tax rate is 32%. If Ayr Manufacturing’s contribution margin ratio is 35% and its fixed costs are $300,000, what level of sales must it achieve to earn a target post-tax income of $300,000?
Problem 9

Excellent Text Book Company produces an accounting text that is used by many universities and colleges. The company sells the book to bookstores at a price of $43.50 each. The costs of manufacturing and marketing the text at the company’s normal volume of 3,000 units per month are:

Unit manufacturing costs:
- Variable materials $5.50
- Variable labour 8.25
- Variable overhead 4.20
- Fixed overhead 6.60
  Total unit manufacturing costs $24.55

Unit marketing cost:
- Variable 2.75
- Fixed 7.70
  Total unit marketing costs 10.45
  Total unit costs $35.00

Required:

a. What is the breakeven volume in units? In sales dollars?
b. Market research indicates that monthly volume could increase to 3,500 units, which is well within production capacity limitations if the price were cut from $43.50 to $38.50 per unit. Would you recommend this action be taken? Support your response by showing your calculations.
Problem 10

The estimates made for Nixon Company, a one-product company, are:

Nixon Company
Projected Income Statement
for the year ended December 31, 1995

Sales revenue (100 units x $100 per unit) $10,000
Manufacturing cost of goods sold:
  Direct materials $1,400
  Direct labour 1,500
  Variable overhead 1,000
  Fixed overhead 500
  4,400
Gross margin 5,600
Selling and administrative expenses:
  Variable 1,100
  Fixed 2,000
  3,100
Operating income $ 2,500

Required:

a. How many units of the product must Nixon sell to breakeven?
b. What would be the operating income if projected units increased by 25%?
c. What would dollar sales be at the breakeven point if fixed overhead increased by $1,700.
Problem 11

Mistry Company manufactures a line of electric garden tools that are sold in general hardware stores. The company's controller, Sylvia Harlow, has just received the sales forecast for the coming year for Mistry's three products: weeders, hedge clippers and leaf blowers. Mistry has experienced considerable variations in sales volumes and variable costs over the past two years and Harlow believes the forecast should be carefully evaluated from a CVP viewpoint. The preliminary budget information for 2008 is:

<table>
<thead>
<tr>
<th>Product</th>
<th>Weeders</th>
<th>Hedge Clippers</th>
<th>Leaf Blowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit sales</td>
<td>50,000</td>
<td>50,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Unit selling price</td>
<td>$28</td>
<td>$36</td>
<td>$48</td>
</tr>
<tr>
<td>Variable manufacturing cost per unit</td>
<td>$13</td>
<td>$12</td>
<td>$25</td>
</tr>
<tr>
<td>Variable selling cost per unit</td>
<td>$5</td>
<td>$4</td>
<td>$6</td>
</tr>
</tbody>
</table>

For 2008, Mistry's fixed factory overhead is budgeted at $2,000,000 and the company's fixed selling and administrative expenses are forecasted to be $600,000. Mistry has an effective tax rate of 40%.

Required:

b. Assuming the sales mix remains as budgeted, determine how many units of each product Mistry Company must sell in order to breakeven in 2008.
c. Determine the total dollar sales Mistry Company must sell in 2008 in order to earn an after-tax net income of $450,000.
d. After preparing the original estimates, Mistry Company determined its variable manufacturing cost of leaf blowers would increase 20% and the variable selling cost of hedge clippers could be expected to increase $1 per unit. However, Mistry has decided not to change the selling price of either product. In addition, Mistry has learned its leaf blower has been perceived as the best value on the market and it can expect to sell three times as many leaf blowers as any other product. Under these circumstances, determine how many units of each product Mistry Company would have to sell in order to breakeven in 2008.
SOLUTIONS

Multiple Choice Questions

1. c  Let X = unit selling price
   \[60,000X - 60,000(4) - 60,000(X)(.1) - 115,000 = 30,000 ÷ .6\]
   \[54,000X = 405,000\]
   \[X = 7.50\]

2. d  A cost-volume-profit chart contains elements (lines, points, axes) that identify variable cost, fixed cost, the breakeven point, total revenue, profit and volume in units. When the total sales revenue line rises above the total cost line, a company will have positive operating income.

3. b  Breakeven = fixed cost / (unit price - variable cost per unit)
   \[= 200,000 / ($80-$60) = 10,000 \text{ units}\]

4. d

5. e  Sales price per unit

<table>
<thead>
<tr>
<th>Sales mix</th>
<th>Radial ($50)</th>
<th>All Terrain ($100)</th>
<th>Super Pro ($200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>25</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>Direct labour</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Contribution margin/unit</td>
<td>0</td>
<td>$25</td>
<td>$105</td>
</tr>
<tr>
<td>Sales mix</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>CM x sales mix</td>
<td>$0</td>
<td>$100</td>
<td>$210</td>
</tr>
</tbody>
</table>

Bundle CM $310

Total fixed overhead = (35,000 x $5) + $150,000 = $325,000

Breakeven bundles = $325,000 ÷ 310 = 1,048.39
Number of radial tires = 1,048 x 1 = 1,049

6. a  Total contribution margin = ($320,000 x .95) - $160,000 = $144,000

The variable costs are allocated to the products based on sales revenue; therefore, both models have a contribution margin percentage of 45%.

7. d  Total sales = [($70,000 / .7) + $80,000 + $24,000] ÷ 40% = $510,000.
8. c Dollar sales mix = $180,000 ÷ $320,000 = .5625 for the digital model and 
   $140,000 ÷ $320,000 = .4375 for the analog model.

   $164,000 CM = (.5625 total sales x .3) + (.4375 total sales x .5)

   Total sales dollars = $423,226

   Digital sales = ($423,226 x .5625) ÷ ($180,000 ÷ 8,000) = 10,581 units.
   Analog sales = ($423,226 x .4375) ÷ ($140,000 ÷ 12,000) = 15,871 units.

9. e Before-tax return on sales = 7% .7 = 10%.
   10% of total sales = 40% of total sales - $105,000.
   Therefore, total sales = $350,000.

   Digital model price = $350,000 x .5625 ÷ 8,000 units = $24.61 per unit.
   Analog model price = $350,000 x .4375 ÷ 12,000 units = $12.76 per unit.

10. a The wider the range of production volumes, the more “steps” of activity and 
    costs are experienced. Therefore, the wider the range in production volumes, 
    the more variable the costs.

11. e Selling price $13.50
    Direct labour ($15 x .2) $3.00
    Material A ($80 x 2) 1.60
    Material B 2.40
    Variable selling and administration costs ($12,500 / 25,000) .50 7.50
    Contribution margin per unit 6.00

12. b Selling price $13.50
    Direct labour ($15 x .2) $3.00
    Material A ($80 x 2) 1.60
    Material B 2.40
    Fixed factory overhead ($50,000 / 25,000) 2.00 9.00
    Gross margin per unit $4.50
13. a  
**Fixed costs** = $50,000 + $37,500 = $87,500  
**Contribution margin** = $13.50 - $8 variable production costs - $.50 variable selling and administration costs = $5 per unit  
**Breakeven volume** = $87,500 ÷ $5 = 17,500 units

Other choices:

b)  $50,000 ÷ $5 = 10,000 (did not include other fixed expenses)

c)  ($50,000 + $12,500 + $37,500) ÷ ($13.50 - $8) = $100,000 ÷ $5.50 = 18,182 (treated variable selling and administration as a fixed cost)

d)  $87,500 ÷ ($13.50 - $8) = $87,500 ÷ $5.50 = 15,909 (omitted variable selling and administration costs)

e)  $87,500 ÷ ($8 + $.50) = $87,500 ÷ $8.50 = 10,294 (used variable costs instead of contribution margin)

14. d  
In a profit-volume chart, profit = (selling price - variable cost per unit) x sales volume - fixed costs. The slope of the profit-volume line represents the unit contribution margin (statement d). The intersection of this line and the horizontal axis is the breakeven sales volume. Changes to the fixed costs do not affect the slope of the line; therefore, statement a) is false. However, a change in selling price or in the variable cost per unit would change the unit contribution margin, so they would definitely affect the slope of the line. Therefore, statements b) and c) are false.
Problem 1

The quote implies the contribution per unit is $10,000 ($1,000,000,000 / 100,000). With that information and knowledge that breakeven is 1,000,000 units, we can estimate fixed costs as:

\[
\text{Profit} = \text{contribution margin} \times \text{units sold} - \text{fixed costs}
\]

\[
0 = 1,000,000 \times 10,000 - \text{fixed costs}
\]

Fixed costs = $10,000,000,000

The CVP chart is
Problem 2

a) CM/unit = $2.50 - .75 - .05 = $1.70  
   Fixed costs = $250,000 + 90,000 = $340,000

   Breakeven quantity = $340,000 / 1.70 = 200,000 units

b) CM ratio = 1.70 / 2.50 = .68  
   Revenue = ($340,000 + 200,000) / .68 = $794,118

c) Pre-tax income = $100,000 / .7 = $142,857  
   Revenue = ($340,000 + 142,857) / .68 = $710,084

d) CM = $700,000 x .68 = $476,000  
   Operating income = $476,000 - 340,000 = $136,000  
   DOL = $476,000 / 136,000 = 3.50

e) Sales level - .20*sales level = 200,000 (the breakeven point)  
   0.8*sales level = 200,000  
   Sales level = 200,000 / .8 = 250,000

f) Lowest margin on contract = (2.5-.85)*210,000 – 370,000 = -$23,500  
   Highest margin on contract = (2.5-.70)*210,000 – 370,000 = $8,000  
   Since all values on this interval will be equally likely

Problem 3

a. Current labour cost = 5.50 * units made  
   New labour cost with machine = 75,000 + 4 * units made  
   Let x equal unit sales and setting the two costs together, we find the breakeven sales  
   5.5x = 75,000 + 4x  
   x = 50,000 units

   If sales are above 50000 units the new machine will reduce costs.

b. The probability of at least breaking even on this rental is computed as follows:

   \[
   \text{Upper limit - breakeven quantity} = \frac{70,000 - 50,000}{70,000 - 40,000} = 66.67\%
   \]
Problem 4

a. Sales mix = 8H : 4O : 3B
   Bundle sales price = (8 x $600) + (4 x $1,800) + (3 x $5,400) = $28,200
   Bundle CM = (8 x $250) + (4 x $550) + (3 x $1,400) = $8,400
   CM ratio = $8,400 / $28,200

   Breakeven sales = $7,500,000 / ($8,400 / 28,200) = $25,178,571

b. Let X = bundles

   8,400X - 7,500,000 = .20(28,200)X
   2,760X = 7,500,000
   X = 2,717.39

   Unbundling, we get:
   Home: 2,717.39 x 8 = 21,740
   Office: 2,717.39 x 4 = 10,870
   Bank: 2,717.39 x 3 = 8,153

Problem 5

Note that the current contribution margin provided by the bank product is $4,200,000. The proposed price would be $4,860 per unit ($5,400 * 90%) and fixed costs would increase by $100,000, the amount of the increased advertising.

The breakeven sales level (x) is given by the following equation:

   4,200,000 = (4,860 – 4,000)x – 100,000

Solve find x = 5,000, which means sales would have to increase by at least 2,000 units (5,000 – 3,000) to justify this proposal.
Problem 6

a. Variable costs will increase by 12% to $22,176,000. Fixed costs remain the same at $7,500,000 as does the target profit at $900,000. The sum of these three items is the total revenue requirement, which is $30,576,000. Since the current revenue is $28,200,000, the required revenue increase will be 8.425319% ((30,576,000 / 28,200,000) - 1). This is the required price increase for each product. The following table summarizes the results.

<table>
<thead>
<tr>
<th>Units sold</th>
<th>8,000</th>
<th>4,000</th>
<th>3,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$651</td>
<td>$5,204,426</td>
<td>$1,952</td>
</tr>
<tr>
<td>Variable cost</td>
<td>392</td>
<td>3,136,000</td>
<td>1,400</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$259</td>
<td>$2,068,426</td>
<td>$552</td>
</tr>
<tr>
<td>Fixed manufacturing</td>
<td>4,500,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed selling and administrative</td>
<td>3,000,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>30,576,000/28,200,000 = 1.08426</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. The reason is the revenue covers not only the variable cost, but also the fixed cost and the target profit. Therefore, an increase in variable cost does not require a proportional increase in revenues since fixed costs and the target profit remain constant.

Problem 7

a. The incremental effect (x) on profit is computed as follows:

\[
x = \text{increase in ticket sales} \times \text{contribution margin per customer} \times \text{number of games per year} \times \text{number of years} - \text{annual salary} \times \text{number of years} - \text{signing bonus}
\]

\[
x = (2,000 \times (75 + 20 - 40) \times 35 \times 5) - (5,000,000 \times 5) = 19,250,000 - 25,000,000 - 2,000,000 = -7,750,000
\]

b. The incremental contribution (y) from additional playoff games is computed as follows:

\[
y = \text{number of additional games} \times \text{capacity} \times \text{contribution margin per customer} \times \text{number of years}
\]

\[
y = 2 \times 17,000 \times 55 \times 5 = 9,350,000
\]

Contract contribution = -7,750,000 + 9,350,000 = $1,600,000
Problem 8

Computing the required pre-tax income (x):
\[ x - (.2 \times 200,000) - (.32 \times (x - 200,000)) = 300,000 \]
Solving to find \( x = \$405,882.35 \)

Letting \( y \) be the required sales revenue
\[ y - .65y - 300,000 = 405,882.35 \]
Solving find \( y = \$2,016,806.72 \)
Problem 9

a. Total fixed costs = (allocated fixed manufacturing costs per unit * (normal volume)) + (allocated fixed marketing costs per unit * (normal volume))
   = ($6.60 x 3,000) + ($7.70 x 3,000)
   = $42,900

   CM/unit = (unit selling price) - (all unit variable costs)
   = $43.50 - ($5.50 + $8.25 + $4.20 + $2.75)
   = $22.80

   Breakeven point in units = total fixed costs / CM per unit
   = $42,900 / $22.80
   = 1,882

   CM ratio = CM / sales = $22.80 / $43.50
   = .52414

   Breakeven point in sales = total fixed costs / CM ratio
   = $42,900 / .52414
   = $81,848

   or, breakeven units x selling price per unit
   = 1,882 x $43.50
   = $81,867 (difference due to rounding of the CM ratio)

b. New CM/unit = $38.50 - $20.70
   = $17.80

   Total contribution margin:
   Before: 3,000 x $22.80 $68,400
   After: 3,500 x $17.80 62,300

   Decrease in TCM
   $ 6,100

   It is not recommended this action be taken as operating income would drop by $6,100.
Problem 10

a. Variable costs per unit = ($1,400 + 1,500 + 1,000 + 1,100) / 100 units
   = $5,000 / 100
   = $50

   CM/unit = $100 - $50 = $50

   Breakeven point in units = ($500 + $2,000) / $50
   = $2,500 / $50
   = 50 units

b. DOL = CM / operating income = $5,000 / 2,500 = 2
   Increase in operating income = 25% x 2 = 50%
   New operating income = $2,500 x 1.5 = $3,750
   or, (125 units x $50) - $2,500 = $3,750
   or, Increase operating income = 25 units x $50 = $1,250
   New operating income = $2,500 + 1,250 = $3,750

c. CM ratio = $50 / $100 = 50%
   Breakeven sales = ($2,500 + 1,700) / .5
   = $4,200 / .5
   = $8,400
Problem 11

a. Weeder CM = $28 - 13 - 5 = $10  
   Hedge clippers CM = $36 - 12 - 4 = $20  
   Leaf blowers CM = $48 - 25 - 6 = $17

   Budgeted net income = [(50,000*10) + (50,000*20) + (100,000*17)  
   - 2,600,000]*0.6  
   = [500,000 + 1,000,000 + 1,700,000 - 2,600,000]*.6  
   = $600,000*.6  
   = $360,000

b. Let a bundle = 1 unit of weeder + 1 unit of hedge clipper + 2 units of leaf blowers  
   (i.e. at their standard mix)

   Then, the bundle contribution margin = $10 + $20 + ($17 x 2) = $64  
   Number of bundles to breakeven = $2,600,000 / $64 = 40,625  
   or, 40,625 weeders, 40,625 hedge clippers and 81,250 leaf blowers

c. Operating income desired = $450,000 / .60 = $750,000  
   Bundle selling price = $28 + $36 + ($48 x 2) = $160  
   Bundle CM ratio = $64 / $160 = 40%  
   Required sales = ($2,600,000 + $750,000) / .40 = $8,375,000

d. New contribution margins:  
   Weeder CM = $28 - 13 - 5 = $10  
   Hedge clippers CM = $36 - 12 - 5 = $19  
   Leaf blowers CM = $48 - 30 - 6 = $12

   New mix: 1:1:3

   Bundle contribution margin = $10 + $19 + ($12 x 3) = $65  
   Number of bundles to breakeven = $2,600,000 / $65 = 40,000  
   or, 40,000 weeders, 40,000 hedge clippers and 120,000 leaf blowers
10. Relevant Costs

Learning Objectives

After completing this chapter, you will:

1. Understand the nature and be able to exploit the decision making insights of the relevant cost concept
2. Recognize the symptoms and understand the causes of the sunk cost phenomenon
3. Recognize the role and importance of both qualitative and quantitative analysis in decision making

Relevant Costs

A relevant cost is a cost or revenue that changes as a result of a decision. The relevant cost idea is that the decision maker need only, and should only, consider the relevant costs associated with a decision. In this regard, the management accountant’s notion of relevant cost is similar to the economist’s notion of incremental cost.

The Sunk Cost Effect

“Beginning in the 1960s, the French and British governments jointly financed the development of a supersonic airplane capable of shuttling passengers between Europe and America at breakneck speeds. But even before the first Concorde was fully assembled, analysts realized the program would be a financial loser. Despite overwhelming evidence they would never recoup their financial outlays, both governments persisted in pouring billions of dollars into the project. And they continued to subsidize the Concorde’s unprofitable operation for nearly three decades until safety issues caused its demise. “

Source: http://allsquareinc.blogspot.com/2009/02/concorde-effect.html

Sunk costs (past costs that have been incurred and are irreversible) are not relevant according to the relevant cost approach. However, to many decision makers, sunk costs as relevant.

The following is an interesting commentary on the sunk cost effect.

The sunk cost effect is a maladaptive economic behaviour that is manifested in a greater tendency to continue an endeavour once an investment in money, effort or time has been made. The Concorde fallacy is another name for the sunk cost effect,
except the former term has been applied strictly to lower animals, whereas the latter has been applied solely to humans. The authors contend there are no unambiguous instances of the Concorde fallacy in lower animals and also present evidence that young children, when placed in an economic situation akin to a sunk cost, exhibit more normatively correct behaviour than do adults.  


Some authors attribute the persistence of the sunk cost effect in decision makers to their desire to avoid loss of prestige in organizations while others believe there may be an evolutionary explanation for the sunk cost effect. While identifying the underlying cause of the sunk cost effect continues to occupy behaviourists, the implication for management accountants is clear, when evaluating decisions management accountants should be vigilant in ensuring sunk costs are not affecting current managerial choices.

Importance of both quantitative and qualitative analysis

The balance of this chapter will focus on decisions where the relevant cost notion has an obvious application. Therefore, we will be considering the financial or quantitative effects of these decisions. Equally important in all organizations are qualitative considerations when making decisions.  For example:

• A manufacturer considering purchasing rather than making an important component may continue to make the component for strategic reasons (such as preserving quality or ensuring timely delivery of the component to a just in time manufacturing facility) even though an outside organization may be able to supply the component at a lower cost.

• An organization considering abandoning a product a sound relevant cost analysis indicates is unprofitable may continue to make the product in order to capture marketing benefits of maintaining a full product line.

• A manufacturer considering a special order a sound relevant cost analysis indicates is financially attractive may reject the order on the grounds that accepting the order may create future expectations about prices the manufacturer would wish to avoid.

Applying the Relevant Cost Idea

The following decisions provide excellent examples of how the relevant cost notion guides effective consideration of the financial attributes of a decision.

1. Whether to make or buy a component

2. Whether to close a department or abandon a product

3. Whether to accept a special order

4. How to allocate a scarce resource – the product mix decision
The Make or Buy Decision

The make or buy decision, also known as the contracting out decision, considers whether an organization should make an intermediate good or service or purchase it from an outside supplier. This is an issue many organizations confront as they focus their efforts on what they feel are the key value added activities they undertake and contract out less essential activities to suppliers.

The following is a good example of the motivation and strategic issues organizations consider when contracting out:

Overall, Canadian cities with privatized garbage service have a per household cost about 20% per less than publicly operated services. When public crews work in the same city as contracted crews, the contractors cost less and serve many more households per worker.

...governments ought not to hand over the keys to the city to any one private contractor, any more than they should to any one union. Replacing a public monopoly with a private monopoly would do little good.


The following example illustrates the role of relevant cost analysis in the make or buy decision.

Cambridge Accounting provides accounting services to its clients. After several significant server failures, the company is considering outsourcing its data processing requirements to Seven Oaks Data Stream.

An analysis of current operations suggests that for every dollar increase in service revenues, variable data processing costs increase by $.10. Fixed costs for the data processing facility are $2,500,000. An analysis of these fixed costs revealed the following distribution:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data processing manager’s salary</td>
<td>$ 100,000</td>
</tr>
<tr>
<td>Data processing staff salaries</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Allocation of building costs to data processing</td>
<td>350,000</td>
</tr>
<tr>
<td>Server depreciation</td>
<td>500,000</td>
</tr>
<tr>
<td>Data centre security costs</td>
<td>50,000</td>
</tr>
</tbody>
</table>

If the data processing centre were closed, the data processing manager would be transferred to another managerial position in the organization. The position is currently open and pays a salary of $90,000. All data processing staff would be transferred to other positions in the organization at their current salary. The existing servers would be sold to yield a net value, after disposal costs, of zero. The data centre security costs would be eliminated if the data processing centre is closed.

Seven Oaks Data Stream has offered to handle all Cambridge Accounting’s data processing requirements at a fee that of $.08 per dollar of Cambridge Accounting’s service revenue plus $250,000 per year.
Required:

a. Assuming Seven Oaks Data Stream will provide a service that equals the current in-house service, under what conditions should the offer be accepted?

The relevant cost analysis is:

If data processing is contracted out, the following costs would be avoided:
- \(0.1 \times \text{service revenues}\)
- \$90,000 in managerial salary
- \$50,000 data centre security costs

If data processing is contracted out, the following costs would be incurred:
- \(0.08 \times \text{service revenues}\)
- \$250,000 fixed fee

The desirability of the contract is determined by the long-term volume of service sales. For the contract to be financially attractive, the costs avoided by contracting out would have to be more than the cost increase from contracting out. That is,

\[0.1 \times \text{service revenues} + \$140,000 > 0.08 \times \text{service revenues} + \$250,000\]

or

\[0.02 \times \text{service revenues} > \$110,000\]

Service revenues > \$5,500,000

Following is a graph showing the cost comparisons:

![Cambridge Accounting Make or Buy](graph.png)

b. The managing partner at Cambridge Accounting believes the quality and reliability of the service provided by Seven Oaks Data Stream surpasses those currently provided in-house.
and would increase revenues by $300,000 per year. Assuming: (1) current capacity could handle this additional business, (2) the current sales level is $4,000,000, and (3) there are no other variable costs other than those associated with data processing, how would this information be factored into your analysis in part a)?

If data processing is contracted out the following costs would be avoided:
- \(0.1 \times 4,000,000 = 400,000\)
- $90,000 in managerial salary
- $50,000 data centre security costs
  Total costs avoided $540,000

If data processing is contracted out the following new costs would be incurred
- \(0.08 \times 4,000,000 = 320,000\)
- $250,000 fixed fee
  Total new costs $570,000

Finally, there is the revenue increase of $300,000, which after the incremental processing costs of .08 per sales dollar, would net $276,000.

Marginal benefits of contracting out = 540,000 – 570,000 + 276,000 = $246,000

**The Keep or Drop Decision**

Organizations are constantly faced with decisions relating to whether to keep or abandon products whose profitability is declining. For example, product line rationalization at General Motors as it edged toward its eventual bankruptcy proceeding, saw the elimination of some longstanding car lines and dramatic cutbacks in productive capacity.

At the General Motors annual meeting in Delaware today, CEO Rick Wagoner will be publicly announcing the latest restructuring round for the beleaguered automaker. In response to plummeting sales of large trucks, GM will close down four more North American Assembly plants by 2010. The plants in Janesville, Wisconsin, Oshawa Ontario, Moraine, Ohio and Toluca, Mexico are already running reduced production schedules and will cease operations entirely as products are discontinued or shifted to other plants. The Janesville plant builds medium trucks and SUVs while Moraine builds the old body on frame Trailblazer, GMC Envoy and Saab 9-7x SUVs. The other plants build full-size pickup trucks. The closures affect 10,000 employees at those plants. Those that aren’t among the 19,000 who are taking buyouts will be offered transfers to other locations to fill spaces vacated by the departing workers. The closures are expected to save GM about $1 billion a year.

Source: http://www.autoblog.com/2008/06/03/breaking-gm-to-close-4-truck-plants-may-sell-or-close-hummer/
These types of decisions involve complex considerations of the interactions among strategic, cost cutting and human resource objectives in organizations. As mentioned earlier, the focus in this chapter is only on the financial dimensions of the relevant cost examples that we consider.

Bob’s Bar and Restaurant (BBR) offers three areas to its customers: bar, restaurant and games. Bob is concerned about the follow segment income statement recently prepared by his accountant:

<table>
<thead>
<tr>
<th></th>
<th>Restaurant</th>
<th>Bar</th>
<th>Games</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$220,000.00</td>
<td>$180,000.00</td>
<td>$40,000.00</td>
<td>$440,000.00</td>
</tr>
<tr>
<td>Variable costs</td>
<td>80,000.00</td>
<td>60,000.00</td>
<td>20,000.00</td>
<td>160,000.00</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$140,000.00</td>
<td>$120,000.00</td>
<td>$20,000.00</td>
<td>$280,000.00</td>
</tr>
<tr>
<td>Fixed cost</td>
<td>120,000.00</td>
<td>70,000.00</td>
<td>45,000.00</td>
<td>235,000.00</td>
</tr>
<tr>
<td>Segment contribution</td>
<td>$20,000.00</td>
<td>$50,000.00</td>
<td>-$25,000.00</td>
<td>$45,000.00</td>
</tr>
</tbody>
</table>

Bob feels these results confirm his intuition the games area should be closed and the restaurant and bar areas expanded.

**Required:**

a. Based on this information would you recommend that Bob close the games area?

Absent any additional information about fixed costs closing the games area would result in a lost contribution margin of $20,000, which would decrease BBR’s profit by $20,000.

b. Assume the fixed costs in the above exhibit are comprised of two components: costs that can be eliminated if each area is closed and ongoing costs that can only be eliminated if BBR is closed. These latter costs are allocated based on floor space occupied. A further analysis by Michael provided the following exhibit. What recommendation would you make now about the games room?

<table>
<thead>
<tr>
<th></th>
<th>Restaurant</th>
<th>Bar</th>
<th>Games</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$220,000.00</td>
<td>$180,000.00</td>
<td>$40,000.00</td>
<td>$440,000.00</td>
</tr>
<tr>
<td>Variable costs</td>
<td>80,000.00</td>
<td>60,000.00</td>
<td>20,000.00</td>
<td>160,000.00</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$140,000.00</td>
<td>$120,000.00</td>
<td>$20,000.00</td>
<td>$280,000.00</td>
</tr>
<tr>
<td>Avoidable Fixed Cost</td>
<td>100,000.00</td>
<td>50,000.00</td>
<td>15,000.00</td>
<td>165,000.00</td>
</tr>
<tr>
<td>Margin</td>
<td>$40,000.00</td>
<td>$70,000.00</td>
<td>$5,000.00</td>
<td>$115,000.00</td>
</tr>
<tr>
<td>Fixed Cost Allocation</td>
<td>20,000.00</td>
<td>20,000.00</td>
<td>30,000.00</td>
<td>70,000.00</td>
</tr>
<tr>
<td>Segment contribution</td>
<td>$20,000.00</td>
<td>$50,000.00</td>
<td>-$25,000.00</td>
<td>$45,000.00</td>
</tr>
</tbody>
</table>

This analysis suggests the lost contribution margin if the bar is closed would decrease to $5,000 because of avoidable fixed costs savings and, therefore, closing the games area would still result in reduced BBR profitability.
c. Assume now if the games area is closed and its space is reallocated to the restaurant and bar, sales in each area would increase by 10%. What recommendation would you now make about the games room?

<table>
<thead>
<tr>
<th>Lost contribution margin – games area</th>
<th>($20,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoidable fixed costs</td>
<td>15,000</td>
</tr>
<tr>
<td>Incremental contribution margin</td>
<td></td>
</tr>
<tr>
<td>Restaurant: $140,000 x 10%</td>
<td>14,000</td>
</tr>
<tr>
<td>Bar: $120,000 x 10%</td>
<td>12,000</td>
</tr>
<tr>
<td>Incremental Effect</td>
<td><strong>$21,000</strong></td>
</tr>
</tbody>
</table>

The Special Order

The special order problem considers the situation where an organization receives a one-time offer to buy a product (good or service). The assumption is that accepting or rejecting this order will have no future consequences other than the incremental cash flows created by the order. For example, accepting a special order to supply a product for $40 that is sold to existing customers for $50 may create problems with existing customers and expectations on the part of the new customer that the special order price of $40 will consider. For this reason, many people believe assumptions underlying the special order analysis are seldom met in practice.

The following is an example illustrating the special order analysis.

Brant Microwave manufactures a line of microwave ovens it sells with its own name and also with various brand names for large retail chains.

There are 40 assembly workers and each is paid an annual salary of $70,000. Each worker works approximately 1,650 hours per year. The resulting labour rate is, therefore, $42.42 ($70,000 / 1,650) per hour. The number of assembly workers, which is the constraining factor of production, cannot be increased.

Brant Microwave is currently operating at 90% of capacity (capacity is determined by available labour hours) and is actively considering an offer from Steve’s Discount Warehouse. Steve has offered to buy 10,000 microwaves and Brant Microwave has developed the following cost report for this microwave:

<table>
<thead>
<tr>
<th>Price per unit</th>
<th>$80.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>$50.00</td>
</tr>
<tr>
<td>Labour (.5 hours @ $42.42)</td>
<td>21.21</td>
</tr>
<tr>
<td>Fixed manufacturing overhead</td>
<td>15.00</td>
</tr>
<tr>
<td>Profit per unit</td>
<td>-$6.21</td>
</tr>
</tbody>
</table>

There are two components of the fixed manufacturing overhead assigned to this product. There is the regular fixed manufacturing overhead that is applied to all production at the rate of $20 per labour hour and a cost to develop a mould that will be used to make the plastic cabinet for the
product. The mould cost would be $25,000, so $2.50 cost is assigned to each of the 10,000 units in the offer. The mould would be worthless when this order is completed.

By comparison, the sales manager has indicated the following is the data for what is currently considered to be the least profitable product Brant Microwave makes, the current volume of this latter product being 15,000 units per year:

<table>
<thead>
<tr>
<th>Price per unit</th>
<th>$90.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>$70.00</td>
</tr>
<tr>
<td>Labour (.25 hours @ $42.42)</td>
<td>10.61</td>
</tr>
<tr>
<td>Fixed manufacturing overhead</td>
<td>5.00</td>
</tr>
</tbody>
</table>

The sales manager is eager to accept Steve’s offer in order to use the idle capacity but feels the price offer from Steve is far too low to justify accepting it. The sales manager has said this offer is unacceptable since it is less profitable than what is currently viewed as the least profitable product in the Brant Microwave line-up.

Required:

a. Should this offer be accepted or rejected? Explain.

The number of current worker hours available for this order is 6,600 (10% * 40 * 1,650). This order will require 5,000 (10,000 * .5) labour hours, so Brant Microwave has the capacity available to undertake the order.

Note that labour costs and manufacturing overhead costs are fixed so they are irrelevant in considering the relevant costs of this order. The incremental effect of accepting this order would be:

<table>
<thead>
<tr>
<th>Revenue</th>
<th>(10,000 * $80)</th>
<th>$800,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials cost</td>
<td>(10,000 * $50)</td>
<td>500,000</td>
</tr>
<tr>
<td>Mould cost</td>
<td>25,000</td>
<td></td>
</tr>
<tr>
<td>Incremental cash flow from order</td>
<td>$275,000</td>
<td></td>
</tr>
</tbody>
</table>

Assuming no other effects relating to this order, it should be accepted since it increases Brant Microwave contribution margin by $275,000. The profitability of current products is not relevant since there is excess capacity and there is no use for the currently idle capacity.

b. Assume the order from Steve is for 20,000 units and, if the order is accepted, all 20,000 units must be produced. What is the minimum price per unit for Steve’s order that would be acceptable to Brant Microwave?

Steve’s order will now require 10,000 (20,000 units * .5 hours per unit) labour hours to complete. As noted in part a) the current idle capacity is 6,600 so 3,400 (10,000 – 6,600)
labour hours will have to be displaced from what is deemed to be the least profitable product noted above.

The contribution margin per unit for the existing product is $20 (90 - 70) and each unit of the existing product requires .25 labour hours. Therefore, the opportunity cost (see Chapter 2 to refresh your knowledge of opportunity cost) of labour is $80 (20 / .25). The following is the cost summary for Steve’s order:

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>Quantity</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity cost</td>
<td>3,400 hours</td>
<td>$80</td>
<td>$272,000</td>
</tr>
<tr>
<td>Materials cost</td>
<td>20,000 units</td>
<td>$50</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Mould cost</td>
<td></td>
<td></td>
<td>25,000</td>
</tr>
<tr>
<td>Incremental order relevant cost</td>
<td></td>
<td></td>
<td>$1,297,000</td>
</tr>
</tbody>
</table>

Therefore, the minimum acceptable price per microwave would be $64.85 (1,297,000 / 20,000)

Relevant Costs and Resource Allocation:

Increased pressures on all organizations (private sector, public sector and not-for-profit) to use resources more effectively have, in turn, increased interest in tools and approaches to evaluate and guide resource allocation decisions. Relevant cost contributes insight into effective resource allocation by focusing on the idea that we should evaluate and compare the incremental benefits of allocating a scarce resource to its alternative uses and making the allocation that provides the highest incremental benefit. The discussion of relevant cost in this context, which is also called the product mix decision, bridges our discussion of opportunity cost in Chapter 2 with our discussion of linear programming we will take up in Chapter 11.

Consider Wellesley Corporation manufactures novelty products used primarily in the advertising industry. Wellesley has three main products, basic, custom and deluxe, with the following characteristics:

<table>
<thead>
<tr>
<th>Product</th>
<th>Basic</th>
<th>Custom</th>
<th>Deluxe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$35.00</td>
<td>$40.00</td>
<td>$65.00</td>
</tr>
<tr>
<td>Materials</td>
<td>12.00</td>
<td>19.50</td>
<td>39.00</td>
</tr>
<tr>
<td>Labour</td>
<td>7.00</td>
<td>9.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Manufacturing overhead</td>
<td>12.00</td>
<td>8.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Profit per unit</td>
<td>$4.00</td>
<td>$3.50</td>
<td>$1.00</td>
</tr>
</tbody>
</table>

Joanna Rose, the general manager at Wellesley Corporation, has been asked by the Board of Directors to present a business forecast for the upcoming year. Joanna has convened a meeting of the production and marketing managers and the chief financial officer. The marketing manager has urged that Wellesley focus primarily on the deluxe product on the grounds it conveys the image that Wellesley Corporation is a high class operation. (Joanna suspects that the real reason is the marketing manager gets a bonus based on revenues and the revenue for this product is the highest.) The chief financial officer argues the company should focus on basic product since it has the highest profit per unit. The production supervisor argues that the company should focus
on the custom product since it creates the least number of issues in the plant relating to labour and materials handling.

A brief investigation by Joanna reveals that while all materials and labour costs are variable, all manufacturing overhead is fixed. Manufacturing overhead is allocated to the three products at a rate of $100 per hour of machine time the product consumes. The company is under contract to produce various amounts of the three products. However, there is 1,000 uncommitted hours of machine time that can be allocated to new production opportunities.

Required:

a. If Wellesley Corporation can sell any additional product it can produce, what is the best use of the 1,000 machine hours?

The relevant cost approach to the resource allocation problem begins by computing the relevant cash flows associated with each alternative use of the scarce resource. The relevant cash flows can be expressed as the contribution margin for each product.

<table>
<thead>
<tr>
<th>Product</th>
<th>Basic</th>
<th>Custom</th>
<th>Deluxe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$35.00</td>
<td>$40.00</td>
<td>$65.00</td>
</tr>
<tr>
<td>Materials</td>
<td>12.00</td>
<td>19.50</td>
<td>39.00</td>
</tr>
<tr>
<td>Labour</td>
<td>7.00</td>
<td>9.00</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Recall that the limiting factor of production is machine time. Therefore, the objective is to use this limiting factor of production in the most profitable way.

The first step in this process is to identify the amount of machine time each unit of each product requires. We know the machine time allocation rate is $100. Therefore, we can divide the manufacturing overhead allocations in the exhibit above that displays product profit by the machine hour overhead rate to identify the number of machine hours each product consumes.

Machine hours used by:

Basic = $12 / $100 = .12 hours

Custom = $8 / $100 = .08 hours

Deluxe = $5 / $100 = .05 hours

With this information, we can complete the following table to identify each product’s contribution margin per hour of machine time.
We now know the best use of the machine hours is to produce the custom product since it provides the highest contribution per machine hour.

Therefore, the best solution is to use all 1,000 available machine hours to produce 12,500 (1,000 / .08) units of the custom product.

Returning to the discussion of opportunity cost in Chapter 2, we can add the following line to the above exhibit:

Recall the opportunity cost of any course of action is the value of the next best use of a constraining resource. If a machine hour is used to produce either basic or deluxe products, the opportunity cost is $143.75, which is the value of the machine hour if it is used to produce the custom product. The best use of a limiting factor of production is to allocate it to the product that has the lowest opportunity cost. We will exploit this idea in Chapter 11 when we consider linear programming.

b. If the production manager indicates the maximum additional amount of any product that can be sold is 6,000 units, what is the best use of the 1,000 machine hours?

From part a), we know we should begin by producing 6,000 units of the custom product with the currently idle capacity. That would consume 480 machine hours (6,000 * .08) leaving 520 (1,000 - 480) available machine hours. Returning to the table we produced in part a), we find that, given the contribution margin per machine hour, the next best use of the machine time is to produce the basic product. With the remaining 520 machine hours, we can produce 4,333 (520 / .12) units of the basic product, which is less than the maximum additional amount the marketing manager says can be sold.
Conclusion:

The relevant cost idea gives us a powerful way to think about organizing for effective decision making. The idea is simple in theory – identify all the future incremental cash flows that result from following a course of action. However, the idea is often difficult to implement in practice since we must identify all future consequences. You should ensure you have a good grasp of the relevant cost idea since you will use the concept many times not only in the Strategic Leadership Program, but also in your decision making career.
Problems with Solutions

Multiple Choice Questions

1. West Coast Laser (WCL) has a production capacity limit of 4,000 laser machine hours and 1,000 image machine hours. The direct costs per hour to operate the machines are $15 and $20, respectively. Both machines are operating at 90% of capacity and all current production is sold at $1,500 per unit.

   Each unit of output requires $250 of direct materials, four laser machine hours and one image machine hour to produce. Indirect variable overhead costs are $200 per unit and indirect fixed overhead costs are $225 per unit based on full capacity. A prospective customer, Company L, has offered to buy 240 units at $1,350 per unit. If the offer is accepted, all 240 units must be delivered by the end of the year. WCL can lease machinery to accommodate the new customer’s order at a cost of $70,000. By what amount would WCL’s income change if Company L’s offer is accepted and the machine is leased?

   a) $254,000 increase
   b) $72,800 increase
   c) $106,000 decrease
   d) $90,800 increase
   e) $126,800 increase
2. The budgeted income for RST Ltd. for next year is:

Sales – 100,000 units @ $20  $2,000,000
Variable manufacturing costs  $800,000
Fixed manufacturing costs  300,000
Sales commissions – $1.50 per unit  150,000
Fixed selling and administration expenses  350,000  1,600,000

Operating income  $ 400,000

Assume a regular customer has requested RST Ltd. to provide a quote for a special order of 8,000 units. RST Ltd. has sufficient capacity to fill the order and would be required to pay only $6,000 in sales commissions. If RST Ltd. would like the special order to make a contribution to operating income of $28,000, the sales price per unit that should be quoted to the customer for the special order is:

a) $12.25  
b) $20.00  
c) $15.75  
d) $15.25  
e) $19.25
Questions 3 – 5 refer to the following:

The Melville Company produces a single product called a Pong. Melville has the capacity to produce 60,000 Pongs each year. If Melville produces at capacity, the per unit costs to produce and sell one Pong are:

- Direct materials: $15
- Direct labour: 12
- Variable factory overhead: 8
- Fixed factory overhead: 9
- Variable selling expense: 8
- Fixed selling expense: 3

The regular selling price for one Pong is $80. A special order has been received by Melville from Mowen Company to purchase 6,000 Pongs during the current year. If this special order is accepted, the variable selling expense will be reduced by 75%. However, Melville will have to purchase a specialized machine to engrave the Mowen name on each Pong in the special order. This machine will cost $9,000 and will have no use after the special order is filled.

3. Assume Melville can sell 54,000 units of Pong to regular customers during the current year. At what selling price for the 6,000 special order units would Melville be economically indifferent between accepting or rejecting the special order from Mowen?
   a) $51.50
   b) $49.00
   c) $37.00
   d) $38.50

4. Assume Melville can sell only 50,000 units of Pong to regular customers during the current year. If Mowen Company offers to buy the special order units at $65 per unit, the effect of accepting the special order on Melville's operating income will be:
   a) $60,000 increase
   b) $90,000 decrease
   c) $159,000 increase
   d) $36,000 increase
5. Assume Melville can sell 58,000 units of Pong to regular customers during the current year. If Mowen Company offers to buy the special order units at $70 per unit, the effect of accepting the special order on Melville's net income for the current year will be:
   a) $66,000 increase
   b) $41,000 increase
   c) $198,000 increase
   d) $50,000 increase

Questions 6 – 7 refer to the following:

Meacham Company has traditionally made a subcomponent of its major product. Annual production of 20,000 subcomponents resulted in the following per unit costs:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$10.00</td>
</tr>
<tr>
<td>Direct labour</td>
<td>9.00</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>7.50</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$31.50</strong></td>
</tr>
</tbody>
</table>

Meacham has received an offer from an outside supplier who is willing to provide 20,000 units of this subcomponent each year at a price of $28 per subcomponent. Meacham knows the facilities could be rented to another company for $75,000 per year if the subcomponent were purchased from the outside supplier

6. If Meacham decides to purchase the subcomponent from the outside supplier, how much higher or lower will net income be than if Meacham continued to make the subcomponent?
   a) $45,000 higher
   b) $70,000 higher
   c) $30,000 lower
   d) $70,000 lower

7. At what price per unit charged by the outside supplier would Meacham be economically indifferent between making the subcomponent or buying it from the outside?
   a) $30.25
   b) $29.25
   c) $26.50
   d) $31.50
8. Dunford Company produces three products with the following costs and selling prices:

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price per unit</td>
<td>$40</td>
<td>$30</td>
<td>$35</td>
</tr>
<tr>
<td>Variable cost per unit</td>
<td>24</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Machine hours per unit</td>
<td>5</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

If Dunford has a limit of 30,000 machine hours but no limit on units produced, then the three products should be produced in the order:

a) Y, Z, X
b) X, Y, Z
c) X, Z, Y
d) Z, X, Y
Problem 1

Drumbo Engineering manufactures small engines. The engines are sold to manufacturers who install them in products like lawn mowers. The company currently manufactures all the parts used in these engines but is considering a proposal from an external supplier who has offered to supply a starter assembly used in these engines.

The starter assembly is currently manufactured in Division 3 of Drumbo Engineering. The costs relating to Division 3 for the past 12 months were:

| Direct materials | $175,000 |
| Direct labour    | 125,000  |
| Manufacturing overhead | 350,000 |
| **Total**        | $650,000 |

Over the past year, Division 3 manufactured 165,000 starter assemblies. Therefore, the average cost of a starter assembly is computed as $4 ($650,000 / 162,500).

Further analysis of manufacturing overhead revealed the following information. Of the total manufacturing overhead reported, 20% is variable. Of the fixed portion, $140,000 is an allocation of general factory overhead that would remain unchanged for the company as a whole if production of the starter assembly is discontinued. A further $60,000 of the manufacturing overhead is avoidable if the self-manufacture of the starter assembly division is discontinued. The balance of the fixed overhead, $80,000 is the division manager’s salary. If the self-manufacture of the starter assembly division is discontinued, the manager of Division 3 would be transferred to Division 2 at the same salary. The move would allow the company to save the $65,000 that would otherwise be paid to attract an outsider to this position.

Required:

a. Simcoe Electronics, a reliable supplier, has offered to supply starter assembly units at $3.50 per unit. Since this is less than the current average cost of $4 per unit, the vice president of manufacturing is eager to accept this offer. Should the outside offer be accepted? (Hint: Production output in the coming year may be different from production output last year.)

b. How, if at all, would your respond to part a) change if the company could use the vacated plant space for storage and, in so doing, avoid $40,000 of outside storage charges currently incurred? Why is this information relevant or irrelevant?
Problem 2

The general manager of Princeton Manufacturing, a manufacturer of washing machines, is considering a special order for 20,000 machines. The machine would be similar to an existing product currently being made for a long-term customer. The cost card for the existing machine shows the following information:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$225</td>
</tr>
<tr>
<td>Direct labour</td>
<td>95</td>
</tr>
<tr>
<td>Manufacturing overhead</td>
<td>120</td>
</tr>
<tr>
<td>Total manufacturing costs</td>
<td>$440</td>
</tr>
<tr>
<td>Selling and administration costs</td>
<td>75</td>
</tr>
<tr>
<td>Total product cost</td>
<td>$515</td>
</tr>
</tbody>
</table>

A costing study has established that approximately half the manufacturing overhead assigned to the average machine is variable and approximately 20% of the selling and administration costs assigned to the average machine is variable.

Required:

a. Absent any other issues, what is the minimum price Princeton Manufacturing should accept for this order?

b. Assume the average machine, whose cost card appears above, sells for $1,100. Princeton Manufacturing has available capacity to produce 60% of the special order, but would have to sacrifice the sale of 800 regular machines to complete this order. How, if at all, would the minimum price Princeton Manufacturing should accept for this order change and why.

Problem 3

Continue the analysis from part c) in the BRR restaurant example in this chapter by assuming Bob has decided to close the games area and assign half the area the games room now occupies to each of the bar and restaurant. Pat, a prodigious drinker and games enthusiast and, therefore, one of Bob’s best patrons, approached Bob with the following comment. “I hear you are considering closing the games area. Our group has been talking it over and we want to tell you if the games area is closed, we will be moving our business elsewhere.” Bob asked Michael to follow up on the possibility of lost customers resulting from closing the games room. Michael reported back the following information. For every dollar decrease in games room revenues, bar revenues will drop by $.30 and restaurant revenues will drop by $.10. Should Bob close the games room area?
Problem 4

Plevna Manufacturing makes and distributes small prefabricated homes in kits. The kits contain all the pieces needed to assemble the home and all that is required is the builder erects the home on a foundation.

The variable cost to make each kit is $30,000 and the selling price per kit is $40,000, with variable selling and distribution costs averaging about $5,000 per home kit.

Currently, the company is operating at capacity, which is dictated by the machinery in the manufacturing division. Each kit requires about 10 hours of machine time and the total available machine time is 5,000 hours per year. Plevna Manufacturing is currently making and selling 500 kits a year. Increasing the plant capacity in the foreseeable future is not a viable option.

Willie Scott is the company’s salesperson. Willie has recently been approached a number of times by people wanting to buy cottages to erect on recreational properties. The cottages would be made by modifying the existing home product. The modification process would begin with a completed home kit. The manufacturing division would then incur additional materials and labour costs of $3,000 and three hours of machine time to convert a home kit into a cottage kit. The variable selling and administrative costs associated with each cottage kit are estimated as $4,000 in addition to the $5,000 cost of the regular kit.

Required:

Given this information, what is the minimum price Plevna should charge for the cottage kit?
Problem 5

Friendly Hearth Company (FHC) manufactures inserts for home fireplaces. Last year, FHC completed an order of 1,000 fireplace inserts for Warm Your Heart Company, which operated a chain of fireplace supply stores. Warm Your Heart Company paid 20% of the order price but subsequently declared bankruptcy and never took delivery of products. FHC citing the contract stipulations, refused to refund the deposit to the trustee in bankruptcy handling the Warm Your Heart wrap-up.

The financials associated with the Warm Your Heart order were:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order price</td>
<td>$450,000</td>
</tr>
<tr>
<td>Direct materials</td>
<td>$125,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>65,000</td>
</tr>
<tr>
<td>Manufacturing overhead</td>
<td>100,000</td>
</tr>
<tr>
<td>Selling and administrative</td>
<td>50,000</td>
</tr>
<tr>
<td>Order projected profit</td>
<td>$110,000</td>
</tr>
</tbody>
</table>

The price for this order was determined by applying the mark-up over variable costs FHC always uses to set order prices. An analysis of costs concluded that all selling and administrative costs are fixed and approximately 20% of manufacturing overhead is variable. The completed inserts are now languishing in a rented warehouse space that is costing FHC $5,000 per month.

Advertisements on the FHC website have generated three offers for this inventory.

Down Home Company has offered “to take the lot off your hands for $300,000”. The FHC CFO has adamantly opposed this since it will cause a loss to be reported for this project.

Northern Comforts has asked for enhancements to the existing inventory that would result in $10,000 in materials costs and $25,000 in labour costs and would require 200 labour hours of work. Because of labour constraints, accepting this offer and using the required labour hours would require FHC to sacrifice other production that would provide revenues of $25,000.

A company that is negotiating to acquire the assets of Warm Your Heart has indicated that it will acquire the production at the agreed price of the original order, less the original deposit if FHC would be willing to hold the inventory for another eight months. FHC believes there is no risk this company would default on this offer if accepted.

Given this information, what is the minimum price Northern Comforts must offer to make its bid the best for FHC?
Problem 6

Jacques’ empire (see Chapters 5 and 8) is expanding and he has acquired a small grocery store with a Liquor Control Board of Ontario (LCBO) license. The store has a shelf space of 100,000 units.

As an astute businessman, Jacques realizes that shelf space in the grocery store is a constraining factor of production in his new grocery business and has decided he needs to maximize the contribution provided by each metre of shelf space in his store.

Jacques wants to expand the LCBO licensee area, but faces restrictions. The LCBO restricts the space devoted to the sale of liquor to be 10% or less of the store’s shelf space.

Jacques has divided the store operations into five groups: produce, meat, groceries, diary and liquor. Like the LCBO, there are guidelines set down by the chain, of which Jacques is a franchisee, relating to the shelf space that can be devoted to each area. The following is a segment income statement reflecting current operations and the minimum shelf space occupancy required by the chain and the maximum shelf space dictated by the LCBO for liquor operations:

<table>
<thead>
<tr>
<th></th>
<th>Grocery</th>
<th>Dairy</th>
<th>Meat</th>
<th>Produce</th>
<th>Liquor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$150,000</td>
<td>$45,000</td>
<td>$100,000</td>
<td>$75,000</td>
<td>$110,000</td>
<td>$480,000</td>
</tr>
<tr>
<td>Cost of Merchandise Sold</td>
<td>$110,000</td>
<td>$30,000</td>
<td>$70,000</td>
<td>$55,000</td>
<td>$90,000</td>
<td>$355,000</td>
</tr>
<tr>
<td>Gross Margin</td>
<td>$40,000</td>
<td>$15,000</td>
<td>$30,000</td>
<td>$20,000</td>
<td>$20,000</td>
<td>$125,000</td>
</tr>
<tr>
<td>Selling and Administrative Expenses</td>
<td>$40,000</td>
<td>$15,000</td>
<td>$15,000</td>
<td>$25,000</td>
<td>$5,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>Area Contribution</td>
<td>$0</td>
<td>$0</td>
<td>$15,000</td>
<td>-$5,000</td>
<td>$15,000</td>
<td>$25,000</td>
</tr>
<tr>
<td>Shelf Space Restriction</td>
<td>30%</td>
<td>15%</td>
<td>10%</td>
<td>15%</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

Jacques has determined the cost of merchandise sold is variable and all selling and administrative expenses are fixed and allocated to each area based on floor space occupied.

Required:

Jacques wants to develop a shelf plan that maximizes his profit potential. Since his choices are apparently and, therefore, easily audited by the LCBO and the grocery chain management, Jacques has decided for once to stick to the rules when running a business. Assume sales and variable costs will change in proportion to the shelf space occupied and fixed cost will not change.
Problem 7
Ronson Electric produces three products, X, Y and Z. Cost and revenue characteristics of the three products are: (per unit)

<table>
<thead>
<tr>
<th></th>
<th>Product X</th>
<th>Product Y</th>
<th>Product Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$40</td>
<td>$40</td>
<td>$36</td>
</tr>
<tr>
<td>Less: variable expenses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>15</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Labour and overhead</td>
<td>7</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$18</td>
<td>$12</td>
<td>$9</td>
</tr>
<tr>
<td>Contribution margin ratio</td>
<td>45%</td>
<td>30%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Demand for the company’s products is strong, with far more orders on hand each month than the company has raw material available to produce. The same kind of raw material is used in each product. The raw material costs $2.50 per kilogram, with a maximum of 5,000 kilograms available each month. Which orders would you advise the company to accept first, those for product X, Y or Z? Which orders second? Third? Explain, and show your computations.

Problem 8
Kimco Inc. produces a single product. The cost of producing and selling a single unit of this product at the company’s normal activity level of 8,000 units per month is:

- Direct materials $2.50
- Direct labour 3.00
- Variable overhead .50
- Fixed overhead 4.25
- Variable selling and administrative expense 1.50
- Fixed selling and administrative expense 2.00

The normal selling price is $15 per unit. The company’s capacity is 10,000 units per month. An order has been received from an overseas source for 2,000 units at a price of $12 per unit. This order would not disturb regular sales.

Required:

1. If the order were accepted, by how much would monthly profits be increased or decreased? (The order would not change the company’s total fixed costs.)
2. Assume the company has 500 units of this product, which are inferior to the current model, left over from last year. The units must be sold through regular channels at reduced prices. What unit cost figure is relevant for establishing a minimum selling price for these units? Explain.
Problem 9

The following forecasted variable costing income statement was prepared for Martin Company:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$100,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td>45,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$55,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>25,000</td>
</tr>
<tr>
<td>Net income</td>
<td>$30,000</td>
</tr>
</tbody>
</table>

The president of Martin knows there is uncertainty associated with all of these estimates. Currently, the pro forma statement represents the most likely outcome. The president, however, wants to conduct a sensitivity analysis to examine the worst case and best cases scenarios as well. After consultation with his managers, the following additional information was determined:

- The worst case and best case scenarios for sales represent a +/- change of 25% of the most likely levels.
- The worst case and best case scenarios for fixed costs represent a +/- change of 20% of the most likely levels.
- Variable costs are always proportional to sales. The worst case for the behaviour of variable costs is they climb to 60% of sales. The best case scenario for variable costs is they fall to 40% of sales.

Required:

Calculate the operating income for Martin Company using all variables at their worst case levels. Repeat this process and calculate the net income with all variables assuming their best case levels. How likely do you think these ends points are?
Problem 10

When you completed your audit of the Surtel Company, management asked for your assistance in deciding whether to continue manufacturing a part or to buy it from an outside supplier. The part, which is named Faktron, is a component used in some of the finished products of the company. From your audit working papers and from further investigation, you develop the following data as being typical of the company's operations:

• The annual requirement for Faktrons is 5,000 units. The lowest quotation from a supplier was $8 per unit.

• Faktrons have been manufactured in the precision machinery department. If Faktrons are purchased from an outside supplier, certain machinery will be sold and would realize its net book value.

• Following are the total costs of the precision machinery department during the year under audit when 5,000 Faktrons were made:

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$67,500</td>
</tr>
<tr>
<td>Direct labour</td>
<td>50,000</td>
</tr>
<tr>
<td>Indirect labour</td>
<td>20,000</td>
</tr>
<tr>
<td>Light and heat</td>
<td>5,500</td>
</tr>
<tr>
<td>Power</td>
<td>3,000</td>
</tr>
<tr>
<td>Depreciation</td>
<td>10,000</td>
</tr>
<tr>
<td>Property taxes and insurance</td>
<td>8,000</td>
</tr>
<tr>
<td>Payroll taxes and other benefits</td>
<td>9,800</td>
</tr>
<tr>
<td>Other</td>
<td>5,000</td>
</tr>
</tbody>
</table>

• The following precision machinery department costs apply to the manufacture of Faktrons: direct materials, $17,500; direct labour, $28,000; indirect labour, $6,000; power, $300; other $500. The sale of the equipment used for Faktrons would reduce the following costs by the amounts indicated: depreciation, $2,000; property taxes and insurance, $1,000.

• The following additional precision machinery department costs would be incurred if Faktrons were purchased from an outside supplier: freight $.50 per unit; and, indirect labour for receiving, materials handling, and inspection $5,000. The cost of the purchased Faktrons would be considered a precision machinery department cost.

Required:

a. Prepare a schedule comparing the total costs of the precision machinery department (1) when Faktrons are made, and (2) when Faktrons are bought from an outsider supplier.

b. Discuss the considerations, in addition to the cost factors, you would bring to the attention of managers in assisting them in deciding whether to make or buy Faktrons. Include in your discussion considerations that might be applied to the evaluation of the outside supplier.
Problem 11

Tsui Company needs a total of 125 tons of sheet steel, 50 tons of 2-inch width and 75 tons of 4-inch width, for a customer's job. Tsui can purchase the sheet steel in these widths directly from Jensteel Corporation, a steel manufacturer or it can purchase sheet steel from Jensteel that is 24 inches wide and have it slit into the desired widths by Precut, Inc. Both vendors are local and have previously supplied materials to Tsui.

Precut specializes in slitting sheet steel provided by a customer into any desired width. When negotiating a contract, Precut tells its customers there is a scrap loss in the slitting operation, but this loss has never exceeded 2.5% of input tons. Precut recommends that if a customer has a specific tonnage requirement, it should supply an adequate amount of steel to yield the desired quantity. Precut's charges for steel slitting are based on good output, not input handled.

The 24-inch wide sheet steel is a regular stock item of Jensteel and can be shipped to Precut within five days after receipt of Tsui's purchase order. If Jensteel is to do the slitting, shipment to Tsui would be scheduled for 15 days after receipt of Tsui's purchase order. Precut has quoted delivery of 10 days after receipt of the sheet steel. In prior dealings, Tsui has found both Jensteel and Precut to be reliable vendors with high quality products.

Tsui has received the following price quotations from Jensteel and Precut:

### Jensteel Corporation Rates

<table>
<thead>
<tr>
<th>Size</th>
<th>Gauge</th>
<th>Quantity</th>
<th>Cost Per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inch</td>
<td>14</td>
<td>50 tons</td>
<td>$210</td>
</tr>
<tr>
<td>4-inch</td>
<td>14</td>
<td>75 tons</td>
<td>200</td>
</tr>
<tr>
<td>24-inch</td>
<td>14</td>
<td>125 tons</td>
<td>180</td>
</tr>
</tbody>
</table>

### Precut, Inc., Steel Slitting Rates

<table>
<thead>
<tr>
<th>Size</th>
<th>Gauge</th>
<th>Quantity</th>
<th>Price Per Ton of Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inch</td>
<td>14</td>
<td>50 tons</td>
<td>$18</td>
</tr>
<tr>
<td>4-inch</td>
<td>14</td>
<td>75 tons</td>
<td>15</td>
</tr>
</tbody>
</table>

### Freight And Handling Charges

<table>
<thead>
<tr>
<th>Destination</th>
<th>Cost Per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jensteel to Tsui</td>
<td>$10.00</td>
</tr>
<tr>
<td>Jensteel to Precut</td>
<td>5.00</td>
</tr>
<tr>
<td>Precut to Tsui</td>
<td>7.50</td>
</tr>
</tbody>
</table>

In addition, Precut has informed Tsui that if it purchases 100 output tons of each width, the per ton slitting rates would be reduced 12%. Tsui knows the same customer will be placing a new order in the near future for the same material and estimates it would have to store the additional
tonnage for an average of two months at a carrying cost of $1.50 per month for each ton. There would be no change in Jensteel's prices for additional tons delivered to Precut.

Required:

1. Prepare an analysis that will show whether Tsui Company should:
   a. Purchase the required slit steel directly from Jensteel Corporation.
   b. Purchase the 24-inch wide sheet steel from Jensteel and have it slit by Precut into 50 output tons two inches wide and 75 output tons four inches wide.
   c. Take advantage of Precut's reduced slitting rates by purchasing 100 output tons of each width.

2. Without prejudice to your answer to Required 1 above, present qualitative arguments why Tsui Company may favour the purchase of the slit steel directly from Jensteel Corporation.
Problem 12

George Jackson operates a small machine shop. He manufactures one standard product available from many other similar businesses and he also manufactures custom products to customer order. His accountant prepared the following annual income statement:

<table>
<thead>
<tr>
<th></th>
<th>Custom Sales</th>
<th>Standard Sales</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$50,000</td>
<td>$25,000</td>
<td>$75,000</td>
</tr>
<tr>
<td>Material</td>
<td>10,000</td>
<td>8,000</td>
<td>18,000</td>
</tr>
<tr>
<td>Labour</td>
<td>20,000</td>
<td>9,000</td>
<td>29,000</td>
</tr>
<tr>
<td>Depreciation</td>
<td>6,300</td>
<td>3,600</td>
<td>9,900</td>
</tr>
<tr>
<td>Power</td>
<td>700</td>
<td>400</td>
<td>1,100</td>
</tr>
<tr>
<td>Rent</td>
<td>6,000</td>
<td>1,000</td>
<td>7,000</td>
</tr>
<tr>
<td>Heat and light</td>
<td>600</td>
<td>100</td>
<td>700</td>
</tr>
<tr>
<td>Other</td>
<td>400</td>
<td>900</td>
<td>1,300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44,000</strong></td>
<td><strong>23,000</strong></td>
<td><strong>67,000</strong></td>
</tr>
<tr>
<td><strong>Profit before</strong></td>
<td><strong>$ 6,000</strong></td>
<td><strong>$ 2,000</strong></td>
<td><strong>$ 8,000</strong></td>
</tr>
</tbody>
</table>

The depreciation charges are for machines used in the respective product lines. The power charge is apportioned on the estimate of power consumed. The rent is for the building space, which has been leased for 10 years at $7,000 per year. The rent, heat and light are apportioned to the product lines based on the amount of floor space occupied. All other costs are current fixed expenses identified with the product line incurring them.

A valued custom parts customer has asked Jackson to manufacture 5,000 special units for him. Jackson is working at capacity and would have to give up some other business to take this order. He cannot renege on custom orders already agreed to, but he could reduce the output of his standard product by about one-half for one year while producing the specially requested custom part. The customer is willing to pay $7 for each part. The material cost will be about $2 per unit and the labour will be $3.60 per unit. Jackson will have to spend $2,000 for a special device that will be discarded when the job is done.

Required:

What is the net gain or loss from the special order?
Problem 13

Strutt Company, which manufactures robes, has enough idle capacity available to accept a special order of 10,000 robes at $8 a robe. A predicted income statement for the year without this special order is:

<table>
<thead>
<tr>
<th>Per Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$12.50</td>
</tr>
<tr>
<td>Manufacturing costs:</td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>6.25</td>
</tr>
<tr>
<td>Fixed</td>
<td>1.75</td>
</tr>
<tr>
<td></td>
<td>8.00</td>
</tr>
<tr>
<td>Gross profit</td>
<td>4.50</td>
</tr>
<tr>
<td>Marketing costs:</td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>1.80</td>
</tr>
<tr>
<td>Fixed</td>
<td>1.45</td>
</tr>
<tr>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$ 1.25</td>
</tr>
</tbody>
</table>

If the order is accepted, variable marketing costs on the special order would be reduced by 25% because all of the robes would be packed and shipped in one lot. However, if the offer is accepted, management estimates it will lose sales of 2,000 robes at regular prices.

Required:

What is the net gain or loss from the special order?
Problem 14

Lam Company manufactures a line of carpeting that includes a commercial carpet and a residential carpet. Two grades of fibre, heavy duty and regular, are used in manufacturing both types of carpeting. The mix of the two grades of fibre differs in each type of carpeting, with the commercial grade using a greater amount of heavy duty fibre.

Lam will introduce a new line of carpeting in two months to replace the current line. The present fibre in stock will not be used in the new line. Management wants to exhaust the present stock of regular and heavy duty fibre during the last month of production.

Data regarding the current line of commercial and residential carpeting are:

<table>
<thead>
<tr>
<th></th>
<th>Commercial</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price per roll</td>
<td>$1,000</td>
<td>$800</td>
</tr>
<tr>
<td>Production specifications per roll of carpet:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy duty fibre</td>
<td>80 kg</td>
<td>40 kg</td>
</tr>
<tr>
<td>Regular fibre</td>
<td>20 kg</td>
<td>40 kg</td>
</tr>
<tr>
<td>Direct labour – hours</td>
<td>5 hours</td>
<td>5 hours</td>
</tr>
<tr>
<td>Standard cost per roll of carpet:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy duty fibre ($3 per kg)</td>
<td>$240</td>
<td>$120</td>
</tr>
<tr>
<td>Regular fibre ($2 per lb.)</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Direct labour ($30 per DLH)</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Variable manufacturing overhead (60% of direct labour cost)</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Fixed manufacturing overhead (120% of direct labour cost)</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Total standard cost per roll</td>
<td>$700</td>
<td>$620</td>
</tr>
</tbody>
</table>

Lam has 42,000 kg of heavy duty fibre and 20,000 kg of regular fibre in stock. There are a maximum of 4,000 direct labour hours available during the month. The labour force can work on either type of carpeting.

Sufficient demand exists to sell 250 rolls of commercial carpets and 500 rolls of residential carpets.

Required:

Calculate the number of rolls of commercial carpet and residential carpet Lam Company must manufacture during the last month of production to maximize overall profitability.
Question 15

Andres Company manufactures and sells three different products: Ex, Why and Zee. Projected income statements by product line for the year are presented below:

<table>
<thead>
<tr>
<th>Product</th>
<th>Unit Sales</th>
<th>Sales Revenue</th>
<th>Variable Cost of Units Sold</th>
<th>Fixed Cost of Units Sold</th>
<th>Gross Margin</th>
<th>Variable Non-Manufacturing Costs</th>
<th>Fixed Non-Manufacturing Costs</th>
<th>Operating Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex</td>
<td>10,000</td>
<td>$925,000</td>
<td>285,000</td>
<td>304,200</td>
<td>335,800</td>
<td>270,000</td>
<td>125,800</td>
<td>($60,000)</td>
</tr>
<tr>
<td>Why</td>
<td>500,000</td>
<td>$1,000,000</td>
<td>350,000</td>
<td>289,000</td>
<td>361,000</td>
<td>200,000</td>
<td>136,000</td>
<td>$25,000</td>
</tr>
<tr>
<td>Zee</td>
<td>125,000</td>
<td>$575,000</td>
<td>150,000</td>
<td>166,800</td>
<td>258,200</td>
<td>80,000</td>
<td>78,200</td>
<td>$100,000</td>
</tr>
<tr>
<td>Total</td>
<td>635,000</td>
<td>$2,500,000</td>
<td>785,000</td>
<td>760,000</td>
<td>955,000</td>
<td>550,000</td>
<td>340,000</td>
<td>$65,000</td>
</tr>
</tbody>
</table>

Production costs are similar for all three products. Fixed non-manufacturing costs are allocated to products in proportion to revenues. The fixed cost of units sold is allocated to products by various allocation bases, such as square feet for factory rent and machine hours for repairs.

Andre’s management is concerned about the loss on product Ex and is considering two alternative courses of corrective action.

Alternative A – Andres would lease new machinery for the production of product Ex. Management expects the new machinery would reduce variable production costs so total variable costs (cost of units sold and non-manufacturing costs) for product Ex would be 52% of product Ex revenues. The new machinery would increase total fixed costs allocated to product Ex from $430,000 to $480,000 per year. No additional fixed costs would be allocated to products Why or Zee.

Alternative B – Andres would discontinue the manufacture of Product Ex. Selling prices of Products Why and Zee would remain constant. Management expects Product Zee production and revenues would increase by 50%. The machinery devoted to Product Ex could be sold at scrap value that equals its removal costs. Removal of this machinery would reduce total fixed costs by $30,000 per year. The remaining fixed costs allocated to Product Ex include $155,000 of rent expense per year. The space previously used for Product Ex could be rented to an outside organization for $157,500 per year.

Required:

Prepare a schedule analyzing the effect of alternative A and alternative B on projected total operating profit.
SOLUTIONS

Multiple Choice Questions

1. e Contribution margin per unit from company L:
   
   Price $1,350
   
   Variable costs:
   
   Direct materials $250
   Laser machine (4 x $15) 60
   Image machine (1 x $20) 20
   Variable overhead 200 530
   
   Contribution margin $ 820
   
   Total contribution margin from company L ($820 x 240) $196,800
   Less cost of leased machinery to increase capacity 70,000
   Total increase in income from company L’s offer $126,800

2. a RST Ltd. has sufficient capacity to fill the order; therefore, there are no opportunity costs.
   
   Desired contribution margin = $28,000 ÷ 8,000 units = $3.50/unit
   Variable costs = $8 + $.75 = $8.75
   Therefore, the sales price should be $8.75 + $3.50 = $12.25 per unit.

3. d $15 + 12 + 8 + 2 = $37 + (9,000 / 6,000) = $38.50

4. c [6,000 x (65 - 37)] - 9,000 = $159,000 increase

5. b { [6,000 x (70 - 37)] - 9,000} - [4,000 x (80 - 43)] = $41,000 increase

6. a Cost to buy: 20,000 x $28 $560,000
   Cost to make: 200,000 + 180,000 + 150,000 + 75,000 605,000
   Differential in favour of buying $45,000

7. a $605,000 ÷ 20,000 = $30.25

8. d

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM/unit</td>
<td>$16</td>
<td>$14</td>
<td>$15</td>
</tr>
<tr>
<td>Machine hours per unit</td>
<td>5</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>CM/machine hour</td>
<td>$3.20</td>
<td>$2.00</td>
<td>$3.75</td>
</tr>
<tr>
<td>Rank</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
Problem 1

a. The relevant costs in this decision are the costs that can be avoided by contracting out this production and the outside costs.

The inside costs that can be avoided are:

i. The variable costs, which include direct materials costs of $175,000, direct labour costs of $125,000 and manufacturing overhead of $70,000 (20% of $350,000), for a total of $370,000. Given the current production is 165,000 units the variable cost avoided inside if production were contracted out is $(370,000 / 165,000) \times \text{units made}$. 

ii. The $65,000 that would otherwise be paid to the outsider.

iii. The $60,000 of avoidable fixed costs.

The outside costs will be $3.50 for every unit produced.

We need to find the production level at which the inside costs and outside costs are equal. This can be found using the following equation:

\[
\text{Inside costs} = \text{outside costs} \\
\frac{370,000}{165,000} \times \text{units produced} + 65,000 + 60,000 = 3.5 \times \text{units produced} \\
\text{units produced} = 99,398 \text{ units}
\]

For production above this amount, producing inside would be less costly. This can be shown using the following graph:

b. The opportunity to avoid $40,000 of storage costs increases the point at which production would be less costly inside the organization. From the above, we now have:

\[
\frac{370,000}{165,000} \times \text{units produced} + 65,000 + 60,000 + 40,000 = 3.5 \times \text{units produced} \\
\text{and units produced} = 131,205
\]
Problem 2

a. The minimum price absent any strategic issues would be the total relevant costs associated with this order. On a per unit basis these are:

<table>
<thead>
<tr>
<th>Costs</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$225</td>
</tr>
<tr>
<td>Direct labour</td>
<td>95</td>
</tr>
<tr>
<td>Variable manufacturing overhead</td>
<td>60 (50% * 120)</td>
</tr>
<tr>
<td>Variable selling and administrative</td>
<td>15 (20% * 75)</td>
</tr>
</tbody>
</table>

Therefore, the relevant costs for 20,000 machine orders would be $7,900,000 (20,000*395).

b. In this case, there will be an opportunity loss associated with the 800 machines that must be given up to accept this order. The contribution margin for the existing machine is $705 (1,100 – 395). Therefore, the lost contribution will be $564,000 (800 * 705) and the minimum acceptable price for the order would be $8,464,000 (7,900,000 + 564,000).

Problem 3

Net effect on income from part (c) $21,000

Contribution margin lost:

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restaurant</td>
<td>$40,000 x 0.10 x 140 / 220* (2,545)</td>
</tr>
<tr>
<td>Bar</td>
<td>$40,000 x 0.3 x 120 / 180* (8,000)</td>
</tr>
</tbody>
</table>

* contribution margin ratio (CM/Sales)

$10,455

Since the incremental effect is positive, the games area room should still be closed down.

Problem 4

The contribution margin per kit is $5,000 ($40,000 – 30,000 – 5,000). Since each kit requires 10 hours of machine time, the opportunity cost of machine time is $500 (5,000 / 10).

If the cottage kit is made, Plevna will sacrifice $35,000 in net revenue and will incur additional materials costs of $3,000. In addition there is an opportunity cost of $1,500 (500 * 3) for the three machine hours. Finally, there is $4,000 of variable selling and administrative cost. Therefore, the minimum price for the cottage kit will be $43,500 (35,000 + 3,000 + 1,500 + 4,000).
Problem 5

Opportunity 1

The relevant item is the $300,000 cash offer.

Opportunity 3

The offer would be $360,000 (450,000 – 20% * 450,000). The incremental costs would be $40,000 (eight months * $5,000 per month). Therefore, the incremental benefit of this offer would be $320,000 (360,000 – 40,000).

Opportunity 2

Accepting this order would require rejecting Opportunity 3, which would provide a contribution of $320,000. There would be additional materials costs of $10,000 and $25,000 in labour costs. In addition, production that would provide revenues of $25,000 would be sacrificed.

FHC uses a constant mark-up over variable costs. Since the variable cost of the original order was $210,000 (125,000 + 65,000 + 20% * 100,000), the standard ratio of price to variable costs is (450,000 / 210,000) and, therefore, the standard contribution margin ratio is 53% (450,000 - 210,000) / 450,000. Thus, the contribution margin, hence incremental, loss from a $25,000 loss in revenues would be $13,333 (25,000 * 53%).

Therefore, the relevant cost of accepting this offer and the minimum acceptable price would be $358,333 (320,000+10,000+25,000+13,333).
Problem 6

We can begin this analysis by identifying the current floor space occupied. Assume for discussion purposes the store has 100,000 units of shelf space. The occupancy of each area is reflected by the selling and administration expenses allocated to that area. For example, since grocery is allocated $40,000 of the total selling and administrative expenses of $100,000 and since these costs are allocated based on shelf space occupied, it means that grocery is currently occupying 40,000 units of shelf space.

The relevant item for each area is the contribution margin it contributes to the store operations. With this in mind, we can construct the following table using the data provided:

<table>
<thead>
<tr>
<th></th>
<th>Grocery</th>
<th>Dairy</th>
<th>Meat</th>
<th>Produce</th>
<th>Liquor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$150,000</td>
<td>$45,000</td>
<td>$100,000</td>
<td>$75,000</td>
<td>$110,000</td>
<td>$480,000</td>
</tr>
<tr>
<td>Cost of merchandise sold</td>
<td>110,000</td>
<td>30,000</td>
<td>70,000</td>
<td>55,000</td>
<td>90,000</td>
<td>355,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$40,000</td>
<td>$15,000</td>
<td>$30,000</td>
<td>$20,000</td>
<td>$20,000</td>
<td>$125,000</td>
</tr>
<tr>
<td>Current area occupied</td>
<td>40,000</td>
<td>15,000</td>
<td>15,000</td>
<td>25,000</td>
<td>5,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Area constraint</td>
<td>30,000</td>
<td>15,000</td>
<td>10,000</td>
<td>15,000</td>
<td>10,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Contribution margin per unit shelf space</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$2.00</td>
<td>$0.80</td>
<td>$4.00</td>
<td></td>
</tr>
</tbody>
</table>

With this information, Jacques can begin to reallocate the shelf space in the store by taking shelf space away from the lowest contribution margin business and reallocating it to the highest. So the following are the steps to follow:

Take 5,000 units from produce and assign to liquor, which has the highest contribution margin per unit of shelf space and can expand its allocation. This shift moves liquor to its maximum shelf space allocation.

Take 5,000 units from produce and assign to meat, which has the highest contribution margin per unit of shelf space in the departments than can expand their shelf space. Produce has now reached the lower limit of the shelf space it can occupy.

Take 10,000 units from grocery and assign it to meat, which has a higher contribution margin per unit of shelf space. This brings grocery down to its minimum of 30,000.

Since both grocery and dairy have the same contribution margin per unit of shelf space, there is no gain in moving shelf space among these two and the following allocation of shelf space is best:

Grocery – 30,000
Dairy – 15,000
Meat – 30,000
 Produce – 15,000
Liquor – 10,000
Problem 7

<table>
<thead>
<tr>
<th></th>
<th>Product X</th>
<th>Product Y</th>
<th>Product Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution margin per unit</td>
<td>$18</td>
<td>$12</td>
<td>$9</td>
</tr>
<tr>
<td>Raw material required per unit of product (kgs)</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Contribution margin per kilogram</td>
<td>$3</td>
<td>$6</td>
<td>$2.25</td>
</tr>
<tr>
<td>Order filling sequence</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

As a resource constraint problem, the correct approach is to determine the contribution margin per unit of input. This allows Ronson to identify the most effective use of raw material.

Problem 8

a. Change in profit = (selling price – variable costs) * no. of units
   = ($12 – $7.50) * 2,000
   = $9,000 increase in net income

b. The relevant minimum sales price is $1.50, (variable selling and administrative expense).

   The cost of producing these products is a sunk cost and since they must be sold through regular channels, the company will incur the regular selling and administrative expenses.

Problem 9

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Worst Case</th>
<th>Most Likely Case</th>
<th>Best Case Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (+/- 25%)</td>
<td>$75,000</td>
<td>$100,000</td>
<td>$125,000</td>
</tr>
<tr>
<td>Variable costs (40%-60% of cost)</td>
<td>45,000</td>
<td>45,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$30,000</td>
<td>$55,000</td>
<td>$75,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>30,000</td>
<td>25,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Net income</td>
<td>0</td>
<td>$30,000</td>
<td>$55,000</td>
</tr>
</tbody>
</table>
Problem 10

a. Cost to buy:
   
<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price: 5,000 x $8</td>
<td>$40,000</td>
</tr>
<tr>
<td>Freight: 5,000 x $.50</td>
<td>2,500</td>
</tr>
<tr>
<td>Indirect labour</td>
<td>5,000</td>
</tr>
<tr>
<td>Payroll taxes and insurance (14%* of indirect labour)</td>
<td>700</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$48,200</strong></td>
</tr>
</tbody>
</table>

Cost to make:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$17,500</td>
</tr>
<tr>
<td>Direct labour</td>
<td>28,000</td>
</tr>
<tr>
<td>Indirect labour</td>
<td>6,000</td>
</tr>
<tr>
<td>Payroll taxes and insurance (14% of direct and indirect labour)</td>
<td>4,760</td>
</tr>
<tr>
<td>Power</td>
<td>300</td>
</tr>
<tr>
<td>Other</td>
<td>500</td>
</tr>
<tr>
<td>Property taxes and insurance</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$58,060</strong></td>
</tr>
</tbody>
</table>

From a purely quantitative basis, the Faktrons should be purchased from the external supplier.

Note that depreciation is not considered since it is not a relevant cost.

* payroll taxes and insurance as a percentage of total labour costs =
  $9,800 (50,000 + 20,000) = 14%

b. Working capital requirements may be affected – to the extent that working capital increases (decreases), then the cost of carrying working capital needs to be factored in.

Impact on employee morale if we outsource especially if the displaced labour cannot be accommodated elsewhere in the company.

Possible disruption in production scheduling if the external supplier does not supply on time.

We need to consider the technical competence and financial strength of the supplier.
Problem 11

a. 1. 2-inch: 50 tons x $210   $10,500
   4-inch: 75 tons x $200      15,000
   Shipping: 125 tons x $10    1,250
   **$26,750**

2. Cost of steel from Jensteel:
   125 tons / .975 = 128.21 ton x $180  $23,078
   Cost of shipping from Jensteel to Precut
   128.21 ton x $5                   641
   Cost of slitting at Precut
   2-inch: 50 tons x $18             900
   4-inch: 75 tons x $15             1,125
   Cost of shipping to Tsui:
   125 tons x $7.50                  938
   **$26,682**

3. Cost of steel from Jensteel:
   200 tons / .975 = 205.13 ton x $180 $36,923
   Cost of shipping from Jensteel to Precut
   205.13 ton x $5                   1,026
   Cost of slitting at Precut
   2-inch: 100 tons x $18 x .88     1,584
   4-inch: 100 tons x $15 x .88     1,320
   Cost of shipping to Tsui:
   200 tons x $7.50                  1,500
   Cost of storage: 75 tons x 1.50 x 2 months  225
   **$42,578**

For comparison purposes, the cost for immediate needs is:
   Cost of steel: $36,923 x 125 / 200   $23,077
   Cost of shipping from Jensteel to Precut
   $1,026 x 125 / 200                   641
   Cost of slitting:
   2-inch: $1,584 x 50 / 100           792
   4-inch: $1,320 x 75 / 100           990
   Cost of shipping to Tsui: $1,500 x 125 / 200  938
   Cost of storage: $225 x 125 / 200    141
   **$26,579**
b. The steel has to be shipped and handled twice, there could be slack time and shipping problems.

If quality problems occur, we would be dealing with only one supplier as opposed to two. Also, if there are costs with dealing with vendors, then it would be cheaper dealing with only one.

Problem 12

Revenue of special order: 5,000 x $7 $35,000
Incremental direct costs of the order:
  Material and labour: 5,000 x $5.60 (28,000)
  Special device (2,000)
Contribution margin lost on standard sales:
  Total standard sale CM:
    $25,000 sales – 8,000 materials – 9,000 labour = $8,000 x ½ (4,000)
  Incremental operating income of special order $1,000

Problem 13

CM per unit for regular robes =
  $12.50 sales – 6.25 var. manufacturing – 1.80 var. marketing = $4.45

CM per unit for special order =
  $8 sales – 6.25 var. manufacturing – 1.35 var. marketing = $.40

Total CM on special order: 10,000 x $.40 $4,000
Total CM lost on regular sales: 2,000 x $4.45 (8,900)
Incremental operating income if special order is accepted $(4,900)
Problem 14

Amount of presumed scarce resources required to meet maximum demand:
- Heavy duty fibre: \((250 \times 80) + (500 \times 40) = 40,000\)
- Regular fibre: \((250 \times 20) + (500 \times 40) = 25,000\)
- Direct labour hours: \((250 \times 5) + (500 \times 5) = 3,750\)

The only binding constraint is regular fibre.

<table>
<thead>
<tr>
<th></th>
<th>Commercial</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$1,000</td>
<td>$800</td>
</tr>
<tr>
<td>Variable costs per roll*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct labour</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$760</td>
<td>$560</td>
</tr>
<tr>
<td>Kg of regular fibre</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>CM per kg of regular fibre</td>
<td>$38</td>
<td>$14</td>
</tr>
</tbody>
</table>

Production plan:

<table>
<thead>
<tr>
<th></th>
<th>Regular Fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial rolls:</td>
<td>5,000</td>
</tr>
<tr>
<td>250 rolls x 20 kg</td>
<td></td>
</tr>
<tr>
<td>Residential rolls:</td>
<td>15,000</td>
</tr>
<tr>
<td>375 rolls x 40 kg</td>
<td>20,000</td>
</tr>
</tbody>
</table>

Note that the cost of fibre was not considered. This fibre is in stock and will once depleted will not be replaced. The cost of fibre is, therefore, sunk and not relevant for purposes of calculating contribution margins.
Problem 15

Alternative A:
  Reduction in variable costs:
    Current variable costs: \((285,000 + 270,000)\) \(= 555,000\)
    New variable costs: \(925,000 \times 52\%\) \(= 481,000\)
  Incremental fixed costs: \(480,000 - 430,000\) \(= 50,000\)
  Incremental income \(= 74,000\)

Alternative B:
  CM lost on Product Ex \((925,000 - 555,000)\) \(= 370,000\)
  CM increase on Product Zee:
    \((575,000 - 150,000 - 80,000) \times 50\%\) \(= 172,500\)
  Fixed costs avoided \(= 30,000\)
  Rent \(= 157,500\)
  Incremental income \(= -10,000\)

Note that the reallocation of rent is not relevant since the total rent will remain the same.

Given the company would lose \$10,000 per year if they discontinued Product Ex, it is recommended alternative A be adopted.
11. Linear Programming

Learning Objectives

After completing this chapter, you will:

1. Understand how linear programming can support business decision making
2. Understand the components of a linear programming problem
3. Understand the role of relevant costs in the short-term allocation of resources, also known as the product mix problem.
4. Understand how linear programming can support finding the best short-term allocation of resources
5. Be able to identify and prepare the data needed by a linear program to find the best short-term allocation of resources
6. Be able to solve a simple linear program using the graphical method
7. Recognize other settings where linear programming can be used to identify the best course of action.

Linear Programming and Business Decision Making

Organizations are constantly confronted with choices that, with some ingenuity, can be structured in a way that can be solved using a mathematical tool called linear programming. Some common decisions organizations have solved using linear programming are:

1. Choosing the best short-term product mix
2. Programming a refinery to generate the best yield from a barrel of crude oil
3. Determining the best use of a raw material such as a fish or a tree
4. Determining the best path in a distribution network, called the travelling salesman problem or the transportation problem
5. Choosing the least cost recipe to produce a product that meets given specifications

Linear Programming Problem Components

Linear programs have three components:

1. An objective function, which is a statement, in mathematical terms, of what has to be accomplished. Some common examples include: maximize contribution margin, minimize cost, minimize distance travelled and maximize the expected benefits of public expenditures.
2. The decision variables, which reflect the decision maker’s choices. Some common examples include: the product mix, the mix of input factors of production, the allocation of government funds to different projects and the shortest or least path through a network.

3. The constraints, which reflect the factors that constrain the value of the objective function. Common constraints include: machine hours, labour hours, funds that can be allocated to projects and amounts of products that can be sold.

We will illustrate linear programming using two examples. The first, where an organization is deciding on the best short-term allocation of idle capacity, and the second, where an organization is deciding on choosing the best mix of raw materials to achieve a production objective.

**The Product Mix Problem – Danny Electronics**

After meeting its other production commitments, Danny Electronics has remaining capacity of 24 labour hours and 20 machine hours. This idle capacity can be used to produce two products, A and B. The following exhibit provides the per unit details for these two products:

<table>
<thead>
<tr>
<th>Product</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$140.00</td>
<td>$99.00</td>
</tr>
<tr>
<td>Materials cost</td>
<td>47.00</td>
<td>15.00</td>
</tr>
<tr>
<td>Labour cost</td>
<td>36.00</td>
<td>54.00</td>
</tr>
<tr>
<td>Manufacturing overhead</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>50.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Fixed</td>
<td>25.00</td>
<td>12.50</td>
</tr>
<tr>
<td>Profit</td>
<td>-$18.00</td>
<td>-$7.50</td>
</tr>
</tbody>
</table>

Given that the product sheet shows negative profit for both products, the CFO has argued that the capacity should remain idle and no further production be undertaken.

Further analysis reveals the following information. All materials costs are variable. Labour is paid at $18 per hour and labour costs are variable. All variable manufacturing overhead costs relate to machine costs, which are $25 per hour. Fixed manufacturing costs, which relate to various plant costs, are charged to production at the rate of $12.50 per machine hour.

Given this information is the CFO correct? If not, explain why and the best production plan.

The product mix problem is a relevant cost type problem, which we saw in Chapter 10. Therefore, building on the ideas discussed in Chapter 10, we need to focus on the incremental cash flows associated with producing these two products. In this case, the incremental cash flows are the product contribution margins, which are comprised of each product’s price, materials cost, labour cost and variable manufacturing overhead. The following is a summary:
We are now focused on each product’s contribution margin, which summarizes the incremental cash flow associated with its production.

Recalling the discussion of the product mix problem in Chapter 10, we need to consider the product’s contribution margin and its consumption of the capacity resource in the product mix problem.

Since labour is paid $18 per hour, we know from the above exhibits that Products A and B, respectively, use two (36/18) and three (54/18) labour hours per unit. Since variable manufacturing overhead costs reflect machine time at $25 per hour, we know from the above exhibit that Products A and B, respectively, use two (50/25) and one (25/25) machine hours per unit.

Refer back to the discussion of the product mix problem in Chapter 10 where you will see we are now at an impasse if we try to apply the approach we considered there, since there are now two capacity resources. We cannot use the rule of allocating capacity based on contribution per unit of the capacity since we now have two resources and must consider the resources simultaneously. At this point, we need to turn to linear programming.

**Building the Linear Program**

Recall from the discussion above that a linear program has three components:

- The objective function: In this case the objective function is to maximize the contribution margin by producing the best mix of Products A and B.

- The decision variables: In this case the decision variables are the quantities of Products A and B that will be produced.

- The constraints: In this case there are two constraints, labour hours (there are 24 hours available) and machine hours (there are 20 hours available).

With this information, we can construct the linear program. Let A be the number of units of Product A produced and B be the number of units of Product B produced. We have:
Maximize 7A + 5B (this is the objective function, which is the total contribution margin of the production plan)

Subject to:

2A + 3B ≤ 24 (this is the labour hours constraint – the left hand side is the number of labour hours consumed producing A and B and the right hand side is the number of labour hours available)

2A + B ≤ 20 (this is the machine hours constraint – the left hand side is the number of machine hours consumed producing A and B and the right hand side is the number of machine hours available)

A, B ≥ 0 (this is the non-negativity constraint, which says production cannot be negative)

In practice, linear programs are solved using computers and specialized software packages. In fact there is a tool in Microsoft Excel and Open Office Calc called solver that can be used to solve linear programs. However, in this lesson, we focus on manual solutions to simple linear programs so you can develop the intuition relating to how linear programs find optimal solutions. The approach we will use is graphical.

The Graphical Approach to Solving Linear Programs

Step 1 – Draw the Constraints on a Graph.

The following is a graph showing the labour constraint. The number of units of Product A produced is shown on the vertical (Y) axis and the number of units of Product B produced is shown on the horizontal (X) axis. Since each unit of Product A uses two labour hours, we can produce 12 (24/2) units of Product A if we use all 24 labour hours to produce Product A. Since each unit of Product B uses three labour hours, we can produce eight (24/3) units of Product B if we use all 24 labour hours to produce Product B. The line joining these two points on the graph represents the boundary of the area denoting the feasible set of (A, B) production pairs. Any combination of units of production of Products A and B that lie on this line or below it is feasible since it does not require more labour hours than the 24 hours available.
We now use the same approach to find the end points of the machine hours line is 10 units of Product A and 20 units of Product B. The following is the graph showing the two constraints. We have now completed the process of adding constraints.
Remember for a \((A, B)\) production pair to be feasible, it has to lie on or below both lines. In other words, for a production pair to be possible, it must be jointly feasible to all the constraints. The area that is jointly feasible to all constraints is called the feasible production set or the feasible set. The diagram below illustrates the feasible set for this problem.
Step 2 – Finding the Optimal Solution on the Graph

The trick in linear programming is that the best solution will always be found on the boundary of the feasible set. Moreover, there is no production pair on the boundary of the feasible set that will provide a better solution than a production pair at one of the corners of the feasible set. This means, we only need to look at the corners of the feasible set to find a best solution.

In this case we have three corners. These are:
1. Produce 10 units of A and zero units of B
2. Produce nine units of A and two units of B, or
3. Produce zero units of A and eight units of B.

Since we know the contribution margins of A and B, we can compute the contribution margin of each production pair to determine that the best solution is to produce nine units of A and two units of B as shown in the following diagram:
That’s it!! The decision maker can add various constraints and multiple decision variables to the linear program but this problem illustrates the basic idea. The linear program will find the feasible set and will hunt around the corners of the feasible set to find the best solution.

Finding the Optimal Solution Graphically – The Isoprofit Line

Since, in practice, it is likely that all values used in the linear programming formulation will be estimates, decision makers often want to know how sensitive the optimal solution is to changes in the estimated values used in finding the solution. Linear programs routinely provide this information. However, we can develop our intuition about sensitivity using the graphical analysis we have done so far.

The following is our graphical analysis with a newcomer called the isoprofit line. Note that where the isoprofit line hits the vertical axis the production pair is five units of Product A and zero units of Product B with a total contribution margin of 35 (5 * 7 + 0 * 5). At the point where the isoprofit line intersects the horizontal axis, the production pair is zero units of Product A and seven units of Product B with a total contribution margin of 35 (0 * 7 + 7 * 5). This isoprofit line is a line drawn so all the production pairs of Product A and B on this line provide the same contribution margin of 35.
In a two variable problem like this, the slope of the isoprofit line is the negative of the ratio of the contribution margin of the variable plotted on the horizontal axis divided by the contribution margin of the variable plotted in the vertical axis. In this example, the slope of the isoprofit line is -5/7.

As the isoprofit line moves upward maintaining the same slope, we find pairs of production of Product A and Product B that produce higher total contribution margins. So to find the best
production pair, we keep moving the isoprofit line upward until it just touches one of the corners of the feasible set and the result is shown in the following graph. Note that the isoprofit line has found the corner we discovered earlier is the optimal solution. Note also that the only feasible solution on the isoprofit line is the one we found earlier.
Varying the Linear Programming Parameters

Increasing Capacity

Organizations often look to management accountants to help identify the value of adding additional resources. In the setting we are considering here, the focus would be on adding short-term resources. Graphically, we can visualize adding resources as pushing the constraint line to the right.

Assume machine capacity cannot be increased in this problem. However, production workers are willing to provide an additional 8 hours of time if they are paid a premium over their normal rate of $18 per hour. What is the maximum premium, if any, Danny Electronics should be willing to pay the workers?

To answer this question, we need to resolve the linear program with the revised labour hours constraint, which is:

$$2A + 3B \leq 32$$

Graphically, our original labour hours line will be pushed to the right so it intersects the vertical axis at 16 (32/2) units of Product A and the horizontal axis at 10.67 (32/3) units of Product B. The following is the graphical analysis, which shows the new solution is to produce seven units of Product A and six units of Product B with a total contribution of $79, assuming labour is still priced at its original cost of $18 per hour.
### Danny Electronics

<table>
<thead>
<tr>
<th>Point</th>
<th>Labour Hours</th>
<th>Machine Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>A</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>CM</td>
<td>32</td>
<td>20</td>
</tr>
</tbody>
</table>

#### Jobs Done

<table>
<thead>
<tr>
<th>Point</th>
<th>Jobs</th>
<th>Labour Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>CM</td>
<td>55</td>
<td></td>
</tr>
</tbody>
</table>
Therefore, the addition of eight labour hours has caused contribution margin to increase by $6 (79 – 73). Therefore, the highest premium management should be willing to pay over the normal rate of $18 is $.75 (6/8) or $18.75 per hour for the eight additional hours.

Varying the Product Contribution Margin

Assume the price of Product A increases by $1. This will increase Product A’s contribution by $1 to $8 per unit. Recall that the slope of the isoprofit line is the negative of the contribution margin of Product B divided by the contribution margin of Product A. This means, the slope of the isoprofit line will increase from -5/7 to -5/8.

Graphically, this means the isoprofit line will rotate counter clockwise. If you have a problem picturing this consider anchoring the isoprofit line on its left side at five units of Product A and zero units of Product B, the total contribution margin will be 40 (5 * 8 + 0 *5). If only Product B is produced, we will need to produce eight units of Product B (40/5) to achieve the same contribution margin. The isoprofit line has moved from joining the points (0,5) and (7,0) to joining the points (0,5) and (8,0), which is a counter clockwise rotation about the point (0,5).

With this in mind and returning to the graph with the isoprofit line that found the optimal solution, we can now see the effect of changing Product A’s contribution margin on the optimal production plan.

As Product A’s contribution margin increases and the isoprofit line rotates counter clockwise at some point, it will have the same slope as the machine constraint line, which is -1/2. This is the amount of machine time Product B uses per unit divided by the amount of machine time Product A uses per unit. The isoprofit line and the machine hours constraint line will be coincident where Product A has a contribution margin of 10 and the slope of the isoprofit line is -5/10.

When the isoprofit line is coincident with the machine hours constraint, we have multiple optimal solutions since all the production pairs of A and B along this line will provide the same total contribution margin. The production pairs of 10 units of Product A and zero units of Product B and nine units of Product A and two units of Product B will have the same total contribution margin of 100. If Product A’s contribution margin increases $.01 above $10, the isoprofit line will rotate counter clockwise a fraction more and the optimal production will be unique and equal to five units of Product A and zero units of Product B with a total contribution margin of $110 (10 * 10.1 + 0 * 5).

Uncertainties in the Production Estimates

We call the estimates of the amount of resource a decision variable uses an absorption coefficient. For example, Product A’s absorption coefficient for both labour and machine hours is two. Changes in the relative absorption coefficients of Products A and B will cause the affected constraints to rotate.

Following the approach we used above for the contribution margin, you should be able to show that if Product A’s absorption coefficient for machine hours falls from 2 to 3/2, it will be optimal to produce only Product A. (You can visualize this by imagining that the machine hours constraint is rotated clockwise around the point zero units of Product A and 20 units of Product
B so the machine hour constraint intersects the vertical axis at 15 units of Product A. This allows the isoprofit line to move upward since its upper boundary of the feasible set is extended upward.) Note that the solution shown contemplates non-integer production of Product A, which is not possible.
<table>
<thead>
<tr>
<th>Point</th>
<th>Product</th>
<th>Units Made</th>
<th>Labour Used</th>
<th>MH Used</th>
<th>CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3 A</td>
<td>14.28571</td>
<td>28.57143</td>
<td>28.57143</td>
</tr>
<tr>
<td>A</td>
<td>0</td>
<td>15 B</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0</td>
<td>8 Total used</td>
<td>28.57143</td>
<td>28.57143</td>
</tr>
<tr>
<td>CM</td>
<td>0</td>
<td>105</td>
<td>40 Available</td>
<td>24</td>
<td>20</td>
</tr>
</tbody>
</table>

Since the optimal production plan can change with changes in absorption coefficients, uncertainties in estimating the decision variable absorption coefficients can cause opportunity losses.

**Marketing Constraints**

Assume Danny Electronics can only sell three additional units of Product A. How can we model that constraint? The answer is we simply add the constraint $A \leq 3$ to the above linear programming formulation. The resulting graph and the solution are shown in the following diagram. Note how the Product A sales constraint reduces the feasible set. Only production pairs that are on or below the Product A constraint line are now feasible relative to the Product A marketing constraint. There is now a major change in the optimal solution and the contribution margin associated with the optimal solution.
### Danny Electronics

<table>
<thead>
<tr>
<th>Point</th>
<th>Product</th>
<th>Units Made</th>
<th>Labour Used</th>
<th>Mh Used</th>
<th>CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td>6</td>
<td>18</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>6</td>
<td>8</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>CM</td>
<td></td>
<td>21</td>
<td>51</td>
<td>40</td>
<td>20</td>
</tr>
</tbody>
</table>

**Graph 7.grf**

- **Product A Sales Constraint**
- **Machine Constraint**
- **Labour Constraint**
- **Iso Profit Line**
The Minimum Cost Problem

One of the earliest known applications of linear programming was to minimize the costs of ingredients needed to achieve a production objective, a problem often called the recipe problem.


The setting is the production of animal feed and the objective is to minimize the cost of the raw materials used to make the feed while meeting specific dietary constraints.

In this example, the available raw materials are wheat, barley, soy, fish meal, maize and sunflower. There are three dietary constraints. These are shown in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Wheat</th>
<th>Barley</th>
<th>Soy</th>
<th>Fish</th>
<th>Maize</th>
<th>Sunflower</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>30x_1</td>
<td>28x_2</td>
<td>50x_3</td>
<td>90x_4</td>
<td>34x_5</td>
<td>42x_6</td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>11x_1</td>
<td>10x_2</td>
<td>30x_3</td>
<td>66x_4</td>
<td>9x_5</td>
<td>37x_6</td>
<td>≥ 17.5</td>
</tr>
<tr>
<td>Calories</td>
<td>15x_1</td>
<td>12x_2</td>
<td>10x_3</td>
<td>12x_4</td>
<td>15x_5</td>
<td>10x_6</td>
<td>≤ 10.5</td>
</tr>
<tr>
<td>Fibre</td>
<td>2x_1</td>
<td>3x_2</td>
<td>6x_3</td>
<td>1x_4</td>
<td>2x_5</td>
<td>18x_6</td>
<td>≤ 7.5</td>
</tr>
</tbody>
</table>

The decision variables (x_1 through x_6) are the proportion of the various raw materials (wheat, barley, etc.) that will be used in the formulation of the animal feed. So x_1 is the proportion of wheat used in the final recipe. There are six decision variables reflecting the proportions of each of the six raw materials used in the final recipe.

The objective function is shown as the first line in the table above. The coefficients of each of the decision variables reflect the cost associated with each decision variable. For example, 30 is the cost per unit of wheat added to the formulation. The idea is to minimize the cost of the raw materials while meeting the constraints.

There are three dietary constraints one each for protein, caloric and fibre content. The coefficient associated with each decision variable indicates the proportion per unit of the raw material that contributes to that constraint. For example, fish is 66% protein. There is a dietary constraint for each raw material. For example, protein must comprise at least 17.5% of the total composition of the final product. Finally, there is the constraint that the sum of the proportions of the final product made up by each of the raw materials must sum to one.
Management Accounting

In summary, the following is the linear programming formulation:

Minimize \[ 30x_1 + 28x_2 + 50x_3 + 90x_4 + 34x_5 + 42x_6 \]

Subject to:

The protein constraint: \[ 11x_1 + 10x_2 + 30x_3 + 66x_4 + 9x_5 + 37x_6 \geq 17.5 \]

The calories constraint: \[ 15x_1 + 12x_2 + 10x_3 + 12x_4 + 15x_5 + 10x_6 \leq 10.5 \]

The fibre constraint: \[ 2x_1 + 3x_2 + 6x_3 + x_4 + 2x_5 + 18x_6 \leq 7.5 \]

The yield constraint: \[ x_1 + x_2 + x_3 + x_4 + x_5 + x_6 = 1 \]

Because this problem has more than two decision variables, it cannot be solved using a graphical method. Your responsibility in this program is to be able to formulate problem like this and not to solve it. Solving these problems is quite trivial using linear programming software, the major value added is the formulation itself. (In case you are interested, the minimum cost solution for this problem is a formulation that is 25% barley, 56% soy and 19% sunflower.)

Conclusion:

Linear programming has proven to be an invaluable tool in many decision making settings. As we have seen in the product mix example, linear programming formulations rely on data that is developed by management accountants. Therefore, it is important that management accountants understand how the information they develop is used and also the sensitivity of the resulting decisions to the data. Significant opportunity costs can result when decisions are sensitive to the data estimates. The possibility of large opportunity costs signal to the management accountant the need to undertake additional studies to reduce the uncertainty of the data provided.
Appendix – Opportunity Losses

Note that this is for your reading enjoyment only. The material in this appendix is outside the scope of the CMA Competency Map, which means its materials will not be tested on Accelerated Program Exams or on the Entrance Exam.

The decision making relevance of the discussion of varying the contribution margin is the opportunity loss created by inaccurate estimates. With the estimate of the contribution margin of Products A and B being $7 and $5, respectively, we found the optimal production plan was to produce nine units of Product A and two units of Product B with a total contribution margin of $73.

If this production was scheduled and the contribution margin of Product A turned out to be $10.01, the total realized contribution margin would be $100.09 (9 * 10.01 + 2 * 5). However, we know from our work above that if Product A’s contribution was known to be $10.01 before the production plan was chosen, the decision maker would have chosen to produce 10 units of Product A and zero units of Product B with a total contribution margin of $100.10 (10 * 10.01).

Therefore, the opportunity cost of believing Product A’s contribution margin was $7 when it was actually $10.01 is (100.10 – 100.09). In this example, the opportunity cost is immaterial but in a more realistic example involving the production of thousands of units or where the contribution is large, the opportunity cost arising from estimates of contribution margin that prove to be wrong can be significant.

Why would any of this be relevant to a management accountant? The reason is it is the management accountant who provides contribution margin estimates to decision makers and, therefore, the linear programming model. The more sensitive the optimal solution is to the contribution margin estimates, the greater the chance for an opportunity loss.

In this case, the optimal solution is relatively insensitive to the estimate, for example, Product A’s contribution margin. As long as the slope of the isoprofit line in our graph above lies between the slopes of the machine hours constraint and the labour hours constraint, which is between -1/2 and -3/2, the current solution will remain optimal. Holding Product B’s contribution margin constant at $5 means the range over which Product A’s contribution margin can change without changing the optimal solution can be found by recognizing that the solution will not change as long as the negative of the contribution margin of B and A lines between the slope of the machine hours and labour hours constraint. So we have:

\[
\begin{align*}
-3 & \leq \text{contribution margin of B} \leq -1 \\
2 & \leq \text{contribution margin of A} \leq 2
\end{align*}
\]

and rearranging, we can find

\[
\begin{align*}
10/3 & \leq \text{contribution margin of A} \leq 10
\end{align*}
\]

This is a large range around the initial estimate of $7.
Problems with Solutions

Multiple Choice Questions

The following information pertains to Questions 1 – 3:

A company manufactures two types of plastic covered steel fencing: standard and heavy duty. Both types of fencing pass through the processes involving steel forming and plastic bonding.

The standard type of fencing sells for $15 per roll and the heavy duty fencing sells for $20 per roll. There is an unlimited market for the heavy duty fencing, but outlets for standard fencing are limited to 13,000 rolls per year. However, the factory operations of each process are limited to 24,000 hours per year. Direct labour at $10 per hour is based on forming hours. Variable overhead is applied based on total processing hours at $1 per hour. Direct materials cost $5 and $7 per roll for standard and heavy duty fencing, respectively. Processing hours per roll are:

<table>
<thead>
<tr>
<th></th>
<th>Forming</th>
<th>Bonding</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>.6</td>
<td>0.4</td>
<td>1</td>
</tr>
<tr>
<td>Heavy duty</td>
<td>.8</td>
<td>1.2</td>
<td>2</td>
</tr>
</tbody>
</table>

1. In determining the production mix that would maximize total contribution, which of the following would be an appropriate constraint?
   a) .6 standard + .8 heavy duty ≤ 24,000.
   b) 15 standard + 20 heavy duty ≥ 13,000
   c) 1.0 standard + 2 heavy duty ≤ 24,000
   d) 1.0 standard + 2 heavy duty ≤ 48,000
   e) .4 standard + 1.2 heavy duty ≥ 24,000

2. Which of the following would be an appropriate objective function in determining the production mix that would maximize total contribution?
   a) Maximize $15 standard + $20 heavy duty
   b) Maximize $12 standard + $17 heavy duty
   c) Maximize $3 standard + $3 heavy duty
   d) Maximize $3.40 standard + $4.20 heavy duty
   e) Maximize $3.60 standard + $3.80 heavy duty
3. Assume that to maximize total contribution, the company should maximize its production of standard fencing. How many units of heavy duty fencing can be produced?
   a) Zero
   b) 5,500
   c) 11,000
   d) 15,666
   e) 20,250

The following information pertains to Questions 4 – 6:

Snead Company manufactures two products, Zeta and Beta, each of which passes through two processing operations. All materials are introduced at the start of process 1. No work-in-process inventories exist. Snead may produce either one product exclusively or various combinations of both products subject to the following constraints:

<table>
<thead>
<tr>
<th></th>
<th>Process Number 1</th>
<th>Process Number 2</th>
<th>Contribution Margin per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zeta</td>
<td>2</td>
<td>1</td>
<td>$4.00</td>
</tr>
<tr>
<td>Beta</td>
<td>1</td>
<td>3</td>
<td>5.25</td>
</tr>
</tbody>
</table>

Total capacity in hours per day: 1,000 for process 1, 1,275 for process 2.

A shortage of technical labour has limited Beta production to 400 units per day. There are no constraints on the production of Zeta other than the hour constraints in the preceding schedule. Assume all relationships between capacity and production are linear.

4. Given the objective to maximize total contribution margin, what is the production constraint for process 1?
   a. Zeta + Beta ≥ 1,000
   b. Zeta + Beta ≤ 1,000
   c. 2 Zeta + Beta ≥ 1,000
   d. 2 Zeta + Beta ≤ 1,000
   e. Some other answer

5. Given the objective to maximize total contribution margin, what is the labour constraint for production of Beta?
   a. Beta ≤ 425
   b. Beta ≥ 400
   c. Beta ≤ 400
   d. Beta ≥ 425
   e. Some other answer
6. What is the objective function of the data presented? Maximum is:
   a. 2 Zeta + 1 beta
   b. $4.00 Zeta + $5.25 beta
   c. $400 Zeta + 3($5.25) beta
   d. 2($4.00) Zeta + 3($5.25) beta
   e. Some other answer
Problem 1

Joan Partridge, the owner manager of JP Enterprises (JPE), is deciding on the best allocation of her managerial and technical employees to two types of consulting projects. Both projects involve providing initial guidance to clients about how to select consultants to actually undertake the projects.

Activity costing (AC) guidance projects require two manager hours and two technician hours and generate revenue of $600. Incentive design (ID) guidance projects require one manager hour and four technician hours and generate revenue of $500.

All employees are hourly paid and the rate per hour for managers and technicians is $100 and $50, respectively. JPE has 40 manager hours and 100 technician hours available.

Company overhead, which is fixed, is charged to projects at the rate of $25 per labour hour. The following is the financial summary for the two types of projects:

<table>
<thead>
<tr>
<th></th>
<th>AC Jobs</th>
<th>ID Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$600</td>
<td>$500</td>
</tr>
<tr>
<td>Labour costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager (2 hours @ $100)</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Manager (1 hour @ $100)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Technician (2 hours @ $50)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Technician (4 hours @ $50)</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Overhead allocation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 hours @ $25</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>5 hours @ $25</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Profit per job</td>
<td>$200</td>
<td>$75</td>
</tr>
</tbody>
</table>

Required:

a. If JP wishes to maximum total short-term contribution, what is the best product mix?

b. If the number of AC jobs is unconstrained but no more than 10 ID jobs can be undertaken how, if at all, will this change your response from part a)?
Problem 2

The nutritionist at the Brant General Hospital prepares water-based drinks designed to achieve specific dietary objectives. The current project is to produce a drink that provides at least 16 units of dietary objective 1 (O1) and at least 24 units of dietary objective 2 (O2). The nutritionist can accomplish this objective using two ingredients A and B. The following is a summary of the characteristics per 100 grams of each of the two ingredients:

<table>
<thead>
<tr>
<th></th>
<th>Ingredient A</th>
<th>Ingredient B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per 100 grams</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Dietary units contributed to O1 per 100 grams</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Dietary units contributed to O2 per 100 grams</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Required:

a. Given the financial stress hospitals are facing, the nutritionist has been directed to identify the least cost formulation of a drink that meets the minimum dietary requirements.

b. How, if at all, would your solution in part a) change if preliminary tests indicate the nutritionist should include no more than two units of ingredient B in the recipe for this drink since levels above that create gastric problems for patients.

Problem 3

Horton Company produces two products, a regular chair and a deluxe chair. The following exhibit lists the standard selling prices and manufacturing costs for the two products:

<table>
<thead>
<tr>
<th></th>
<th>Regular</th>
<th>Deluxe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$300</td>
<td>$450</td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>$100</td>
<td>$150</td>
</tr>
<tr>
<td>Direct labour</td>
<td>80</td>
<td>125</td>
</tr>
<tr>
<td>Variable manufacturing overhead</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Fixed manufacturing overhead</td>
<td>25</td>
<td>225</td>
</tr>
<tr>
<td>Chair profit</td>
<td>$75</td>
<td>$100</td>
</tr>
</tbody>
</table>

The chairs each pass through three departments:

1. Preparation, where the pieces of wood that will form the chairs are cut and drilled
2. Assembly, where the pieces of wood are fastened together to form the chairs, and
3. Finishing, where the chairs are sanded and a finish applied.

The following table lists the hours each chair requires of each for the resources and the maximum hours available for each resource.
Required:

Write the objective function and the constraints for the linear program assuming Horton Company wants to choose the production mix that maximizes short-term profits.

Problem 4

Greasy Oil (GO) processes crude oil to produce three products, A, B and C. Crude oil costs $70 per barrel landed at the refinery and $40 per barrel to refine.

After some volume losses in the refinery, the yield from each barrel of crude oil is 60 litres of Product A, 70 litres of Product B and 20 litres of Product C. Each product requires additional processing before it can be sold. The following table provides the revenue and additional processing cost per litre for each product and the maximum amount of product that can be sold:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$2.00</td>
<td>$1.50</td>
<td>$0.80</td>
</tr>
<tr>
<td>Cost</td>
<td>0.50</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Sales</td>
<td>16,000</td>
<td>18,000</td>
<td>6,000</td>
</tr>
</tbody>
</table>

Any product produced but cannot be sold is burned to generate steam and saves GO the $0.20 per litre it would otherwise pay for fuel to generate the steam.

Given this information, and assuming GO wants to maximize its short-term profit, write the equations for the linear program to solve for the amount of crude oil GO should purchase and refine.

Problem 5

Pat Darke has inherited $100,000 from a long lost relative. Being frugal, Pat has decided to invest the entire amount in a portfolio consisting of Government of Canada bonds (yield 4%), certificates of deposit (yield 5.5%), a low risk stock fund (yield 10%) and a high risk stock fund (yield 18%). Based on advice from his trusted financial advisor Ray Connolly, Pat has developed the following portfolio requirements:

1. The proportion of the portfolio invested in the low risk stock fund should be 15% or less.
2. The total funds invested in Government of Canada bonds and certificates of deposit should be at least 35% of the portfolio.
3. The funds invested in the high risk stock fund should not exceed the total funds invested in the low risk stock fund and the certificates of deposit.
Given these stipulations, what is the best distribution of Pat’s $100,000 inheritance if Pat wants to maximize?

Problem 6

Friendly Flyer is a manufacturer of children’s swing sets. The marketing manager wants to determine how to distribute available supply in the three warehouses to three locations of Friendly’s major customer Giant Stores.

The following is a summary of the warehouse supply and store demand for the swing sets

<table>
<thead>
<tr>
<th>Warehouse</th>
<th>Units</th>
<th>Store</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingston</td>
<td>3,000</td>
<td>Ottawa</td>
<td>6,000</td>
</tr>
<tr>
<td>Oshawa</td>
<td>7,000</td>
<td>Toronto</td>
<td>2,000</td>
</tr>
<tr>
<td>London</td>
<td>5,000</td>
<td>Windsor</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td>15,000</td>
<td></td>
<td>13,000</td>
</tr>
</tbody>
</table>

The following is a table summarizing the shipping cost per unit between each warehouse/store pair:

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Ottawa</th>
<th>Toronto</th>
<th>Windsor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingston</td>
<td></td>
<td>80</td>
<td>90</td>
<td>150</td>
</tr>
<tr>
<td>Oshawa</td>
<td></td>
<td>120</td>
<td>30</td>
<td>110</td>
</tr>
<tr>
<td>London</td>
<td></td>
<td>210</td>
<td>120</td>
<td>40</td>
</tr>
</tbody>
</table>

Write the linear program that will minimize the shipping cost of supplying the stores.

Problem 7

Hammertown Steel (HS) is planning raw materials requirements for a 40 metric ton (1 MT = 1,000 kg) order for steel it has received from a customer. HS can source ores from a number of suppliers and wants to ensure it minimizes its raw materials costs, while meeting the order’s exacting product specifications.

All ores contain a mixture of various metals and waste. The following table summarizes the ores offered by various suppliers and the cost per metric ton (MT) of each:

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Composition</th>
<th>Cost/MT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metal 1</td>
<td>Metal 2</td>
</tr>
<tr>
<td>1</td>
<td>20%</td>
<td>11%</td>
</tr>
<tr>
<td>2</td>
<td>34%</td>
<td>15%</td>
</tr>
<tr>
<td>3</td>
<td>22%</td>
<td>19%</td>
</tr>
<tr>
<td>4</td>
<td>9%</td>
<td>14%</td>
</tr>
<tr>
<td>5</td>
<td>17%</td>
<td>10%</td>
</tr>
</tbody>
</table>
Refining eliminates all waste from the ore and the waste is sold to a gravel contractor for a net realizable value of $0. The contract for the steel has the following requirements:

1. The steel must contain at least 25% of metal 1
2. The steel must contain no more than 40% of metal 2
3. The steel may contain no less than 50% and no more than 70% of metal 3.

Write the linear program that will help the decision maker minimize the cost of raw materials needed to meet the requirements of this order.
SOLVED

Multiple Choice Questions

1. a  This function accurately describes the forming hours constraint.

2. c  

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Heavy Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$15</td>
<td>$20</td>
</tr>
<tr>
<td>Direct material</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Direct labour @ $10/forming hour</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Variable overhead @ $1 per total hours</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total variable costs</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Contribution margin per unit</td>
<td>$3</td>
<td>$3</td>
</tr>
</tbody>
</table>

3. d  Forming hours constraint:
24,000 - (.6 x 13,000) = 16,200 forming hours available
16,200 ÷ .8 = 20,250 rolls of heavy duty fencing can be produced

Bonding hours constraint:
24,000 - (.4 x 13,000) = 18,800 bonding hours available
18,800 ÷ 1.2 = 15,666 rolls of heavy duty fencing can be produced

From the above, we see the bonding hours constraint is binding; therefore, only 15,666 rolls of heavy duty fencing can be produced.

4. d

5. c

6. b
Problem 1

a. The contribution margin of the AC and ID projects are $300 (600 – 200 – 100) and $200 (500 – 100 – 200), respectively.

Therefore, the JP Enterprises objective function is:

Maximize 300AC + 200ID

The manager hours constraint can be written as:

2AC +1ID ≤ 40

The technician hours constraint can be written as:

2AC +4ID ≤ 100

and, AC, ID ≥ 0

The following is the graphical solution for this problem, which shows the best product mix is 10 AC jobs and 20 ID jobs, which provide a contribution margin of $7,000.
<table>
<thead>
<tr>
<th>Point</th>
<th>Project</th>
<th>Jobs Done</th>
<th>Tech Hours</th>
<th>Mgr Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AC</td>
<td>0</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>AC</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>AC</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>AC</td>
<td>0</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>AC</td>
<td>Activity costing</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>AC</td>
<td>Incentive</td>
<td>20</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>AC</td>
<td>Design</td>
<td>20</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>AC</td>
<td>Total</td>
<td>100</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td>Available</td>
<td>100</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

Graph 2.png
b. We now need to add the following constraint to the problem we solved in part a):

\[ \text{ID} \leq 10 \]

The following is the graphical solution for this problem, which shows the best product mix is now 15 AC jobs and 10 ID jobs, which provide a contribution margin of $6,500:
<table>
<thead>
<tr>
<th>Point</th>
<th>Activity costing</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project</th>
<th>Incentive design</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Done</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tech</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Point</th>
<th>Activity costing</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project</th>
<th>Incentive design</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Done</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tech</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Point</th>
<th>Activity costing</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project</th>
<th>Incentive design</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Done</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tech</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. This is a minimum cost question and the best solution is to use two units of ingredient A and three units of ingredient B to yield a total cost of 65.</td>
</tr>
</tbody>
</table>

The objective is to minimize the total cost of the ingredients so the objective function will be:

Minimize 10A + 15B

The O1 nutritional constraint will be:

2A + 4B ≥ 16

The O2 nutritional constraint will be:

6A + 4B ≥ 24

and, A, B ≥ 0

The following is the graphical solution:
### Brant General Hospital

#### Nutritional Requirement

<table>
<thead>
<tr>
<th>Units of Ingredient A Used</th>
<th>Units of Ingredient B Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Point</th>
<th>Ingredients</th>
<th>Units Used</th>
<th>O1 Provided</th>
<th>O2 Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>2</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>3</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>Total</td>
<td>16</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>O1 Required</th>
<th>O2 Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>
b. The solution changes since the least cost formulation in part a) required three units of ingredient B. We need to add the following constraint to the ones in part a):

\[ B \leq 2 \]

Imposing this constraint changes the best mix to four units of A and two units of B with a total cost of 70 as shown in the following diagram:
<table>
<thead>
<tr>
<th>Point</th>
<th>Ingredients</th>
<th>Units Used</th>
<th>O1 Provided</th>
<th>O2 Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2</td>
<td>A</td>
<td>4</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>A 8 4</td>
<td>B</td>
<td>2</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>B 0 2</td>
<td>Total</td>
<td>16</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Cost 80 70</td>
<td>Required</td>
<td>16</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>
Problem 3

Given that Horton Company wants to maximize the short-term profitability it needs to identify the contribution margins for the regular and deluxe chairs, which are $100 \,(300 - 100 - 80 - 20)$ and $145 \,(450 - 150 - 125 - 30)$, respectively.

So, letting $R$ be the number of regular chairs produced and $D$ the number of deluxe chairs produced, the objective function is:

Maximize $100R + 145D$

Subject to the following constraints:

Preparation: $3R + 3D \leq 600$

Assembly: $6R + 8D \leq 1160$

Finishing: $3R + 7D \leq 880$

and: $R, D \geq 0$
Problem 4

Note that the net realizable values of A, B and C are, respectively, $1.50 (2 - .5), $1.30 (1.5 - .2) and $.60 (.8 - .2). Letting the amount of excess burned for fuel be D, we can write the contribution margin of D as .2. We have the following objective function after noting the cost of acquiring and refining a barrel of crude oil is $110 (70 + 40) and letting the number of barrels of crude oil purchased and refined equal E.

Maximize \( 1.5A + 1.3B + .6C + .2D - 110E \)

Subject to the following constraints:

Marketing constraints:

\[ A \leq 16,000 \]
\[ B \leq 18,000 \]
\[ A \leq 6,000 \]

Use equations:

The use of Product A must not exceed the amount that is produced:

\[ A + D \leq 60E \text{ or } A + D - 60E \leq 0 \]

The use of Product B must not exceed the amount that is produced:

\[ B + D \leq 70E \text{ or } B + D - 70E \leq 0 \]

The use of Product C must not exceed the amount that is produced:

\[ C + D \leq 20E \text{ or } C + D - 20E \leq 0 \]

and,

\[ A, B, C, D, E \geq 0 \]
Problem 5

Let \( x_1 \) be the amount invested in Government of Canada Bonds
Let \( x_2 \) be the amount invested in certificates of deposit
Let \( x_3 \) be the amount invested in the low risk stock fund
Let \( x_4 \) be the amount invested in the high risk stock fund

The objective function will be:

Maximize \(.04x_1 + .055x_2 + .10x_3 + .18x_4\)

Subject to the following constraints:

Total funds available:
\( x_1 + x_2 + x_3 + x_4 \leq 100,000 \)

Constraint on low return stock fund noting that \( 100,000 \times 15\% = 150,000 \)
\( x_3 \leq 15,000 \)

Constraint on Government of Canada Bonds and certificates of deposit noting \( 100,000 \times 35\% = 35,000 \)
\( x_1 + x_2 \geq 35,000 \)

Constraint on high risk stock fund
\( x_4 \leq x_2 + x_3 \)

and,
\( x_1, x_2, x_3, x_4 \geq 0 \)
Problem 6

We need to begin by defining the following decision variables

Let:

\[ x_1 \] be the number of swing sets shipped from Kingston to Ottawa
\[ x_2 \] be the number of swing sets shipped from Kingston to Toronto
\[ x_3 \] be the number of swing sets shipped from Kingston to Windsor
\[ x_4 \] be the number of swing sets shipped from Oshawa to Ottawa
\[ x_5 \] be the number of swing sets shipped from Oshawa to Toronto
\[ x_6 \] be the number of swing sets shipped from Oshawa to Windsor
\[ x_7 \] be the number of swing sets shipped from London to Ottawa
\[ x_8 \] be the number of swing sets shipped from London to Toronto
\[ x_9 \] be the number of swing sets shipped from London to Windsor

We can now write the following objective function:

Minimize \( 80x_1 + 90x_2 + 150x_3 + 120x_4 + 30x_5 + 110x_6 + 210x_7 + 120x_8 + 40x_9 \)

There will be two sets of constraints. The first reflects the supply from each warehouse and the second reflects the demand at each store.

Supply constraints:

\[ x_1 + x_2 + x_3 \leq 3,000 \]
\[ x_4 + x_5 + x_6 \leq 7,000 \]
\[ x_7 + x_8 + x_9 \leq 5,000 \]

Demand constraints:

\[ x_1 + x_4 + x_7 = 6,000 \]
\[ x_2 + x_5 + x_8 = 2,000 \]
\[ x_3 + x_6 + x_9 = 5,000 \]

and finally

\[ x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9 \geq 0 \]
Problem 7

Begin by defining the decision variables in this problem:

\[ \begin{align*}
  x_1 & \text{ be the metric tons purchased from supplier 1} \\
  x_2 & \text{ be the metric tons purchased from supplier 2} \\
  x_3 & \text{ be the metric tons purchased from supplier 3} \\
  x_4 & \text{ be the metric tons purchased from supplier 4} \\
  x_5 & \text{ be the metric tons purchased from supplier 5} \\
  x_6 & \text{ be the amount of metal 1 available} \\
  x_7 & \text{ be the amount of metal 2 available} \\
  x_8 & \text{ be the amount of metal 3 available} \\
  x_9 & \text{ be the amount of metal 1 used in the final recipe} \\
  x_{10} & \text{ be the amount of metal 2 used in the final recipe} \\
  x_{11} & \text{ be the amount of metal 3 used in the final recipe}
\end{align*} \]

We can now write the following objective function:

\[ \text{Minimize } 36x_1 + 38x_2 + 48x_3 + 25x_4 + 45x_5 \]

We now turn to identifying the problem constraints:

We need to define equations and variables so that the linear program can keep track of the supply of the metals:

Metal availability:

We have:

\[ \begin{align*}
  x_6 &= .20x_1 + .34x_2 + .22x_3 + .9x_4 + .17x_5 \\
  x_7 &= .11x_1 + .15x_2 + .19x_3 + .14x_4 + .10x_5 \\
  x_8 &= .33x_1 + .18x_2 + .28x_3 + .23x_4 + .24x_5
\end{align*} \]

We need to define equations and variables so the linear program can link between metal availability and metal use. Metal use must not exceed what is available and must constitute the appropriate amount in the final recipe.
Use

Metal 1

\[ x_9 \leq x_6 \]

Metal 2

\[ x_{10} \leq x_7 \]

Metal 3

\[ x_{11} \leq x_8 \]

Recipe:

\[ x_9 \geq 40 \times 1,000 \times .25 \text{ or } x_9 \geq 10,000 \]

\[ x_{10} \leq 40 \times 1,000 \times .40 \text{ or } x_{10} \leq 16,000 \]

\[ x_{11} \leq 40 \times 1,000 \times .70 \text{ or } x_{11} \leq 28,000 \]

\[ x_{11} \geq 40 \times 1,000 \times .50 \text{ or } x_{11} \geq 20,000 \]

Finally, what forces the balance:

\[ x_9 + x_{10} + x_{11} = 40 \times 1,000 \text{ or } x_9 + x_{10} + x_{11} = 40,000 \]

and,

\[ x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11} \geq 0 \]
12. Uncertainty

Learning Objectives

After completing this chapter, you will:

1. Understand the scope and role of decision making under uncertainty
2. Understand the implications of uncertainty for organization risk
3. Understand the concept of expected value and be able to compute the expected value of a decision.

Decision Making Under Uncertainty

Uncertainty is the situation where an action can have more than one outcome and the outcome that will occur is unknown. For example, when someone tosses a coin, there are two possible outcomes, face up or face down.

For our purposes, we will define risk as the potential for uncertainty to impair an organization’s ability to achieve its objectives. When a gambler tosses a coin and places a wager on whether the coin will land face up or face down, the gambler is facing risk.

Most important decisions made in organizations involve actions taken place in the face of uncertainty and, therefore, risk. In this chapter, we develop the basics of decision making under uncertainty and apply those basics to some simple situations.

The Elements of Decision Making Under Uncertainty

In order to develop the idea of decision making under uncertainty, we will need the following definitions:

1. An objective function. We saw the idea of an objective function in Chapter 11 when we discussed linear programming. In this setting, as we will see, the objective function will be different.

2. A set of possible actions. This is the set of alternative actions the decision maker can undertake. In the case of tossing a coin, there were two actions given that the wager will be undertaken, wager the coin will fall face up or wager it will fall face down.

3. A set of possible events. This is the set of possible settings that will confront the action. These are beyond the control of the decision maker. In the case of the coin tossing, the possible events are the coin will fall face up or face down. We exclude other possibilities such as the coin landing on its edge.

4. A set of probabilities that define the chance of each event occurring. In the case of tossing a fair coin, we believe the chance of the coin landing face up is half and landing face down is half. The sum of the probabilities of all possible events must equal one. Although this is not a topic in this chapter, you should know that research has
demonstrated that humans have a considerable amount of difficulty processing probability, both in terms of understanding its meaning and the notion that the probability of all possible events should sum to one. This creates issues in practice when advising managers making decisions in the face of uncertainty.

5. **A set of possible outcomes.** Outcomes measure the consequence to the decision maker of each action event pair. Decision makers often express the set of outcomes in an outcomes table. The following is the table for the coin toss example we have been describing, assuming the gambler is betting $1 on the coin toss:

<table>
<thead>
<tr>
<th>Gambler bets face up</th>
<th>Coin Lands Face Up</th>
<th>Win $1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gambler bets face down</td>
<td>Coin Lands Face Down</td>
<td>Lose $1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gambler bets face up</th>
<th>Coin Lands Face Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gambler bets face down</td>
<td>Win $1</td>
</tr>
</tbody>
</table>

### Issues with the Decision Making Under Uncertainty Model

There are a number of often difficult issues surrounding the decision making under uncertainty model:

1. **The objective function.** In this chapter we will adopt the expected value model, which is a commonly used objective function in decision making under uncertainty. The expected value model likely reflects how many, if not most, decisions should be made in organizations. However, there are many other approaches to defining a decision making objective function in the face of uncertainty. Most of these reflect the aversion people often have towards risk. Some common alternatives to the expected value model are the expected utility model, the minimum criterion and the minimum regret criterion.

2. **A set of possible actions.** In this chapter, we will focus on decisions where the alternative actions are known. However, in practice organizations may fail to identify all possible courses of action in a decision making setting. This failure creates lost opportunities. For example, with the advent of availability of digitized music on the Internet, the music publishing companies pursued their (legitimate) rights under copyright protection. However, for a long time the music companies failed to consider alternative actions for distributing their music through the Internet.

3. **A set of possible events.** In many situations, it may be difficult to identify the entire set of possible events. Many times, decision makers fail to consider possible events that can have huge implications for the consequences of their decision. For example, an organization implementing a new product may fail to consider the possibility that a major competitor may soon release a new product that is better. When the event is a random state of nature, such as the weather conditions facing a farmer in a decision about what crop to plant, events are called states.

4. **A set of probabilities that define the chance of each event occurring.** This is the most difficult issue in decision making under uncertainty since countless experiments have shown humans do not usually process uncertainty in ways that are internally consistent or
rational from the perspective of classical statistics. We, therefore, must recognize that the expected value model we discuss in this chapter is offered as an approach to how people should make decisions (that is, expected value decision making is a normative theory) in the face of uncertainty to benefit their organizations rather than how they would make decisions if they relied on basic human probability processing to make those decisions (that is, expected value decision making is not a descriptive theory) psychology.

5. **A set of possible outcomes.** Here again, we face the issue of uncertainty when we estimate the outcome of a joint action event pair. For example, assume in the context of introducing a new product, one action event pair is to introduce the new product and a competitor reacts with a high level response (such as cutting price). The issue is that the outcome of this action event pair is uncertain and must be estimated.

With all this in mind, we continue our discussion of decision making under conditions of uncertainty with the warning that we are approaching this topic in a way that is stylized.

**Probability Forms**

Decision makers assess event uncertainty using two approaches, discrete probability distributions or continuous probability distributions.

**Discrete Probability Distributions**

In a discrete probability distribution, each of a finite number of events is assigned a probability of occurring. The result of coin toss is modeled as a discrete distribution as follows:

| Event – coin lands face up | Probability – \( \frac{1}{2} \) |
| Event – coin lands face down | Probability – \( \frac{1}{2} \) |

In business settings, discrete distributions often appear in the following form. A marketing manager describes his beliefs about the outcome of a marketing program as:

<table>
<thead>
<tr>
<th>Sales (in units)</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>0.1</td>
</tr>
<tr>
<td>120,000</td>
<td>0.15</td>
</tr>
<tr>
<td>140,000</td>
<td>0.4</td>
</tr>
<tr>
<td>160,000</td>
<td>0.2</td>
</tr>
<tr>
<td>180,000</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Expected value is an important concept we will exploit below since it has many important decision making roles. To compute the expected value of sales in the above distribution, we compute the weight each sales amount (outcome) by its probability and sum all the weights. The following table shows the calculation:
It is more likely a decision maker would associate a probability with a range of values. In that case, we weight the mid-point of the range as the value to weight. The following is an example:

### An Example of Decision Making Using Expected Value

A production manager is faced with a choice between two machines, each of which costs $75,000. The machines have the following characteristics relating to their operating cost savings:

<table>
<thead>
<tr>
<th>Cost Savings</th>
<th>Machine 1 Probability</th>
<th>Weight</th>
<th>Cost Savings</th>
<th>Machine 2 Probability</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$45,000</td>
<td>.1</td>
<td>$4,500</td>
<td>20,000</td>
<td>.1</td>
<td>$2,000</td>
</tr>
<tr>
<td>60,000</td>
<td>.2</td>
<td>12,000</td>
<td>50,000</td>
<td>.1</td>
<td>5,000</td>
</tr>
<tr>
<td>80,000</td>
<td>.3</td>
<td>24,000</td>
<td>100,000</td>
<td>.4</td>
<td>40,000</td>
</tr>
<tr>
<td>110,000</td>
<td>.2</td>
<td>22,000</td>
<td>120,000</td>
<td>.3</td>
<td>36,000</td>
</tr>
<tr>
<td>140,000</td>
<td>.2</td>
<td>28,000</td>
<td>130,000</td>
<td>.1</td>
<td>13,000</td>
</tr>
<tr>
<td>$90,500</td>
<td></td>
<td></td>
<td>$96,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If the manager were to choose the between these two machines based on the expected cost savings, she would choose Machine 2, which has an expected net benefit of $5,500 ($96,000 - 90,500).

Assume now, based on above initial calculation, the decision maker asks: “If I choose Machine 1, what is the probability, given my beliefs, that I will at least breakeven?”
We begin by computing the cumulative probability distribution for machine 1. The cumulative distribution is the probability that an outcome will be less than or equal to a value. The following is the cumulative distribution for the machine 1 savings:

<table>
<thead>
<tr>
<th>Cost Savings</th>
<th>Probability</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>45,000</td>
<td>0.1</td>
<td>0.10</td>
</tr>
<tr>
<td>60,000</td>
<td>0.2</td>
<td>0.30</td>
</tr>
<tr>
<td>80,000</td>
<td>0.3</td>
<td>0.60</td>
</tr>
<tr>
<td>110,000</td>
<td>0.2</td>
<td>0.80</td>
</tr>
<tr>
<td>140,000</td>
<td>0.2</td>
<td>1.00</td>
</tr>
</tbody>
</table>

So, for example, we can say that given this decision maker’s beliefs, the probability is 60% that cost savings will be $80,000 or less.

Now the project will breakeven when the operating cost savings equal the machine’s purchase price of $75,000. Using the above table, we can compute the probability that savings will be at least $75,000 by noting that $75,000 is three quarters \((75,000 – 60,000) / (80,000-60,000)\) of the way along the interval between 60,000 and 80,000 of cost savings. The corresponding interval for the cumulative probability is 30% to 60% and, therefore, three quarters of the way along this interval would be 52.5% \((30\% + ¾(60\%-30\%))\). Based on the decision maker’s beliefs, we would conclude the probability the cost savings will be less than or equal to $75,000 is 52.5%. Therefore, the probability the cost savings being equal to or greater than $75,000 (that is, at least breaking even) is 47.5% \((1 – 52.5\%)\).

Continuous Probability Distributions

Continuous distribution events are seen as continuous (infinitely many) so a probability distribution is used to define event probabilities.

The Uniform Distribution

Assume a marketing manager is estimating the sales of a new product. The marketing manager believes sales will not be less than 100,000 units or more than 120,000 units. However, each of these values, and all values on the interval between them are equally likely. When all values on a defined interval are equally likely, we call the distribution a uniform or rectangular distribution. In this setting, we have an infinite number of possible outcomes (if we allow non-integer demands). Since there is an infinite number of possible events, the probability of any one event occurring is zero, a strange concept indeed. In this case we focus on the probability that demand falls in an interval. Assume the marketing manager wants to estimate the probability that demand will be 105,000 units or above since 105,000 unit sales is the breakeven sales for this project. Fortunately, this is easy to do with the uniform distribution. The formula the marketing manager would use to estimate the probability that demand will be 105,000 or higher is 75%:
\[
\frac{120,000 - 105,000}{120,000 - 100,000} = .75
\]

The following picture illustrates this concept. Think of the area enclosed by the rectangle in the following diagram being equal to 1. The space occupied by the cross hatched area equals the probability that demand equals or exceeds 105,000 units. The proportion of the total rectangle that is occupied by the cross hatched area represents the probability that demand will equal or exceed 105,000 units.

More generally, we can compute the probability the outcome drawn from a uniform distribution will equal or exceed some target value as:

\[
\frac{\text{Upper bound} - \text{target value}}{\text{Upper bound} - \text{lower bound}}
\]

We can compute the probability an outcome drawn from a uniform distribution will equal or be less than some target value as:

\[
\frac{\text{Target value} - \text{lower bound}}{\text{Upper bound} - \text{lower bound}}
\]
Decision Making Using the Uniform Distribution

A decision maker is considering a marketing campaign that will cost $5,000,000. The campaign will promote a product whose selling price is $15 and variable cost is $7. The decision maker estimates the sales increase resulting from this campaign is uniformly distributed over the range 500,000 to 800,000 units. Using the expected value criterion, is this project desirable?

The expected value of a uniform distribution is its mid-point, which is computed as follows:

\[
\text{mid-point} = \frac{\text{upper limit} + \text{lower limit}}{2}
\]

In this example, the expected sales increase resulting from this advertising campaign is 650,000 units ((500,000+800,000) / 2). Since the product contribution margin is $8 (15 – 7) per unit, the expected contribution margin increase from the sales campaign is $5,200,000 (650,000 * 8) and the expected incremental contribution from this campaign is $200,000 (5,200,000 – 5,000,000).

Assume the decision maker wants to compute the probability of at least breaking even on this project given the stated beliefs. Once we have captured the decision maker’s beliefs using the uniform distribution, this question can be easily answered.

Recall from our cost volume profit discussions in Chapter 9, we can compute the breakeven sales for the advertising campaign as:

\[
\text{Breakeven sales} = \frac{\text{Advertising costs}}{\text{CM per unit}} = \frac{5,000,000}{8} = 625,000 \text{ units}
\]

Using the formula we developed above, we can compute the probability of sales being at least 625,000 units as:

\[
\frac{800,000 - 625,000}{800,000 - 500,000} = 58.33\%
\]
The Normal Distribution

Because so many populations around us are distributed according to the normal distribution, the normal distribution is widely used in assessing probabilities in decision making. The following is a picture of the normal distribution:

The normal distribution is symmetrical about its middle value, which is called its mean. The dispersion of the distribution about its mean is called the standard deviation. The larger the standard deviation the more the distribution is flatted out while still maintaining its bell shape.

Returning to our example above, assume the marketing manager now feels the uniform distribution is not an adequate characterization of her views. Instead the marketing manager believes the distribution of demand is normally distributed with a mean of 110,000 and a standard deviation of 3,000 units. The following is what the distribution of demand looks like:
Since the normal distribution is continuous like the uniform distribution, we talk about the probability of values under the distribution being more or less than a target value.

The calculation of probabilities using the normal distribution is beyond the scope of this course.

Payoff Tables

Decision analysis is often posed in the context of the decision maker facing uncertain acts of nature. This is the setting where the outcome of the decision is determined either by random acts of nature or the actions of competitors that are modelled as uncertain.

Consider the following setting. Golden Beer Company is planning an advertising promotion for its major product. The sales and marketing team believe the success of the promotion will depend upon the actions of its major competitors, which are difficult to predict with any certainty.

The team has developed the following payoff matrix, which is interpreted as follows. The team has decided on two possible strategies, a low level promotion or a high level promotion. These are the actions in this decision problem. Since promotions are planned in secret and only announced at the last minute, competitors cannot react. What determines outcomes is whether competitors are planning their own promotions, which they implement. The outcomes noted below are the incremental cash flows from the each action event pair:

<table>
<thead>
<tr>
<th>Competitors Have No Promotions Planned</th>
<th>Competitors Have Promotions Planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low level promotion</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>High level promotion</td>
<td>$3,000,000</td>
</tr>
<tr>
<td></td>
<td>$ 200,000</td>
</tr>
<tr>
<td></td>
<td>-$2,000,000</td>
</tr>
</tbody>
</table>

The team believe that based on their knowledge of competitor’s current preoccupations, the probability they are planning promotions is 40%.

With this information, we can compute the expected value of Golden Beer Company’s two possible actions:

- Expected value of low level promotion = 60% * 1,000,000 + 40% * 200,000 = $680,000
- Expected value of high level promotion = 60% * 3,000,000 + 40% * -2,000,000 = $1,000,000

Based on this information, if Golden Beer’s objective is to maximize expected value, it would choose the high level promotion.

Sensitivity of Choice to Probability Estimates

Assume Golden Beer management wanted to know the range of probabilities for which each action alternative would be favoured. If we let the probability that competitors have no promotions planned equal p, management’s question can be answered by solving the following equation for the value p.
Expected value of low level promotion is greater than the expected value of the high level promotion if:

\[ p \times 1,000,000 + (1-p) \times 200,000 > p \times 3,000,000 + (1-p) \times -2,000,000 \]

or

\[ p > 0.523809524 \]

If the assessed probability that competitors are not planning a promotion is approximately 52% or greater, then Golden Beer should implement the high level promotion.

This example has been framed in the context that the actions of competitors are independent of what Golden Beer does. If they are not, that is, each is considering what the other is up to and planning accordingly, then this type of analysis is inappropriate. Rather, the setting should be formulated using concepts in Game Theory, which are beyond the scope of this review. In summary, the decision making here is in the presence of a random set of events.

The Expected Value of Perfect Information

While much of the data for decision models managers use will come from information developed and reported by management accountants, some of the most interesting opportunities for management accountants to support decision making come from special studies suggested by decision problems.

Consider the situation of Eby Company, which is considering purchasing a piece of production equipment that will lower its variable manufacturing costs. The problem is, this is a new piece of equipment and the exact amount of the manufacturing cost savings is unknown. However, based on historical experience, the production manager believes that the per unit cost savings will be either $3.90 with probability .4 or $4.20 with probability.6. The machine will cost $1,000,000 and will produce 250,000 units over its lifetime. Based on this information, the expected value of the machine will be its projected savings minus its costs and we can compute the expected value (incremental costs) of acquiring this machine as:

\[ \text{Expected value} = 40\% \times 3.90 \times 250,000 + 60\% \times 4.20 \times 250,000 - 1,000,000 = 20,000 \]

Assume the production manager is considering a costing study that will establish, with certainty, the actual cost savings associated with this machine. Given this setting, what is the most the production manager should be willing to pay for this study?

Assume the study is undertaken and determines the cost savings per unit will be $3.90. The incremental cash flow provided by the machine would be -$25,000 (3.9 * 250,000 – 1,000,000) and the best decision would be to not buy the machine given knowledge that the cost savings will be $3.90. If the study is undertaken and determines the cost savings per unit will be $4.20, the incremental cash flow provided by the machine would be $50,000 and the best decision, given this information, would be to buy the machine.

Based on prior beliefs, there is a probability of 40% that the study will conclude the best decision is to not purchase the machine with an outcome of $0 and a 60% chance the study will conclude...
the best decision is to purchase the machine with an outcome of $50,000. Therefore, the estimate of decision making with the study results is:

\[
\text{Expected value} = 40\% \times 0 + 60\% \times 50,000 \text{ or } 30,000
\]

However, the expected value of decision making without the study is $20,000 as we computed above. Therefore, the incremental benefit of the study is $10,000 (30,000 – 20,000), which is the most the production manager should be willing to pay for the study.

This value of $10,000 is called the expected value of perfect information. This is an important concept and is widely used, at least implicitly in many decisions. This concept can be used to estimate the potential value of special studies or test markets. The concept is also related to real options analysis which is a formal way of evaluating the potential to delay a decision while more information is developed.

Conclusion:

You should remember that approaches to decision making under uncertainty as discussed above are normative approaches, that is, how the decision should be made if the decision maker has the objective of maximizing the expected value of a decision. For managers making decisions that commit a small part of their organization’s wealth on a decision or in an organization where each owner has a small stake in any outcome, the expected value hypothesis is a reasonable decision making criterion.

However, there is consistent evidence to show that, in general, managers do not process probabilities in the way they were discussed above. Therefore, decisions intended to reflect expected value may not in practice because people, in general, do not do a good job of developing or processing probabilities.

A second issue is that the expected value criterion invariably does not reflect how people make personal decisions in the face of uncertainty. The expected value criterion reflects a concept called risk neutrality. This means, only the expected value or the mean of the decision matters and not its variability. When variability matters, the expected value criterion is no longer appropriate.

Consider the following example. Assume you inherit a lottery ticket that will pay you $10,000,000 if your number is drawn and $0 otherwise. The probability your number will be drawn is known because the number of tickets is known and it equals 1%. Therefore, the expected value of this lottery ticket is $100,000 (1% * 10,000,000). Most people would sell this lottery ticket (before the draw) for less than $100,000. When someone values an asset for less than its expected value, the person is said to be exhibiting risk aversion.

On the other hand, most lottery ticket purchases exhibit risk seeking behaviour since the expected value of the ticket is negative and the payoff to purchasers is less than the amount collected from the ticket buyers.

Risk taking and risk aversion are decision making traits people exhibit and, therefore, must be considered in the context of business decision making. If decisions made by people in
organization setting should reflect the expected value hypothesis then the management accountant should be aware that decision makers may not follow this approach.

As we will see in subsequent chapters, the uncertainty and probability tools we have developed in this chapter can used effectively in modelling the uncertainty decision makers face in many practical settings.
Problems with Solutions

Multiple Choice Questions

The following information relates to Questions 1 – 3:

Maggie Company is considering buying a new production machine. The supplier has advised Maggie Company that, based on the experience of other customers making a product comparable to Maggie Company’s main product, it estimates the cost per unit for Maggie’s product has the following distribution:

<table>
<thead>
<tr>
<th>Cost per Unit</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5.00</td>
<td>0.30</td>
</tr>
<tr>
<td>$5.05</td>
<td>0.20</td>
</tr>
<tr>
<td>$5.10</td>
<td>0.20</td>
</tr>
<tr>
<td>$5.15</td>
<td>0.10</td>
</tr>
<tr>
<td>$5.20</td>
<td>0.10</td>
</tr>
<tr>
<td>$5.25</td>
<td>0.10</td>
</tr>
</tbody>
</table>

1. The probability the cost will be $5.20 or less is:
   a. 90%
   b. 70%
   c. 50%
   d. None of the above

2. The probability the cost will be more than $5.10 is:
   a. 10%
   b. 20%
   c. 30%
   d. 40%

3. The probability the cost will be $5.10, $5.15 or $5.20 is:
   a. 10%
   b. 20%
   c. 30%
   d. 40%
The follow information relates to Questions 4 – 6:

Pepper’s On Line Groceries has been contracting out the delivery of grocery hampers to its customers in Hamilton. The contractor is charging Pepper a fixed amount of $10 for each package irrespective of its destination. A study has concluded the cost per package, if Pepper’s does its own deliveries, will vary between $3 and $15, with all values on this interval equally likely.

4. The probability the cost to deliver a package will be $10 or less is about:
   a. 42%
   b. 58%
   c. 62%
   d. 83%

5. The probability the cost will be $12 or more is about:
   a. 25%
   b. 33%
   c. 58%
   d. 75%

6. The probability the cost will be between $8 and $12 is about:
   a. 20%
   b. 33%
   c. 66%
   d. 80%
Problem 1

A company is considering three alternative machines to produce a new product. The cost structures (unit variable costs plus avoidable fixed costs) for the three machines are shown below. The selling price is unaffected by the machine used.

<table>
<thead>
<tr>
<th>Machine</th>
<th>Unit Variable Cost</th>
<th>Avoidable Fixed Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single purpose machine</td>
<td>$.60</td>
<td>$20,000</td>
</tr>
<tr>
<td>Semi-automatic machine</td>
<td>$.40</td>
<td>$50,000</td>
</tr>
<tr>
<td>Automatic machine</td>
<td>$.20</td>
<td>$120,000</td>
</tr>
</tbody>
</table>

The demand for units of the new product is described by the following probability distribution:

<table>
<thead>
<tr>
<th>Demand</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>200,000</td>
<td>.4</td>
</tr>
<tr>
<td>300,000</td>
<td>.3</td>
</tr>
<tr>
<td>400,000</td>
<td>.2</td>
</tr>
<tr>
<td>500,000</td>
<td>.1</td>
</tr>
</tbody>
</table>

Required:

Calculate expected demand. Calculate the expected costs of each machine. Which machine should be selected?

Problem 2

Your client wants your advice on which of two alternatives he should choose. One alternative is to sell an investment now for $10,000. Another alternative is to hold the investment three days, after which he can sell it for a certain selling price based on the following probabilities:

<table>
<thead>
<tr>
<th>Selling Price</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 5,000</td>
<td>.4</td>
</tr>
<tr>
<td>8,000</td>
<td>.2</td>
</tr>
<tr>
<td>12,000</td>
<td>.3</td>
</tr>
<tr>
<td>30,000</td>
<td>.1</td>
</tr>
</tbody>
</table>

Required:

Would you recommend selling the investment now or hold the investment for three days?
Problem 3

The Elwood Company is considering hiring several new employees to handle an overload from a new contract. If the new people are not hired, there will be delays in contract work. The following payoff matrix has been prepared for analyzing whether new people are needed:

<table>
<thead>
<tr>
<th></th>
<th>Hire New People</th>
<th>Do Not Hire New People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retain new customers</td>
<td>$100,000</td>
<td>$75,000</td>
</tr>
<tr>
<td>Lose new customers</td>
<td>25,000</td>
<td>50,000</td>
</tr>
</tbody>
</table>

Based on past experience, the company expects to retain 75% of the new customers with no new hires.

Required:

Calculate the expected profit for the "no hire" decision.
Problem 4

The Gallant Company manufactures a unique thermostat that yields dramatic cost savings from effective climatic control of large buildings. The efficiency of the thermostat is dependent upon the quality of a specialized thermocoupler. These thermocouplers are purchased from Braun Company for $15 each.

Since early 2003, an average of 10% of the thermocouplers purchased from Braun has not met Gallant's quality requirements. The number of unusable thermocouplers has ranged from 5% to 25% of the total number purchased and has resulted in failures in meeting production schedules. In addition, Gallant has incurred additional costs to replace the defective units because the rejection rate of the units is within the range agreed upon in the contract.

Gallant is considering a proposal to manufacture the thermocouplers. The company has the facilities and equipment to produce the components. The engineering department has designed a manufacturing system that will produce the thermocouplers with a defective rate of 4% of the number of units produced. The following schedule presents the engineer's estimates of the probabilities that different levels of variable manufacturing cost per thermocoupler will be incurred under this system. Additional annual fixed costs incurred by Gallant, if it manufactures the thermocoupler, will amount to $32,500.

<table>
<thead>
<tr>
<th>Estimated Variable Manufacturing Cost Per Thermocoupler Unit</th>
<th>Probability Of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10</td>
<td>.1</td>
</tr>
<tr>
<td>$12</td>
<td>.3</td>
</tr>
<tr>
<td>$14</td>
<td>.4</td>
</tr>
<tr>
<td>$16</td>
<td>.2</td>
</tr>
</tbody>
</table>

Gallant Company will need 18,000 thermocouplers to meet its annual demand requirements.

Required:

Prepare an expected value analysis to determine whether Gallant Company should manufacture the thermocouplers.
Problem 5

The Finch Company manufactures modular furniture for the home and uses a monthly variance system to control costs of the manufacturing departments. Peter Carter is the supervisor of the assembly department and is reviewing the monthly variance analysis for November:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard cost of production materials</td>
<td>$275,000</td>
</tr>
<tr>
<td>Materials price variance</td>
<td>-0-</td>
</tr>
<tr>
<td>Materials quantity variance, unfavourable</td>
<td>19,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$294,000</strong></td>
</tr>
</tbody>
</table>

Carter has gathered the following information to assist him in deciding whether or not to investigate the unfavourable materials quantity variance:

- Estimated cost to investigate the variance: $4,000
- Estimated probability that the assembly department is operating properly: 90%
- If the assembly department is operating improperly:
  - Estimated cost to make the necessary changes: $8,000
  - Estimated present value of future unfavourable variances that would be saved by making the necessary changes: $40,000

Required:

a. Recommend whether or not Finch Company should investigate the unfavourable materials quantity variance.

b. Peter Carter is uncertain about the probability estimate of 90% for proper operation of the assembly department. Determine the probability estimate of the assembly department operating properly that would cause Collins to be indifferent between the two possible actions.
Problem 6

Ajay Patel, the general manager of the Grand River Flyers hockey team, is considering making a one year contract offer to Brett Hart, a prolific goal scorer. Adding Hart to the team will have no effect on regular season sales since those tickets are already sold out. Hart’s effect will be to boost the team’s chances of having a successful playoff season. Patel has estimated the incremental net cash flows (before considering Hart’s salary) of signing Hart as:

<table>
<thead>
<tr>
<th>Incremental Net Cash Flow</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,000,000</td>
<td>0.1</td>
</tr>
<tr>
<td>$3,000,000</td>
<td>0.3</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>0.2</td>
</tr>
<tr>
<td>$8,000,000</td>
<td>0.2</td>
</tr>
<tr>
<td>$9,000,000</td>
<td>0.1</td>
</tr>
<tr>
<td>$10,000,000</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Required:

a. What is the expected value of offering Hart a one year contract before considering his salary?
b. If Hart is offered $6,000,000, what is the probability the Flyers will at least breakeven on this contract?
c. Hart’s agent proposes Hart be paid either $5,000,000 or $2,000,000 plus 50% of the incremental net cash flow he creates. Based on expected value, which contract should the Flyers accept?

Problem 7

Bruce Quinn, the chief financial officer of a large Government of Canada department, is considering two projects, each designed to achieve the same mandated government objective. The costs of both products are subject to uncertainty and are described in the following exhibit:

<table>
<thead>
<tr>
<th>Project 1</th>
<th>Project 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Cost</td>
</tr>
<tr>
<td>$40,000,000</td>
<td>$40,000,000</td>
</tr>
<tr>
<td>$50,000,000</td>
<td>$48,000,000</td>
</tr>
<tr>
<td>$62,000,000</td>
<td>$62,000,000</td>
</tr>
<tr>
<td>$71,000,000</td>
<td>$75,000,000</td>
</tr>
<tr>
<td>$82,000,000</td>
<td>$85,000,000</td>
</tr>
</tbody>
</table>

Required:

a. If the criterion is to choose the project with the lowest expected cost, which project should Bruce recommend?
b. If the criterion is to choose the project whose cost has the lower probability of exceeding $70,000,000, which project should Bruce recommend?
Problem 8

Essence Woo, a project manager at Woodstock Software Company, is deciding which of two possible projects should be implemented. Both projects involve a new computer game that appears to be profitable but available programming resources dictate only one can be implemented. The following table summarizes the present value of the incremental net cash flows for the two games:

<table>
<thead>
<tr>
<th>Net Cash Flow</th>
<th>Probability</th>
<th>Game 1</th>
<th>Net Cash Flow</th>
<th>Probability</th>
<th>Game 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$35,000,000</td>
<td>0.1</td>
<td></td>
<td>$25,000,000</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>$39,000,000</td>
<td>0.1</td>
<td></td>
<td>$35,000,000</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>$45,000,000</td>
<td>0.6</td>
<td></td>
<td>$45,000,000</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>$49,000,000</td>
<td>0.1</td>
<td></td>
<td>$55,000,000</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>$50,000,000</td>
<td>0.1</td>
<td></td>
<td>$65,000,000</td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

Required:

a. If the criterion is to implement the game with the highest present value of incremental cash flows, which game should Essence choose?

b. Is there a circumstance were Essence might prefer to implement Game 1?

Problem 9

Mary Jones, the president and general manager of Down the Road Construction Company, is considering what bid to make on a government contract. Mary has determined the cost of completing the contract will be $5,000,000. Bids must be made in multiples of $100,000. Based on the historical pattern of winning bids, Mary has constructed the following table of bids and the probability they will be accepted:

<table>
<thead>
<tr>
<th>Bid</th>
<th>Probability of Winning</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5,100,000</td>
<td>30%</td>
</tr>
<tr>
<td>$5,200,000</td>
<td>25%</td>
</tr>
<tr>
<td>$5,300,000</td>
<td>20%</td>
</tr>
<tr>
<td>$5,400,000</td>
<td>15%</td>
</tr>
<tr>
<td>$5,500,000</td>
<td>10%</td>
</tr>
<tr>
<td>$5,600,000</td>
<td>5%</td>
</tr>
<tr>
<td>$5,700,000</td>
<td>0%</td>
</tr>
</tbody>
</table>

Required:

a. If Mary makes decisions based on maximizing expected value, what is her best bid?

b. Repeat the analysis assuming Mary now believes the competitor’s bids will vary from $5,000,000 to $5,600,000, with all bids on this interval equally likely.
Problem 10

Angus Company is considering developing a GPS unit to be mounted in automobiles. Given the company’s existing technology, the cost to develop the product would be $5,000,000 and it would be produced using the excess capacity of existing production equipment. The variable cost to make, sell and ship each unit is estimated to be $50.

Angus Company is considering two price points for this product, $130 per unit or $100 per unit. If the product is priced at $130 per unit, total demand over the product’s life is estimated to vary between 50,000 and 80,000 units, with all values on this interval equally likely. If the product is priced at $100 per unit, the total demand over the product’s life is estimated to vary between 70,000 and 140,000 units, with all values on this interval equally likely.

Required:

a. What is the breakeven quantity of sales if the product is priced at $100? At 130?

b. What is the probability of breaking even if the product is priced at $100? At 130?

c. If Angus Company decision makers use the expected value decision making criterion, what price should they set?

Problem 11

Danny T, the senior executive at Drumbo Promotions, is considering the level of advertising for an upcoming event. Demand for the event could be high or low. The effort level Drumbo Promotions can put into promoting the event could be high or low. The following table identifies the payoffs to Drumbo for each of the promotion demand pairs:

<table>
<thead>
<tr>
<th>Demand High</th>
<th>Demand Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion level high</td>
<td>$140,000</td>
</tr>
<tr>
<td>Promotion level low</td>
<td>$ 50,000</td>
</tr>
</tbody>
</table>

Required:

a. If Danny makes decisions based on expected value, what is the probability of demand being high above which Danny would undertake a high promotion level?

b. How much would Danny be willing to pay for a marketing study that would determine, with certainty, whether demand would be high or low for each prior probability assessment from 10% and 90% in increments of 10%?
Problem 12

Don Telfer, a farmer, is deciding whether to plant soy beans or corn in the upcoming period. His decision will depend on weather conditions that prevail during the growing season. Don has developed his expected return for each type of crop for each of two types of weather conditions during the growing season.

<table>
<thead>
<tr>
<th></th>
<th>Weather Condition 1</th>
<th>Weather Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soy beans</td>
<td>$50,000</td>
<td>-$10,000</td>
</tr>
<tr>
<td>Corn</td>
<td>$20,000</td>
<td>$50,000</td>
</tr>
</tbody>
</table>

Required:

a. If Don believes the probability is 65% that weather condition 1 will prevail, what is the best crop for him to plant?

b. What is the most Don should be willing to pay for insurance that will insure him against any loss?

Problem 13

Jacques is on his annual hunt for December holiday bargains. This time he is looking for deals on a new television set to enhance his viewing of his favourite program Timbersports. Jacques research has identified two possible actions. The first is to purchase the television from a local electronics store for $2,000. The alternative is to wait and purchase the television set from a local department store. The current price for the same television set is $2,400. However, based on past experience, Jacques believes the price will be slashed to $1,700 if stock is available in mid-December. However, if there is no stock available, the best alternative price is to buy directly from the manufacturer for $2,500.

Required:

What is the probability that Jacques assesses for the TV to be out of stock at the department store above, which his best choice is to buy now in order to minimize his costs?
SOLUTIONS

Multiple Choice Questions

1. a

Equals the sum of the probabilities of demand being $5, $5.05, $5.10, $5.15 and $5.20 = (.3 + .2 + .2 + .1 + .1) = .9

Alternatively this equals the 1 minus the probability demand is greater than $5.20
= (1 – .1) = .9

2. c

Equals the sum of the probabilities of demand being $5.15, $5.20 and $5.25 = (.1 + .1 + .1) = .3

3. d

.2 + .1 + .1 = .4

4. b

5. a

6. b
Problem 1

Expected demand = (200,000 x .4) + (300,000 x .3) + (400,000 x .2) + (500,000 x .1)
= 80,000 + 90,000 + 80,000 + 50,000
= 300,000

Single purpose machine: $.60(300,000) + 20,000 = $200,000
Semi-automatic machine: $.40(300,000) + 50,000 = $170,000
Automatic machine: $.20(300,000) + 120,000 = $180,000

Select semi-automatic machine.

Problem 2

Expected value after three days = (5,000 x .4) + (8,000 x .2) + (12,000 x .3) + (30,000 x .1) = $2,000 + 1,600 + 3,600 + 3,000
= $10,200

Recommend you hold on to the investment as the expected payoff is $200 more than what could be received now. However, consider there is a 60% chance you will receive less than $10,000. A risk adverse investor will sell the investment now.

Problem 3

($75,000 x .75) + ($50,000 x .25) = $68,750

Problem 4

Expected variable cost to make
= ($10 x .10) + (12 x .30) + (14 x .40) + (16 x .20)
= $13.40

Cost to buy: 18,000 / .90 x $15 = $300,000

Cost to make:
  Variable costs: 18,000 / .96 x $13.40 = $251,250
  Avoidable fixed costs = 32,500

Annual savings if thermocouplers are made = $16,250
Problem 5

a. Payoff table:

<table>
<thead>
<tr>
<th>States</th>
<th>Running properly p = .90</th>
<th>Not running properly p = .10</th>
<th>Expected Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigate</td>
<td>$4,000</td>
<td>$4,000 + 8,000</td>
<td>$4,800</td>
</tr>
<tr>
<td>$4,000 + 8,000</td>
<td>= $12,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do not investigate</td>
<td>$0</td>
<td>$40,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

The variance should not be investigated.

b. Let x = the probability the assembly department is running properly

Then: $4,000x + 12,000(1-x) = 40,000(1-x)
$4,000x + 12,000 – 12,000x = 40,000 – 40,000x
32,000x = 28,000
x = 87.5%
Problem 6

a.  

<table>
<thead>
<tr>
<th>Incremental Net Cash Flow</th>
<th>Probability</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,000,000</td>
<td>0.1</td>
<td>$200,000</td>
</tr>
<tr>
<td>$3,000,000</td>
<td>0.3</td>
<td>$900,000</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>0.2</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>$8,000,000</td>
<td>0.2</td>
<td>$1,600,000</td>
</tr>
<tr>
<td>$9,000,000</td>
<td>0.1</td>
<td>$900,000</td>
</tr>
<tr>
<td>$10,000,000</td>
<td>0.1</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Contract expected value</td>
<td></td>
<td>$5,600,000</td>
</tr>
</tbody>
</table>

b. We need to compute the probability of a value of $6,000,000 or above. Note that $6,000,000 is one-third of the way along the interval between $5,000,000 and $8,000,000; therefore, the prorated share of the probability of a value lying between $6,000,000 and $8,000,000 would be $2/3 \times .2 = .1333$. Therefore, the probability of at least breaking even on this contract is .33 (.1 + .1 + .1333).

c. Since the expected value of the incremental cash flows Hart creates is $5,600,000, the expected net return to the Flyers of the straight salary offer is $600,000 ($5,600,000 - $5,000,000). The expected cost to the Flyers of the $2,000,000 plus 50% offer is $4,800,000 and the net return to the Flyers is $800,000. Since both of these contracts have a positive expected value, both are worth considering, but the $2,000,000 plus 50% offer is better for the Flyers.
Problem 7

a. Choose Project 1, which has the lowest expected cost as shown in the following table:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Probability</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$40,000,000</td>
<td>0.1</td>
<td>$4,000,000</td>
</tr>
<tr>
<td>$50,000,000</td>
<td>0.2</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>$62,000,000</td>
<td>0.4</td>
<td>$24,800,000</td>
</tr>
<tr>
<td>$71,000,000</td>
<td>0.2</td>
<td>$14,200,000</td>
</tr>
<tr>
<td>$82,000,000</td>
<td>0.1</td>
<td>$8,200,000</td>
</tr>
</tbody>
</table>

b) The probability of costs being $70,000,000 or less in Project 1 will be:

\[
.1 + .2 + .4 \times \left( \frac{70,000,000 - 62,000,000}{71,000,000 - 62,000,000} \right) = 65.56\% 
\]

The probability of costs being $70,000,000 or less in Project 2 will be:

\[
.1 + .2 + .2 \times \left( \frac{70,000,000 - 62,000,000}{75,000,000 - 62,000,000} \right) = 42.31\% 
\]

Based on this criterion, Bruce would recommend Project 2.

Problem 8

a. If the criterion is to implement the game with the highest expected net present value, Essence should choose game 2 as shown in the following exhibit:

<table>
<thead>
<tr>
<th>Net Cash Flow</th>
<th>Probability</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>$35,000,000</td>
<td>0.1</td>
<td>$3,500,000</td>
</tr>
<tr>
<td>$39,000,000</td>
<td>0.1</td>
<td>$3,900,000</td>
</tr>
<tr>
<td>$45,000,000</td>
<td>0.6</td>
<td>$27,000,000</td>
</tr>
<tr>
<td>$49,000,000</td>
<td>0.1</td>
<td>$4,900,000</td>
</tr>
<tr>
<td>$50,000,000</td>
<td>0.1</td>
<td>$5,000,000</td>
</tr>
</tbody>
</table>

b. Note that while the expected value of game 2 is $45,000,000, the possible outcomes vary from $25,000,000 to $65,000,000 with all values on this interval equally likely. If Essence prefers, all other things being equal, less risk, then she might be willing to sacrifice some expected return for less uncertainty. If this is the case, Essence would not be making decisions using the expected value criterion.
Problem 9

a. The bid that maximizes expected value is either $5,300,000 or $5,400,000 as shown in the following table:

<table>
<thead>
<tr>
<th>Bid</th>
<th>Contract Cost</th>
<th>Incremental Cash Flow</th>
<th>Probability of Winning</th>
<th>Bid Expected Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5,100,000</td>
<td>$5,000,000</td>
<td>$100,000</td>
<td>30%</td>
<td>$30,000</td>
</tr>
<tr>
<td>$5,200,000</td>
<td>$5,000,000</td>
<td>$200,000</td>
<td>25%</td>
<td>$50,000</td>
</tr>
<tr>
<td>$5,300,000</td>
<td>$5,000,000</td>
<td>$300,000</td>
<td>20%</td>
<td>$60,000</td>
</tr>
<tr>
<td>$5,400,000</td>
<td>$5,000,000</td>
<td>$400,000</td>
<td>15%</td>
<td>$60,000</td>
</tr>
<tr>
<td>$5,500,000</td>
<td>$5,000,000</td>
<td>$500,000</td>
<td>10%</td>
<td>$50,000</td>
</tr>
<tr>
<td>$5,600,000</td>
<td>$5,000,000</td>
<td>$600,000</td>
<td>5%</td>
<td>$30,000</td>
</tr>
<tr>
<td>$5,700,000</td>
<td>$5,000,000</td>
<td>$700,000</td>
<td>0%</td>
<td>$0</td>
</tr>
</tbody>
</table>

b. If we let $B$ be the amount bid, the probability of $B$ winning is $(5,600,000 - B) / (5,600,000 - 5,000,000)$ and the return from that bid will be $B - 5,000,000$.

So, the expected value of any bid $B$ will be:

\[
\frac{(5,600,000 - B) \times (B - 5,000,000)}{(5,600,000 - 5,000,000)}
\]

By using trial and error or basic calculus, the best bid is found to be $5,300,000.
Problem 10

The following is a summary that provides the response for parts a through c:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$130</td>
<td>$100</td>
</tr>
<tr>
<td>Variable cost</td>
<td>$50</td>
<td>$50</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$80</td>
<td>$50</td>
</tr>
<tr>
<td>Fixed cost</td>
<td>$5,000,000</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Breakeven quantity</td>
<td>62,500</td>
<td>100,000</td>
</tr>
<tr>
<td>Upper range distribution</td>
<td>80,000</td>
<td>140,000</td>
</tr>
<tr>
<td>Lower range distribution</td>
<td>50,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Range</td>
<td>30,000</td>
<td>70,000</td>
</tr>
<tr>
<td>BE probability</td>
<td>58.33%</td>
<td>57.14%</td>
</tr>
<tr>
<td>Expected value</td>
<td>$200,000</td>
<td>$250,000</td>
</tr>
</tbody>
</table>

a. Divide the contribution margin for each product by the fixed costs of $5,000,000 to get the breakeven quantity for each product.

b. The probability of breaking even for each product is computed using the following calculation (upper bound of range for that product - breakeven quantity for that product) / (upper bound of range for that product - lower bound of the range for that product).

c. The expected value for each product is computed by multiplying the product’s expected sales level, which is the mid-point of its sales range by the product’s contribution margin and subtracting $5,000,000.
Problem 11

a) Let $p$ be the probability that demand is high:

we have, $\text{EV PH} > \text{EV PL}$

$$p \times 140,000 + (1-p) \times 30,000 > p \times 50,000 + (1-p) \times 80,000$$

and solve to find $p > \frac{5}{14}$

b) The following is a table that lists for each of the values of $p$, the expected value of each decision, the best decision and the expected value of perfect information (EVPI):

<table>
<thead>
<tr>
<th>Pr DH</th>
<th>Pr DL</th>
<th>EV PH</th>
<th>EV PL</th>
<th>Decision</th>
<th>Max</th>
<th>EVPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>90%</td>
<td>41,000</td>
<td>77,000</td>
<td>PL</td>
<td>77,000</td>
<td>9,000</td>
</tr>
<tr>
<td>20%</td>
<td>80%</td>
<td>52,000</td>
<td>74,000</td>
<td>PL</td>
<td>74,000</td>
<td>18,000</td>
</tr>
<tr>
<td>30%</td>
<td>70%</td>
<td>63,000</td>
<td>71,000</td>
<td>PL</td>
<td>71,000</td>
<td>27,000</td>
</tr>
<tr>
<td>40%</td>
<td>60%</td>
<td>74,000</td>
<td>68,000</td>
<td>PH</td>
<td>74,000</td>
<td>30,000</td>
</tr>
<tr>
<td>50%</td>
<td>50%</td>
<td>85,000</td>
<td>65,000</td>
<td>PH</td>
<td>85,000</td>
<td>25,000</td>
</tr>
<tr>
<td>60%</td>
<td>40%</td>
<td>96,000</td>
<td>62,000</td>
<td>PH</td>
<td>96,000</td>
<td>20,000</td>
</tr>
<tr>
<td>70%</td>
<td>30%</td>
<td>107,000</td>
<td>59,000</td>
<td>PH</td>
<td>107,000</td>
<td>15,000</td>
</tr>
<tr>
<td>80%</td>
<td>20%</td>
<td>118,000</td>
<td>56,000</td>
<td>PH</td>
<td>118,000</td>
<td>10,000</td>
</tr>
<tr>
<td>90%</td>
<td>10%</td>
<td>129,000</td>
<td>53,000</td>
<td>PH</td>
<td>129,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>
Problem 12

a) The expected value of planting soy beans = 50,000 * .65 + -10,000 * .35 = $29,000
The expected value of planting corn = 20,000 * .65 + 50,000 * .35 = $30,500
The best choice is to plant corn.

b) Since the only crop that incurs potential losses is the soy beans, Don would only buy insurance if soy beans were planted. Let the cost of the insurance equal x and recalling the insurance will cover any loss, we want to find a value for insurance such that the soy beans provide the same expected value as the corn.

We have 50,000 * .65 – x = 30,500 and solving we find x = $2,000

Therefore, if the insurance premium is less than $2,000, Don would prefer to plant soy beans and insure the corn.

Problem 13

Let p be the probability that Jacques assesses for the probability the department store will be out of stock. We need to find the probability above, which the expected cost of buying in the future exceeds the current price of $2,000.

Therefore, find p such that:

p * 2500 + (1-p) * 1700 > 2000

Solving find p >3/8
13. Pricing

Learning Objectives

After completing this chapter, you will:

1. Understand the role that cost information plays in pricing decisions
2. Understand and be able to compute the appropriate cost based price in short-term and long-term pricing situations
3. Recognize and be able to interpret the scope and role of cost information in setting international transfer prices
4. Understand and be able to apply target costing when developing price for a new product
5. Understand and be able to apply basic analysis to evaluate an organization’s control over its pricing policy.

The Role of Cost Information in Pricing

The role of cost information in product pricing depends on the nature of the product market.

Management’s Pricing Role

<table>
<thead>
<tr>
<th>Market Sets Price</th>
<th>Supplier Sets Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Use cost information to identify whether the market price provides an adequate return on investment given the organization’s cost and capital structure</td>
<td>• Use cost information to identify a product/price combination customers find acceptable and provides an adequate return on investment given the organization’s cost and capital structure</td>
</tr>
</tbody>
</table>

In highly competitive markets, the market sets the price and the role of cost information is to help management decide whether it can compete profitably at the market determined price.

If products can be differentiated or if the market is dominated by a one or a few large suppliers, the role of cost information is to help management identify a target price customers will find acceptable and will allow the organization to recover its costs and provide an adequate return on invested capital.

This chapter will consider the role of cost information in each of these pricing environments.

Cost Information and Short- and Long-Term Pricing

Costs and Short-Term Pricing

Chapter 10 discussed the role of cost information in short-term pricing in the context of the special order problem. The idea in the special order problem is in the short-term, if there are no long-term implications, the price offered should at least cover short-term variable costs plus any opportunity costs. Note that the special order problem is characterized by a non-competitive situation – the supplier is asked whether or not to accept a price offer.
But what about the role of cost information in the short-term pricing of ongoing products whose demand fluctuates across periods? Of particular interest in this context is pricing services that cannot be inventoried, for example, pricing airline tickets. Over many routes, the market for airline seats is reasonably competitive, which means that through intense competition the airlines, in effect, create a market price. The airline will supply seats in this market using the same criterion used in the special order problem. That is, supply a seat as long as the price at least meets the variable cost plus any opportunity cost of supplying the seat. The problem is since an airline’s variable costs comprise of such a tiny total of its total costs, short-term pricing results in cycles of airline bankruptcies, a topic covered below.

Costs and Long-Term Pricing

An organization can use cost information in several different ways when it sets the price for its products. However, the most widely used approach is cost plus a mark-up. The primary reason for the popularity of this approach is it provides a price based on a profit target. If the price is one the customers find reasonable and the profit target is based on the costs of an efficient supplier with a rate of return on invested capital that reflects market expectations, the price reflects a stable long-term equilibrium price that will support demand and supply.

An example:

Carr Company is developing an electric motor to sell to suppliers in the home heating industry. Customers regard Carr Company’s products as superior because of the company’s outstanding reputation for product quality and performance. For this reason, Carr Company can set the prices for its products.

Based on past experience developing and selling many types of electric motors, the finance group at Carr Company has developed the following prospective costs for this new motor:

<table>
<thead>
<tr>
<th></th>
<th>Per Unit</th>
<th>Annual (50,000 units)</th>
<th>Total for Product Life (10 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials cost</td>
<td>$105.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct labour cost</td>
<td>145.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable overhead cost</td>
<td>25.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable S,G and A</td>
<td>22.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total variable cost</td>
<td>$297.00</td>
<td>$14,850,000</td>
<td>$148,500,000</td>
</tr>
<tr>
<td>Fixed manufacturing</td>
<td>2,500,000</td>
<td>25,000,000</td>
<td></td>
</tr>
<tr>
<td>Fixed S,G and A</td>
<td>450,000</td>
<td>4,500,000</td>
<td></td>
</tr>
<tr>
<td>Cost of quality</td>
<td>150,000</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Product development costs</td>
<td></td>
<td>10,000,000</td>
<td></td>
</tr>
<tr>
<td>Product abandonment costs</td>
<td></td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Total product related costs</td>
<td></td>
<td>$191,000,000</td>
<td></td>
</tr>
<tr>
<td>Total lifetime unit sales</td>
<td></td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td>Total product cost per unit</td>
<td></td>
<td>$382.00</td>
<td></td>
</tr>
<tr>
<td>Prospective selling price (20% mark-up)</td>
<td></td>
<td>$458.40</td>
<td></td>
</tr>
</tbody>
</table>
The total lifetime product cost is estimated to be $382 per unit. If Carr Company adds 20% mark-up to the computed product cost to provide a return on invested capital, the prospective target price would be $458.40.

Varying Demand and Varying Prices

When demand is seasonal, prices will vary to reflect the fluctuations in demand and the actions of competitors. While prices may vary in the short-term, in the long-term, the average price will need to at least equal the target long-term price or the organization will fail to recover its total out of pocket costs and its capital costs, thereby, impairing owner’s wealth.

The Role of the Management Accountant in Supporting Revenue Control

Assume during the first five years of the project, Carr Corporation faces lower demand than planned. The sales force begins to engage in aggressive price cutting in order to meet the target sales levels in the original plan. The following results were observed over the first five years of the motor project’s life:

![Graph showing revenue tracking]

It is evident the revenue to date experience is tracking well below the projected target revenues required to justify this project.

This type of analysis illustrates the management accountant’s role in providing control information after the fact. Recall that fixed costs are sunk so, if demand is lower than expected and the only way to improve revenues is to decrease prices (that is, demand is elastic), then the sales force is doing what is required as long as the short-term price covers the short-term variable cost. However, if price cutting reflects undisciplined sales force activities merely designed to boost short-term unit sales then management intervention is required to restore target pricing discipline.

When variable costs are comprised of a small fraction of fixed costs, a situation is created where organizations are tempted to engage in short-term pricing that easily covers variable costs, but
fails to achieve an average cost that meets the target long-term price. This is precisely what causes the cyclical pattern of airline bankruptcies.

The Management Accountant’s Role in Revenue Control

As part of the process of evaluating ongoing performance, senior management at Carr Company might ask the management accountant to investigate how prices were set during the first five years of the motor project. Assume the management accountant’s investigation produces the following result:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target price</td>
<td>$458.40</td>
</tr>
<tr>
<td>Average discretionary competitive discount - 5%</td>
<td>-22.92</td>
</tr>
<tr>
<td>Adjusted price</td>
<td>435.48</td>
</tr>
<tr>
<td>Average quantity discount - 3%</td>
<td>-13.06</td>
</tr>
<tr>
<td>Invoice price</td>
<td>422.42</td>
</tr>
<tr>
<td>Average prompt payment discount - 1.5%</td>
<td>-6.34</td>
</tr>
<tr>
<td>Net price</td>
<td>416.08</td>
</tr>
<tr>
<td>Average take backs - .5%</td>
<td>-2.08</td>
</tr>
<tr>
<td>Realized average price</td>
<td>$414.00</td>
</tr>
</tbody>
</table>

The following, called a price waterfall, shows the sources of price erosion for the motor:
The sales force at Carr Company controls the discretionary competitive discount and the average take backs (the cost to recover unsold inventory from customers) through direct negotiations with customers, while management policy sets the quantity discount and the prompt payment discount. More than half of the price erosion is caused by concessions made by the sales force offering a level of discounts senior management might consider far too high and, therefore, control more tightly.
Contractual Settings Where Cost Information Determines the Price

There are five major contractual settings where cost information determines the price:

1. Cost plus contracts
2. Insurance claims
3. Legal settings
4. Bidding
5. International transfer pricing

Cost Plus Contracts

In cost plus contracts, the supplier is reimbursed costs plus a profit margin. In this sense, cost plus contracts follow the same approach as the Carr Company example illustrated above. The difference being that the parties to the contract must agree how the contract costs are to be computed. The key areas of negotiation will be:

1. How variable costs will be computed and whether standard or actual costs will be used for variable costs,
2. What fixed manufacturing costs will be deemed to be related to the contract and the basis for allocating fixed costs to the contract,
3. What selling, general and administrative costs will be deemed to be related to the contract,
4. What other costs such as product development and abandonment costs will be deemed to be allocated to the project,
5. The base upon which the mark-up percentage will be applied, and
6. The mark-up percentage.

Many cost plus contract disputes focus on failures to adequately specify what costs are to be included in computing the total contract cost and how these costs will be computed. (The other major dispute focuses on inadequate or potentially fraudulent record keeping by the supplier.) During contract costing disputes, appeals to generally accepted costing standards or conventional industry costing standards are invariably useless, since acceptable costing practices vary widely. A vital role for management accountants on both sides of cost plus contracting is to ensure all components of costs in the contract are fully specified.

Insurance Claims

Unless otherwise specified, insurance claims focus on the cost of the loss. Therefore, in effect, developing an insurance policy requires attention to the same details discussed in cost plus contracting with the exception that there is no mark-up.
Legal Settings

There are legal issues surrounding the relationship between costs and prices when an organization is charged with predatory pricing under the provisions of the Canadian Competition Act. A price is deemed unreasonable and, therefore, predatory under the Act if:

- It is deemed to be either intended to drive or to have the effect of driving, competitors out of a market, and
- It is followed by a price increase deemed to be intended to recover losses incurred during the predatory pricing period.

The role of pricing in claims of predatory pricing focuses on price relative to variable cost in general and average variable cost in particular. Prices that approach or fall beneath average variable costs are likely to be viewed as increasingly unreasonable and, therefore, regarded as potentially predatory.

Therefore, management accountant must ensure the accounting system can compute costs in a reasonably accurate way, not only for internal decision making regarding prices, but also to withstand charges, if they are laid, that the price charged for the organization’s products are below variable costs.

Bidding Settings

Competitive bidding situations are a form of cost plus pricing in environments where the expectation is the contract will be awarded to the lowest bidder. The tension is that as the bid price is increased, the profit is increased if the bid is successful, but the probability of the bid being successful decreases. Therefore, there are two major forms of uncertainty in the competitive bidding environment: costs are subject to uncertainty, and being awarded the contract is uncertain. The one certainty is the price if the bid is accepted.

Return to the data for Carr Company and assume all the information is the same, except the situation is now:

1. A single customer is asking for bids to supply 50,000 units of the motor each year for 10 years.
2. The computed total price per unit is subject to uncertainty. Based on the underlying cost data, the Carr Company cost analyst believes the total product cost per unit is now estimated to lie between $370 and $400 with all values on this interval equally likely.
3. The bid is to be expressed as a price per unit. Based on an analysis of past bidding situations, the marketing manager believes any bid equal to or more than $480 will lose with certainty and any bid less than or equal to $380 will win with certainty. The probability of a bid between $380 and $480 being accepted is \(\frac{480 - \text{bid amount}}{100}\). For example, a bid of $400 would have an 80% probability of being accepted.

Using the expected value criterion developed in Chapter 12, we can write the expected value of any bid being equal to the probability the bid will be accepted multiplied by the product of the
difference between the bid amount and the expected cost per unit and the total number of units in the order. Recalling the properties of the uniform distribution discussed in Chapter 12, the expected cost per unit will be $385 \((400 + 370) / 2\) and the expected value of any bid \(b\) will be:

\[
\text{Expected value of } b = (480 - b) / 100 * (b - 385) * (50,000 * 10)
\]

By trial and error or simple calculus, we find the bid amount that maximizes expected profit is $432.50 and the expected profit associated with this bid is $11,281,250.

Note that the expected profit margin range for this bid is a high of 16.89\% \((432.50-370) / 370\) to a low of 8.13\% \((432.50-400) / 400\) and an expected value of 12.34\% \((432.50-385) / 385\).

Therefore, with this expected profit maximizing bid, Carr Company has no chance of achieving its target mark-up of 20\% on costs.

The role of accurate cost information is critical in this exercise since it provides the basis for the best bid.

International Transfer Pricing

Whenever organizations transfer goods or services between two tax jurisdictions, they must price the transfer in order to determine the profit and, therefore, the tax liability in each tax jurisdiction.

The transfer price that international conventions (reflecting the OECD guidelines on international transfer pricing) is an arm’s length market price (called the comparable uncontrolled price or CUP). Unfortunately, there is seldom an agreement on a CUP and transfer prices are based one of the four subsidiary methods, one of which is cost plus. Since tax authorities are aware it is in an organization’s interests to use a transfer price to shift income to the lower tax jurisdiction, the affected tax authorities will carefully scrutinize how the organization computes the cost base for the cost plus based transfer price. Generally, the tax authorities will use the approach described in the cost plus contracts section above when evaluating a proposed cost base for a transfer price.

Cost Information and Price in Product Planning

As we have seen, cost plus pricing moves from cost toward establishing a market price. An alternative approach works backward from the market prices to determine what cost must be in order for the product to be successful. This approach is called target costing.

Target costing is a planning tool, rather than an operational tool, since it is used to determine the product’s design and the design of the process that will make the product. The rationale for target costing is the realization that, on average, 80\% of a product’s costs are committed at the time the product and its manufacturing process are designed. Therefore, it is easier to reduce product costs during the planning stage rather than after the product is designed and its manufacturing system is put in place.
The target costing approach involves the following steps:

1. The price the market will set for a proposed product with specific attributes is estimated. This might be done by evaluating the price for similar products or by questioning prospective customers using customer panels. This price is called the target price.

2. The cost of developing and producing the proposed product is estimated. This is called the as-if cost.

3. The product and process design determine the required investment level in the product which, in turn, allows the organization to identify the target profit that will provide the required return on investment. The target profit is deducted from the target price to compute the target cost.

4. The product’s as-if cost is compared to the target cost. If the target cost is less than the as-if cost, the product development team reformulates the product and process design to reduce the product’s as-if cost. If the as-if cost reduction results in changing the target price the customer is willing to pay, this must be taken into account. The product and process redesign continues until the as-if cost is less than the target cost.
During the recursive planning process when a tentative product and process design are developed and their resulting target profits and target costs are computed, there is a delegation of the cost reduction targets to each of the product’s components. For example, assume a proposed product has 40 components that comprise 90% of the product’s estimated as-if cost. A significant planning consideration is what proportion of the as-if cost reduction will be assigned to each of the components. This delegation of cost reduction targets is particularly difficult, primarily because different components may have significantly different potential for cost reduction and, in many cases, the design of the components will not only affect their own costs, but the costs of other components and assembly costs. Common tools used at this stage include value engineering (compares the value to the cost of each component or each product feature) and design for manufacturing assembly (which considers the manufacturing cost of each design).

There is a significant role for the management accountant in target costing. Not only does the management accountant prepare the cost estimates that are crucial in guiding the entire target costing process, but often is the obvious choice to play the general management role on a team often comprised of functional specialists such as design, engineering and marketing.
Problems with Solutions

Multiple Choice Questions

Questions 1 – 5 inclusive refer to the data for Carr Company in the cost plus example in the chapter.

1. If sales are 40,000 per year the prospective selling price will be:
   a. $403.25
   b. $445.80
   c. $483.90
   d. None of the above

2. Return to the original data in the problem. If the project has an eight year life, the target selling price will be:
   a. $387.75
   b. $403.20
   c. $427.43
   d. $465.30

3. Return to the original data in the problem. If the mark-up is 25%, the target selling price will be:
   a. $387.60
   b. $445.00
   c. $465.70
   d. None of the above

4. Return to the original data in the problem. If the product abandonment costs are $2,500,000, the target selling price will be:
   a. $390.50
   b. $460.80
   c. $480.00
   d. None of the above

5. Return to the original data in the problem. If the fixed manufacturing costs each year are $3,000,000, the target selling price will be:
   a. $390.55
   b. $410.00
   c. $445.50
   d. None of the above
Questions 6 – 8 refer to the following data:

Brantford Ovens, a supplier of cooking ovens, is considering developing an oven that would be used in retail pizza shops. What is the target cost in each of the following questions?

Question 6
1. Target price – $12,000
2. Required return – 25% margin on costs
The target cost is:
   a. $8,000
   b. $9,600
   c. $10,000
   d. None of the above

Question 7
1. Target price – $12,000
2. Required return – 25% margin on sales
The target cost is:
   a. $8,000
   b. $9,600
   c. $10,000
   d. None of the above

Question 8
1. Target price – $12,000
2. Annual sales – 500 units
3. Average inventory and capital asset investment level for this product during its lifetime – $1,500,000
4. Required pre-tax return on invested capital – 25%
The target cost is:
   a. $10,900
   b. $11,000
   c. $11,750
   d. None of the above
Problem 1

Amelia Hughes is a commercial helicopter pilot who uses her helicopter to fly employees of large organizations from the Hamilton area to airports in the Northern United States. The average commute time from Hamilton to these US airports is one hour, which cuts down travel time considerably.

Since Amelia is operating at approximately 60% of capacity, she is considering offering two hour helicopter tours to various venues from her home airport in Hamilton. Tours would focus primarily on Toronto and Niagara Falls.

Since she would have no competitors, Amelia plans to price the tours by the hour. The prices Amelia offers to current customers are based on hourly market rates, which average 120% of the total hourly cost of each flight.

Amelia has estimated flight related costs as:

- Variable operating costs per hour – $400
- Fixed ground related costs per flight – $50
- Allocation of the annual fixed cost (including depreciation on Amelia’s helicopter) of Amelia’s other flight related costs – $30 per hour based on operating at 60% of capacity and using the expected activity level as the denominator to compute the fixed overhead rate.

Required:

a. What hourly rate will Amelia charge her current customers?

b. If Amelia’s tour operation results in increasing operations to 80% of capacity and she continues to compute the hourly fixed cost overhead rate in the same way, what would be Amelia’s revised hourly rate?

c. What is the apparent relationship between the planned level of capacity use and the rate Amelia charges her customers?

d. Amelia has no control over the rates she charges business customers since they are set by the market. What hourly rate should she charge for her proposed tours? Since she would have no competition, there is no current market rate.
Problem 2

Ayr Company manufactures residential and commercial security alarms. The company has designed a new residential alarm that is able to connect to home Wi-Fi systems. This feature reduces the cost of installation and avoids the need for conventional telephone access to monitoring systems. Because the system is advanced and innovative it has no direct competitors and, therefore, Ayr Company plans to use a cost based price for this new product. The company policy is to mark-up total manufacturing cost by 30% to set the product price.

Ayr Company is organized into three departments: stores, production and assembly. The fixed cost structure in each department is:

<table>
<thead>
<tr>
<th>Department</th>
<th>Cost Driver</th>
<th>Fixed Manufacturing Overhead</th>
<th>Practical Capacity</th>
<th>Average Activity Level</th>
<th>Planned Activity Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stores</td>
<td>Materials cost</td>
<td>$200,000</td>
<td>$1,200,000</td>
<td>$900,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Production</td>
<td>Machine hours</td>
<td>$1,200,000</td>
<td>10,000</td>
<td>7,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Assembly</td>
<td>Labour hours</td>
<td>$450,000</td>
<td>8,000</td>
<td>5,000</td>
<td>7,000</td>
</tr>
</tbody>
</table>

The costs in each department for this new product have been estimated as:

Stores:
- Materials – $35
- Direct labour – .15 hours @ 18 per hour
- Variable overhead – materials cost * 20%

Manufacturing:
- Materials – $2.50
- Direct labour – .2 hours @$22 per hour
- Machine hours – .15
- Variable overhead – machine hours $15

Assembly
- Materials – $.75
- Direct labour – .9 hours @ $28
- Variable overhead – labour hours * $2

Required:

The current approach is to compute manufacturing costs as all variable costs plus an allocation of total plant fixed manufacturing overhead based on an hourly rate for direct labour. The current total labour hours worked in this plant is 12,000 hours. Compute the product price based on the current policy.
Problem 3

Return to the data in Problem 2.

Required:

Compute the product price under each of the following assumptions:

a. The fixed manufacturing overhead rate is calculated using departmental practical capacity.

b. The fixed manufacturing overhead rate is calculated using average departmental activity level.

c. The fixed manufacturing overhead rate is calculated using planned departmental activity rate.

Problem 4

Niagara Steelworks is engaged in a costing dispute with Public Works Canada. The company has a cost plus contract to supply speciality steel that has no evident market price. The contract calls for Niagara Steelworks to be reimbursed for its manufacturing costs plus 35%. An independent shipper hauls the steel from the Niagara Steelworks plant to the various construction sites.

The variable cost of manufacturing the steel is $200 per ton, which is not in dispute. The issue concerns the allocation of fixed manufacturing costs to this product. Current annual fixed manufacturing cost at Niagara Steelworks is $300,000,000. The plant is operating at 40% of practical capacity, which is measured in tons. Niagara Steelworks computes the fixed manufacturing overhead rate by dividing fixed manufacturing cost by the planned level of operations. This has resulted in charging this contract a rate of $120 per ton for fixed manufacturing costs.

Cost analysts at Public Works have objected citing industry evidence that, on average, steel companies are using 70% of their practical capacity.

Required:

a. Compute the contract price per ton using Niagara Steelwork’s approach.

b. Compute the contract price per ton if Niagara Steelwork’s uses average capacity use in the industry to compute the fixed manufacturing overhead rate.

c. If you were hired to arbitrate this dispute, how would you resolve it?

d. If you were a Public Works Canada auditor, what would you recommend based on this experience?
Problem 5

Nancy Ng is preparing a bid to supply and maintain plants for a year in the head office of a large organization. Nancy estimates the costs associated with this job will be $15,000 for the plants, $8,000 for direct labour and $3,000 for other variable costs related to the contract. Nancy’s only other costs are office costs that do not depend on the number or size of contracts she is awarded.

Nancy applies a mark-up on the estimated contract cost to determine a target bid price.

The income statement Nancy’s accountant prepared last year follows:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales</strong></td>
<td>$290,000</td>
</tr>
<tr>
<td>Contract related costs</td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>45,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>55,000</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>24,500</td>
</tr>
<tr>
<td></td>
<td>124,500</td>
</tr>
<tr>
<td>Contract contribution to head office costs</td>
<td>165,500</td>
</tr>
<tr>
<td>Head office costs</td>
<td>80,000</td>
</tr>
<tr>
<td>Income before taxes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$85,500</td>
</tr>
</tbody>
</table>

Required:

a. What average mark-up percentage is Nancy using to price jobs?

b. If Nancy uses the average mark-up percentage you found in part a), what bid would she submit on this job?
Problem 6

Grand River Company (GRC) manufactures hotel furniture. Recently, GRC received an order for 500 beds at $1,000 per bed. The production manager has developed a preliminary cost of making one of these beds as:

- Direct materials – $400
- Direct labour – $200
- Variable overhead – $50
- Fixed manufacturing overhead – 120% of direct labour cost

Required:

a. If GRC has a target of 20% on sales, what is the target cost?

b. If GRC has a target of 30% on total manufacturing cost, what is the target cost?

Problem 7

Eye Savers Company (ESC) manufactures a variety of eye care products. ESC is considering the introduction of a lens cleaner for anti-reflective plastic lenses.

Initial cost estimates, which include the product and packaging cost per 125 ml package of this product, were:

- Direct materials – $1.45
- Direct labour – $.35
- Variable manufacturing overhead – $.20

ESC has a target margin of 100% of variable manufacturing costs.

Market research suggests the target price for this product would be $3.75

Required:

a. What is this product’s target variable cost?

b. Assume ESC will only offer products that meet its target margin. The plant manager has indicated a re-engineering project costing $1,000,000 could reduce the initial variable cost estimate to the target cost. Ignoring taxes and the time value of money, what is the breakeven level of this product’s lifetime sales that would justify this study?
Problem 8

Return to the data of Problem 7. Assume the results of a consumer panel testing a sample of the proposed product revealed the following information. The lifetime demand for this product follows this formula:

\[
\text{Lifetime demand in units} = 1,000,000 - ((\text{variable cost} - 1.50) \times 1,000,000)
\]

The target price for the product is a function of the appearance of the product and its packaging which, in turn, are directly affected by the product’s variable cost. The apparent relationship is:

<table>
<thead>
<tr>
<th>Variable Cost</th>
<th>Target Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.50</td>
<td>$1.50</td>
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<tr>
<td>$1.55</td>
<td>$1.88</td>
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<td>$2.63</td>
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<tr>
<td>$2.00</td>
<td>$2.66</td>
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Required:

Given this information, what is best product and packaging design?
Multiple Choice Solutions

Q 1 (c)

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<th>Annual</th>
<th>Total for Product Life</th>
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<tbody>
<tr>
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<td>$105.00</td>
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<tr>
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<td>$11,880,000 $118,800,000</td>
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Q 2 (d)

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Q4 (b)

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Q 5 (d)

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<td>Direct labour cost</td>
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<td>Variable overhead cost</td>
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<tr>
<td>Variable S,G and A</td>
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<tr>
<td><strong>Total variable cost</strong></td>
<td><strong>$297.00</strong></td>
<td><strong>$14,850,000</strong></td>
<td><strong>$148,500,000</strong></td>
</tr>
<tr>
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<tr>
<td>Fixed S,G and A</td>
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<td>4,500,000</td>
<td></td>
</tr>
<tr>
<td>Cost of quality</td>
<td>150,000</td>
<td>1,500,000</td>
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</tr>
<tr>
<td>Product development costs</td>
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</tr>
<tr>
<td>Product abandonment costs</td>
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<td><strong>Total product related costs</strong></td>
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<td></td>
<td><strong>$470.40</strong></td>
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</table>

Q 6 (b)

The formula is:

Target price - target margin = target cost

12,000 - .25* target cost = target cost

Target cost = $9,600

Q 7 (d)

The formula is:

Target price - target margin = target cost

12,000 - .25* target price = target cost

12,000 - .25 * 12000 = target cost

Target cost = $9,000
Q 8 (d)

The formula is:

Target price - target margin = target cost

$12,000 - 0.25 \times \left( \frac{1,500,000}{500} \right) = \text{target cost}

Target cost = $11,250
Problem 1

a)

<table>
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<tr>
<th>Cost Description</th>
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</thead>
<tbody>
<tr>
<td>Variable overhead cost per hour</td>
<td>$400.00</td>
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<tr>
<td>Fixed flight cost ($50/1)</td>
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<tr>
<td>Other flight related fixed costs</td>
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<tr>
<td><strong>Total hourly flight cost</strong></td>
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<tr>
<td>Mark-up @ 20%</td>
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<tr>
<td><strong>Hourly price</strong></td>
<td><strong>$576.00</strong></td>
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b)

<table>
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<th>Cost Description</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Variable overhead cost per hour</td>
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<tr>
<td>Fixed flight cost ($50/2)</td>
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</tr>
<tr>
<td>Other flight related fixed costs - (80-20)/80*30</td>
<td>22.50</td>
</tr>
<tr>
<td><strong>Total hourly flight cost</strong></td>
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<td>Mark-up @ 20%</td>
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<tr>
<td><strong>Hourly price</strong></td>
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</tr>
</tbody>
</table>

c)

As planned capacity use goes up, price goes down
Apparently as demand goes up, price will go down
Therefore, as demand drops price will go up

d)

Since the objective is to use currently idle capacity, one approach would be to start with a higher price and then lower the price until desired capacity use is reached
Problem 2

Note that the total labour hours per unit in all departments will be 1.25 (.15+.20+.90). Total fixed manufacturing cost in all departments will be $1,850,000 ($200,000 + $1,200,000 + $450,000). The rate per labour hour for fixed overhead will be $154.17 (1,850,000 / 12,000). Therefore, the fixed overhead allocated per unit will be $192.71 (1.25 * $154.17).

<table>
<thead>
<tr>
<th></th>
<th>Stores</th>
<th>Production</th>
<th>Assembly</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$35.00</td>
<td>$2.50</td>
<td>$0.75</td>
<td>$38.25</td>
</tr>
<tr>
<td>Direct labour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.15 hours @ $18</td>
<td>2.70</td>
<td></td>
<td></td>
<td>2.70</td>
</tr>
<tr>
<td>.20 hours @ $22</td>
<td></td>
<td>4.40</td>
<td></td>
<td>4.40</td>
</tr>
<tr>
<td>.90 hours @ $28</td>
<td></td>
<td></td>
<td>25.20</td>
<td>25.20</td>
</tr>
<tr>
<td>Variable overhead</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials cost * 20%</td>
<td>7.00</td>
<td></td>
<td></td>
<td>7.00</td>
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<tr>
<td>Machine hours * $15</td>
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<tr>
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Problem 3

a)  

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<tr>
<td>Fixed overhead</td>
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b)  

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<tr>
<td>Labour hours * $2</td>
<td></td>
<td></td>
<td>1.80</td>
<td>1.80</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$200,000/900,000 * 35</td>
<td>7.78</td>
<td></td>
<td></td>
<td>7.78</td>
</tr>
<tr>
<td>$1,200,000/7,000 * .15</td>
<td>25.71</td>
<td></td>
<td></td>
<td>25.71</td>
</tr>
<tr>
<td>$450,000/5,000 * .9</td>
<td></td>
<td></td>
<td>81.00</td>
<td>81.00</td>
</tr>
<tr>
<td>Total manufacturing cost</td>
<td>$196.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price mark-up @ 30%</td>
<td></td>
<td></td>
<td></td>
<td>58.83</td>
</tr>
<tr>
<td>Product price</td>
<td></td>
<td></td>
<td></td>
<td>$254.92</td>
</tr>
</tbody>
</table>
c)

<table>
<thead>
<tr>
<th></th>
<th>Stores</th>
<th>Production</th>
<th>Assembly</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$35.00</td>
<td>$2.50</td>
<td>$0.75</td>
<td>$38.25</td>
</tr>
<tr>
<td>Direct labour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.15 hours @ $18</td>
<td>2.70</td>
<td></td>
<td></td>
<td>2.70</td>
</tr>
<tr>
<td>.20 hours @ $22</td>
<td></td>
<td>4.40</td>
<td></td>
<td>4.40</td>
</tr>
<tr>
<td>.90 hours @ $28</td>
<td></td>
<td></td>
<td></td>
<td>25.20</td>
</tr>
<tr>
<td>Variable overhead</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials cost * 20%</td>
<td>7.00</td>
<td></td>
<td></td>
<td>7.00</td>
</tr>
<tr>
<td>Machine hours * $15</td>
<td></td>
<td>2.25</td>
<td></td>
<td>2.25</td>
</tr>
<tr>
<td>Labour hours * $2</td>
<td></td>
<td></td>
<td></td>
<td>1.80</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$200,000/1,000,000 * 35</td>
<td>7.00</td>
<td></td>
<td></td>
<td>7.00</td>
</tr>
<tr>
<td>$1,200,000/8,000 * .15</td>
<td></td>
<td>22.50</td>
<td></td>
<td>22.50</td>
</tr>
<tr>
<td>$450,000/7,000 * .9</td>
<td></td>
<td></td>
<td></td>
<td>57.86</td>
</tr>
<tr>
<td>Total manufacturing cost</td>
<td></td>
<td></td>
<td></td>
<td>$168.96</td>
</tr>
<tr>
<td>Price mark-up @ 30%</td>
<td></td>
<td></td>
<td></td>
<td>50.69</td>
</tr>
<tr>
<td>Product price</td>
<td></td>
<td></td>
<td></td>
<td>$219.64</td>
</tr>
</tbody>
</table>
Problem 4

a)  

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable manufacturing cost per ton</td>
<td>$200.00</td>
</tr>
<tr>
<td>Fixed manufacturing cost per ton</td>
<td>120.00</td>
</tr>
<tr>
<td>Total manufacturing cost per ton</td>
<td>$320.00</td>
</tr>
<tr>
<td>Mark-up @ 35%</td>
<td>112.00</td>
</tr>
<tr>
<td>Contract price per ton</td>
<td>$432.00</td>
</tr>
</tbody>
</table>

b)  

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable manufacturing cost per ton</td>
<td>$200.00</td>
</tr>
<tr>
<td>Practical capacity (300,000,000/(.4 * 120))</td>
<td>6,250,000</td>
</tr>
<tr>
<td>Average capacity (70% of practical)</td>
<td>4,375,000</td>
</tr>
<tr>
<td>Fixed manufacturing cost per ton</td>
<td>68.57</td>
</tr>
<tr>
<td>Total manufacturing cost per ton</td>
<td>$268.57</td>
</tr>
<tr>
<td>Mark-up @ 35%</td>
<td>94.00</td>
</tr>
<tr>
<td>Contract price per ton</td>
<td>$362.57</td>
</tr>
</tbody>
</table>

c) The problem is the contract did not specify the basis for computing the fixed manufacturing overhead rate, leaving the company free to charge idle capacity costs to this contract. It seems unfair to expect the government contract to absorb excess capacity costs. The industry average, which reflects general conditions and average industry efficiency in dealing with the conditions faced, appears to be a more reasonable approach.

d) The fixed manufacturing overhead rate itself should be specified in the contract. Not only does this eliminate the idle capacity costs discussed in c), but it also deals with any other fixed manufacturing overhead inefficiencies.

Problem 5

a. Average mark-up percentage = (290,000 - 124,500) / 124,500 = 132.93%

b. | Cost          | Amount  |
    |---------------|---------|
    | Plant costs   | $15,000 |
    | Direct labour costs | 8,000  |
    | Other variable costs | 3,000  |
    | Total contract related costs | 26,000  |
    | Mark-up       | 34,562  |
    | Contract price| $60,562 |
Problem 6

a. Target cost = target price – target margin
   
   Target cost = $1000 – 20% * $1000 = $800

b. Target cost = target price – target margin
   
   Target cost = $1000 - .30*(400 + 200 + 50 + 1.2 * 200) = $1000 - $267 = $737

Problem 7

a.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$1.45</td>
</tr>
<tr>
<td>Direct labour</td>
<td>0.35</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>0.20</td>
</tr>
<tr>
<td>Total variable cost</td>
<td>$2.00</td>
</tr>
<tr>
<td>Target margin @ 100% of variable cost</td>
<td>$2.00</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Target price</td>
<td>$3.75</td>
</tr>
<tr>
<td>Target margin</td>
<td>2.00</td>
</tr>
<tr>
<td>Target variable cost</td>
<td>$1.75</td>
</tr>
</tbody>
</table>

b. The re-engineering project would result in a product that would have a contribution margin of $2 per unit. Therefore, the breakeven quantity of lifetime sales of this product would be 500,000 (1,000,000 / 2).
Problem 8

Developing the product that has the functionality provided by the variable cost of $1.70 provides the highest contribution margin.

<table>
<thead>
<tr>
<th>Variable Cost</th>
<th>Target Price</th>
<th>CM</th>
<th>Demand</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.50</td>
<td>$1.50</td>
<td>$0.00</td>
<td>1,000,000</td>
<td>$0.00</td>
</tr>
<tr>
<td>$1.55</td>
<td>$1.88</td>
<td>$0.33</td>
<td>950,000</td>
<td>$313,500.00</td>
</tr>
<tr>
<td>$1.60</td>
<td>$2.09</td>
<td>$0.49</td>
<td>900,000</td>
<td>$441,000.00</td>
</tr>
<tr>
<td>$1.65</td>
<td>$2.24</td>
<td>$0.59</td>
<td>850,000</td>
<td>$501,500.00</td>
</tr>
<tr>
<td>$1.70</td>
<td>$2.34</td>
<td>$0.64</td>
<td>800,000</td>
<td>$512,000.00</td>
</tr>
<tr>
<td>$1.75</td>
<td>$2.42</td>
<td>$0.67</td>
<td>750,000</td>
<td>$502,500.00</td>
</tr>
<tr>
<td>$1.80</td>
<td>$2.49</td>
<td>$0.69</td>
<td>700,000</td>
<td>$483,000.00</td>
</tr>
<tr>
<td>$1.85</td>
<td>$2.54</td>
<td>$0.69</td>
<td>650,000</td>
<td>$448,500.00</td>
</tr>
<tr>
<td>$1.90</td>
<td>$2.59</td>
<td>$0.69</td>
<td>600,000</td>
<td>$414,000.00</td>
</tr>
<tr>
<td>$1.95</td>
<td>$2.63</td>
<td>$0.68</td>
<td>550,000</td>
<td>$374,000.00</td>
</tr>
<tr>
<td>$2.00</td>
<td>$2.66</td>
<td>$0.66</td>
<td>500,000</td>
<td>$330,000.00</td>
</tr>
</tbody>
</table>
14. Budgeting

Learning Objectives

After completing this chapter, you will:

1. Understand the structure of the master budget and the role it plays in planning and control.
2. Be able to develop and interpret a master budget for a simple organization.
3. Be able to develop and interpret inventory, labour and cash budgets.
4. Understand the structure of static and flexible budgets and the role they play in planning and control.

What is a Budget?

In the private sector, there are two types of budgets:

1. Operating budgets summarize the level of activities such as sales, purchasing, production and the acquisition of the various factors of production.
2. Financial budgets identify the expected financial consequences of the activities summarized in the operating budgets. The major financial budgets are the projected balance sheet, the projected income statement and the project statement of cash flows.

In the public sector, budgets reflect the spending authority granted to the unit that will make the expenditures. These notes focus on budgets in the private (for profit) sector.

The Role of Budgets

The organization plan reflects the implementation of the organization’s strategy for a planning period, which is usually one year. The plan results in a set of implemented activities (do). The results of those activities are monitored (check). These results are studied and any required revisions are developed and implemented as a revised plan (act/revise).

Budgets are an important part of the organization’s planning and control cycle. The domain of budgeting is shown as the shaded area in this exhibit. Budgets provide quantitative targets (both financial and non-financial) of planned activities. These measures are used to communicate organization objectives, thereby, providing a coordinating and integrating role in the organization. After the fact, the targets developed in the plan provided the basis against
which results are compared. The purpose of the comparison of planned and actual results is two-fold:

1. To identify opportunities to improve organization performance.
2. To assign accountability for performance failures and rewards for performance success.

It should be noted that while most people agree on the important role of using performance results to identify opportunities for improvement, there is strong disagreement about the accountability role. Since much of the information used to set performance targets in the budget comes from the people whose performance will be evaluated by the budget, there is a strong incentive for people to manipulate the information they provide, which is then used to set budget targets. This mitigates getting truthful information for budget setting. Other people argue that holding people accountable for budget numbers focuses attention on debating the reasonableness of performance measures and targets and distracts attention from using the numbers to effect performance improvement. The tension is that accountability is thought to motivate people to strive to achieve budget targets and, without accountability for budget results, a major benefit of budgeting is lost.

These are serious issues that are taken up in the Strategic Leadership Program. In this chapter, we focus on the process of budgeting and not the behavioural issues surrounding budgeting.

**The Master Budget**

The master budget is the overall budget plan. The following diagram provides a summary view of the components and inter-relationships of the master budget components:
Master Budget Components

Behind the master budget are the organization business strategies and sales forecasts. The results of senior level planning in the organization are the specific organization goals the organization expects to achieve during the budget period.

The organization objectives result in a formal sales plan that identifies the planned level of sales for the organization’s products. The sales plan, combined with the organization’s inventory policy (e.g. produce on demand or hold 30 days of projected sales in inventory) results in the production plan.

The production plan triggers the activities needed to support production. These activities include:

1. The need to acquire additional machinery and equipment.
2. The need to acquire and train or lay off employees
3. The amount and time of the various raw materials needed for production.

Related to the sales and production plans are the discretionary spending plans. Discretionary spending is spending on support activities that is not driven directly by production levels, but are required to support sales and production activities. The most common discretionary spending items are: advertising, research and development, training and travel. Discretionary spending is subject to periodic authorization that reflects the organization’s circumstances and objectives.

The projected or pro forma financial statements reflect the expected financial consequences of the various operating plans.

The following table summarizes the above discussion of the components of the master budget. It should be noted that, in practice, the operating budgets are often referred to as operating plans.

<table>
<thead>
<tr>
<th>Financial Budgets</th>
<th>Operating Budgets</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Projected income statement</td>
<td>• Sales budget</td>
</tr>
<tr>
<td>• Projected balance sheet</td>
<td>• Capital spending budget</td>
</tr>
<tr>
<td>• Projected statement of cash flows</td>
<td>• Production budget</td>
</tr>
<tr>
<td></td>
<td>• Material purchasing plan</td>
</tr>
<tr>
<td></td>
<td>• Labour hiring and training plan</td>
</tr>
<tr>
<td></td>
<td>• Administrative and discretionary spending plan</td>
</tr>
</tbody>
</table>

The Recursive Nature of Master Budget Development

By its nature the development of the master budget and its component budgets is recursive. The following are some situations that would require recycling and redeveloping the budget:

- The initial budget generates forecasted financial results that are deemed unacceptable and a more aggressive budget is demanded.
• The initial budget generates a production plan that requires the acquisition of capital equipment or skilled labour that cannot be accommodated in the time available.

• An unforeseen circumstance (such as a product failure or a competitor’s initiative) arises that requires a major reworking of the planned budget

The Sales and Production Plan

The sales plan provides the foundation for all operational planning, since it is the driver for all production and selling activities. The sales plan will specify the amount and timing of product sales. The following is an example of how the sales plan drives the production plan.

Eva Company is a retail operation selling a single product whose average price is $100 per unit. The inventory policy is to have on hand at the beginning of each month 60% of the month’s budgeted sales. The product purchase price is $40. Purchases are paid in the month following the purchase. All sales are credit sales with 25% collected during the month of sale, 40% in the following month, 30% in the third month and 5% never collected.

The following is the summary for the first six months of the upcoming year, which shows sales, purchases and the net cash flows associated with the sales and purchases activities:

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Budgeted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>1,300</td>
<td>1,400</td>
</tr>
<tr>
<td>December</td>
<td>1,000</td>
<td>1,100</td>
</tr>
<tr>
<td>January</td>
<td>1,200</td>
<td>1,300</td>
</tr>
<tr>
<td>February</td>
<td>1,500</td>
<td>1,400</td>
</tr>
<tr>
<td>March</td>
<td>1,600</td>
<td>1,600</td>
</tr>
<tr>
<td>April</td>
<td>1,700</td>
<td>1,700</td>
</tr>
<tr>
<td>May</td>
<td>1,800</td>
<td>1,800</td>
</tr>
<tr>
<td>June</td>
<td>1,900</td>
<td>1,900</td>
</tr>
<tr>
<td>July</td>
<td>1,800</td>
<td>1,900</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inventory</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening</td>
<td>780</td>
<td>600</td>
<td>720</td>
<td>900</td>
<td>840</td>
<td>660</td>
<td>780</td>
<td>540</td>
<td>720</td>
</tr>
<tr>
<td>Available</td>
<td>1,120</td>
<td>1,120</td>
<td>1,380</td>
<td>1,440</td>
<td>1,220</td>
<td>1,220</td>
<td>1,060</td>
<td>1,060</td>
<td>1,060</td>
</tr>
<tr>
<td>Sales</td>
<td>1,300</td>
<td>1,000</td>
<td>1,200</td>
<td>1,500</td>
<td>1,400</td>
<td>1,100</td>
<td>1,300</td>
<td>900</td>
<td>720</td>
</tr>
<tr>
<td>Ending inventory</td>
<td>600</td>
<td>720</td>
<td>900</td>
<td>840</td>
<td>660</td>
<td>780</td>
<td>540</td>
<td>720</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cash flow</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening cash</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collections</td>
<td>44,994</td>
<td>108,694</td>
<td>168,994</td>
<td>242,394</td>
<td>322,094</td>
</tr>
<tr>
<td>Available</td>
<td>45,394</td>
<td>115,500</td>
<td>131,000</td>
<td>128,500</td>
<td>118,094</td>
</tr>
<tr>
<td>Purchases - 100% last month</td>
<td>44,800</td>
<td>55,200</td>
<td>57,600</td>
<td>48,800</td>
<td>48,800</td>
</tr>
<tr>
<td>Ending cash</td>
<td>108,094</td>
<td>168,994</td>
<td>242,394</td>
<td>322,094</td>
<td>391,794</td>
</tr>
</tbody>
</table>

To illustrate, consider the March total collections figure. That number is derived as follows:

• From January sales: 1,200 units * $100 per unit * 30% = $36,000
• From February sales: 1,500 units * $100 per unit * 40% = $60,000
• From March sales: 1,400 units * $100 per unit * 25% = $35,000

Consider the details of the March inventory values in the table above:

• Target opening inventory – March budgeted sales * 60% = 1,400 * 60% = 840
• Target ending inventory – April budgeted sales * 60% = 1,100 * 60% = 660
• Target purchases = March budgeted sales + target ending inventory – target opening inventory = 1,400 + 660 – 840 = 1,220

Finally, consider the source of the March purchases value reported above:
• Amount – February purchases * $40 = 1,440 * 40 = $57,600

Labour Budget

If direct labour is paid based on the amount of work done, the direct labour budget follows directly from the production schedule. For example, assume direct labour use is tied to purchases (handling materials receipts) and sales (handling materials distribution). Assume .10 labour hours is required to handle each unit of materials receipt and .20 labour hours is required to handle each unit of materials distribution. If materials receipt labour is paid $20 per hour and materials shipment labour is paid $18 per hour, the following is the labour budget that would result. All direct labour workers are paid currently.

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td>1,200</td>
<td>1,500</td>
<td>1,400</td>
<td>1,100</td>
<td>1,300</td>
<td>900</td>
</tr>
<tr>
<td>Materials distribution labour (hours)</td>
<td>240</td>
<td>300</td>
<td>280</td>
<td>220</td>
<td>260</td>
<td>180</td>
</tr>
<tr>
<td>Materials distribution labour cost</td>
<td>$4,320</td>
<td>$5,400</td>
<td>$5,040</td>
<td>$3,960</td>
<td>$4,680</td>
<td>$3,240</td>
</tr>
<tr>
<td>Purchases (units)</td>
<td>1,380</td>
<td>1,440</td>
<td>1,220</td>
<td>1,220</td>
<td>1,060</td>
<td>1,080</td>
</tr>
<tr>
<td>Materials receipt labour (hours)</td>
<td>138</td>
<td>144</td>
<td>122</td>
<td>122</td>
<td>106</td>
<td>108</td>
</tr>
<tr>
<td>Materials receipt labour cost</td>
<td>$2,760</td>
<td>$2,880</td>
<td>$2,440</td>
<td>$2,440</td>
<td>$2,120</td>
<td>$2,160</td>
</tr>
<tr>
<td>Total labour budget</td>
<td>$7,080</td>
<td>$8,280</td>
<td>$7,480</td>
<td>$6,400</td>
<td>$6,800</td>
<td>$5,400</td>
</tr>
</tbody>
</table>

To illustrate, consider the labour budget for April:
• Materials distribution labour hours required = units sold * .2 = 1100 * .2 = 220
• Materials distribution labour cost = hours required * $18 = 220 * 18 = $3,960
• Materials receipt labour hours required = units purchased * .1 = 1220 * .1 = 122
• Materials receipt labour cost = hours required * $20 = 122 * 20 = $2,440
• Total labour budget = $3,960 + $2,440 = $6,400

Labour Scheduling

In some cases, labour must be hired on a salary basis and workers are paid a set amount that is independent of the number of hours they actually work. This setting creates challenging circumstances, since there is usually an upper bound of the number of hours salaried employees can work and, if work demands exceed that upper bound, more expensive part time employees must be hired. The following is an example.
Finnegan Company provides web design services for its clients. Demand is highly variable. Designers are paid a salary of $6,000 per month and work a maximum of 640 hours each month. If demand exceeds the total available hours from the monthly contracted employees additional workers can be hired on an hourly basis. The workers are paid $12 per hour.

Finnegan Company has estimated the monthly demand (in hours) for web design services and has identified what they believe is the best labour plan when labour must be contracted monthly and semi-annually. The labour budget and the associated costs appear on the following page. The upper panel on the page shows the labour plan when labour must be contracted monthly, the middle panel on the page shows the labour plan when labour must be contacted quarterly and the lower panel shows the labour plan when labour must be contracted semi-annually.

This example illustrates the important role demand forecasting has on labour requirements and how planned costs will increase when labour, or for that matter any fixed cost, must be contracted for longer periods. This example highlights the important role management accountants have in identifying the importance of labour flexibility when demand is variable. Note that, in practice, management would likely want to simulate the expected costs of different hiring plans under varying assumptions of monthly demand. These models can be rich and their potential is only limited by the skill of the management accountant in extracting valid data from operations personnel and designing appropriate simulation models. You will explore some of these issues in the Strategic Leadership Program.
### Finnegan Company - Monthly Contracts

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>Demand</td>
<td>4,000</td>
<td>4,800</td>
<td>5,000</td>
<td>4,200</td>
<td>3,800</td>
<td>4,500</td>
<td>5,800</td>
<td>4,400</td>
<td>3,900</td>
<td>3,700</td>
<td>4,200</td>
<td>4,900</td>
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<tr>
<td>Labour Hours Required</td>
<td>3,000</td>
<td>3,600</td>
<td>3,750</td>
<td>3,150</td>
<td>2,850</td>
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<td>2,925</td>
<td>2,775</td>
<td>3,150</td>
<td>3,675</td>
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<tr>
<td>Full Time Employees</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<td>5</td>
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<td>4</td>
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<tr>
<td>Hours Available @ 640hours/month</td>
<td>2,560</td>
<td>3,200</td>
<td>3,840</td>
<td>3,200</td>
<td>2,560</td>
<td>3,200</td>
<td>4,380</td>
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<td>2,560</td>
<td>2,560</td>
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<td>3,200</td>
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<tr>
<td>Excess Hours</td>
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<td>90</td>
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<td>Part-Time Hours Required</td>
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<td>100</td>
<td>365</td>
<td>215</td>
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<td>475</td>
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<tr>
<td>Full Time Employee Cost @ $6,000 per month</td>
<td>$24,000</td>
<td>$30,000</td>
<td>$36,000</td>
<td>$30,000</td>
<td>$24,000</td>
<td>$30,000</td>
<td>$42,000</td>
<td>$30,000</td>
<td>$24,000</td>
<td>$24,000</td>
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<td>$5,280</td>
<td>$4,800</td>
<td>$0</td>
<td>$0</td>
<td>$3,480</td>
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<td>$0</td>
<td>$1,200</td>
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<td>$2,580</td>
<td>$0</td>
<td>$5,700</td>
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<tr>
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<td>$29,280</td>
<td>$34,800</td>
<td>$36,000</td>
<td>$30,000</td>
<td>$27,480</td>
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<td>$31,200</td>
<td>$28,380</td>
<td>$26,580</td>
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### Finnegan Company - Quarterly Contracts

<table>
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<th>12</th>
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<tr>
<td>Demand</td>
<td>4,000</td>
<td>4,800</td>
<td>5,000</td>
<td>4,200</td>
<td>3,800</td>
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<td>4,400</td>
<td>3,900</td>
<td>3,700</td>
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<td>4,900</td>
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<tr>
<td>Labour Hours Required</td>
<td>3,000</td>
<td>3,600</td>
<td>3,750</td>
<td>3,150</td>
<td>2,850</td>
<td>3,375</td>
<td>4,350</td>
<td>3,300</td>
<td>2,925</td>
<td>2,775</td>
<td>3,150</td>
<td>3,675</td>
</tr>
<tr>
<td>Full Time Employees</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hours Available @ 640hours/month</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>2,560</td>
<td>2,560</td>
<td>2,560</td>
<td>2,560</td>
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<tr>
<td>Excess Hours</td>
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<td>0</td>
<td>0</td>
<td>50</td>
<td>350</td>
<td>0</td>
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<td>0</td>
<td>275</td>
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<td>215</td>
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<td>1,115</td>
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<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
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<tr>
<td>Part-Time Employee Cost @ $12.00 per hour</td>
<td>$0</td>
<td>$4,800</td>
<td>$6,600</td>
<td>$0</td>
<td>$0</td>
<td>$2,100</td>
<td>$13,800</td>
<td>$1,200</td>
<td>$0</td>
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<td>$7,080</td>
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<tr>
<td>Total Labour Cost</td>
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<td>$34,800</td>
<td>$36,600</td>
<td>$30,000</td>
<td>$30,000</td>
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<td>$31,200</td>
<td>$30,000</td>
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<td>$31,080</td>
<td>$37,380</td>
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### Finnegan Company - Semi Annual Contracts

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<th>4</th>
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<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>4,000</td>
<td>4,800</td>
<td>5,000</td>
<td>4,200</td>
<td>3,800</td>
<td>4,500</td>
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<td>4,400</td>
<td>3,900</td>
<td>3,700</td>
<td>4,200</td>
<td>4,900</td>
</tr>
<tr>
<td>Labour Hours Required</td>
<td>3,000</td>
<td>3,600</td>
<td>3,750</td>
<td>3,150</td>
<td>2,850</td>
<td>3,375</td>
<td>4,350</td>
<td>3,300</td>
<td>2,925</td>
<td>2,775</td>
<td>3,150</td>
<td>3,675</td>
</tr>
<tr>
<td>Full Time Employees</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
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</tr>
<tr>
<td>Hours Available @ 640hours/month</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
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<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
</tr>
<tr>
<td>Excess Hours</td>
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<td>0</td>
<td>50</td>
<td>350</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>275</td>
<td>425</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Part-Time Hours Required</td>
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<td>400</td>
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<td>0</td>
<td>175</td>
<td>1,150</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>475</td>
</tr>
<tr>
<td>Full Time Employee Cost @ $6,000 per month</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
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<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Part-Time Employee Cost @ $12.00 per hour</td>
<td>$0</td>
<td>$4,800</td>
<td>$6,600</td>
<td>$0</td>
<td>$0</td>
<td>$2,100</td>
<td>$13,800</td>
<td>$1,200</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$5,700</td>
</tr>
<tr>
<td>Total Labour Cost</td>
<td>$30,000</td>
<td>$34,800</td>
<td>$36,600</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$32,100</td>
<td>$43,800</td>
<td>$31,200</td>
<td>$30,000</td>
<td>$26,580</td>
<td>$31,080</td>
<td>$37,380</td>
</tr>
</tbody>
</table>
Other Expenditures

Expenditures, such as advertising and research and development, are driven by periodic budget authorizations. These expenditures reflect ongoing strategic initiatives and operational initiatives and the availability of funds.

Static Budgets

Static budgets are prepared at the start of the budget period to provide an overall financial summary of planned operations.

Consider the operations of Maggie Company, which manufactures plastic rain barrels. Each rain barrel requires:

- 20 units of plastic resin with an expected cost of $2.50 per unit
- Two valves with an expected cost of $.60 each
- .5 hours of finishing labour with an expected cost of $20 per hour

The Maggie Company accountant has estimated variable manufacturing overhead cost as $2.50 per unit and variable selling costs as $4 per unit. Estimated annual fixed manufacturing, selling and administrative costs are $5,000,000. Maggie Company executives believe the company will sell 200,000 rain barrels in the upcoming year at a price of $100 apiece.

The following is the static budget for Maggie Company:

<table>
<thead>
<tr>
<th>Maggie Company</th>
<th>Revenue</th>
<th>Standard</th>
<th>Cost</th>
<th>Static Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>Price</td>
<td>Total Units</td>
<td>Total Dollars</td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>$100.00</td>
<td>200,000</td>
<td>$20,000,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable Costs</th>
<th>Standard</th>
<th>Total Units</th>
<th>Total Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td>20</td>
<td>4,000,000</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>Valves</td>
<td>2</td>
<td>400,000</td>
<td>240,000</td>
</tr>
<tr>
<td>Finishing Labour</td>
<td>0.5</td>
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<tr>
<td>Manufacturing Overhead</td>
<td>1</td>
<td>800,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Selling</td>
<td>1</td>
<td>800,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
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<tr>
<td>Contribution Margin</td>
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<td>$6,460,000</td>
<td></td>
</tr>
<tr>
<td>Fixed Costs</td>
<td></td>
<td>$5,000,000</td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td></td>
<td></td>
<td>$1,460,000</td>
</tr>
</tbody>
</table>
Note that the unit amounts are called standards, for example, the standard price per unit of plastic is $2.50. The standard plastic cost per barrel is $50 (20 units of plastic multiplied by the standard price for plastic of $2.50).

The amounts in the total units and total dollars columns are called budgeted amounts. Budgeted amounts are computed by multiplying the unit standards by the budgeted activity level, which, in this case, is 200,000 rain barrels. For example, since the production plan calls for a production of 200,000 rain barrels and since the standard use of finishing labour is .5 hours per unit, the budgeted labour hours is 100,000 (200,000 * .5) and the budgeted cost of finishing labour is $2,000,000 (100,000 hours * $20 standard price per hour).

We can now flex the static budget by developing different budget amounts of different levels of activity. Assume that during the most recent year, Maggie Company planned on producing 200,000 rain barrels but actually produced 210,000. We can flex the static budget as follows to develop the budget against which the actual results can be compared:

<table>
<thead>
<tr>
<th>Maggie Company</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue</strong></td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
</tr>
<tr>
<td><strong>Variable costs</strong></td>
</tr>
<tr>
<td>Plastic</td>
</tr>
<tr>
<td>Valves</td>
</tr>
<tr>
<td>Finishing labour</td>
</tr>
<tr>
<td>Manufacturing overhead</td>
</tr>
<tr>
<td>Selling</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
</tr>
<tr>
<td><strong>Fixed costs</strong></td>
</tr>
<tr>
<td><strong>Profit</strong></td>
</tr>
</tbody>
</table>

Note that the static and flexible budget concepts reflect the discussion of cost volume profit relationships in Chapter 9. The rain barrels have a total variable cost of $67.70 and a contribution margin of $32.30 (100 – 67.70) per unit. Therefore, the profit equation for Maggie Company will be:

Profit = number of rain barrels produced * contribution margin per rain barrel – fixed costs

Profit = number of rain barrels produced * 32.30 - $5,000,000.

Therefore, the flexible budget profit is simply the profit line in the cost volume profit chart.
The Overall Cash Budget

When organizations are under financial stress, senior executives pay huge attention to the cash budget since cash is the organization’s life’s blood. Organizations that hold too much cash create opportunity cost losses, since cash is generally non-productive. Holding too little cash creates the possibility of missed opportunities or having to rely on expensive financing alternatives in the spot market.

Cash flow forecast statements usually separate cash flows relating to ongoing operations from cash flows relating to the acquisition of fixed assets and the effects on cash of financing.

The following example illustrates a cash budget for a simple organization. Sales drives the cash flow items and the major variables in the cash flow statement are:

- Sales are collected as follows:
  - 20% in the month of sale
  - 50% in the month following the month of sale
  - 25% in the second month following the month of sale
  - 5% never collected
- Other miscellaneous cash inflows are estimated to be $10,000 per month
- Materials purchases are 27% of current sales
- Direct labour costs are 25% of current sales
- Other factory related costs are $170,000 per month plus 15% of sales
- Selling costs are 5% of sales
- Administrative costs are $100,000 per month plus 4% of sales
- Other costs are estimated to be $10,000 per month
- The company wants to maintain a minimum cash balance of $100,000 and cash balances are maintained at this level through the line of credit accounts, which charges or pays interest based on whether the balance is positive or negative
The advantage of modelling cash flows is it allows planners to manage cash more effectively by identifying when significant shortages or surpluses will be generated by planned operations.

<table>
<thead>
<tr>
<th>Sales</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1,600,000</td>
<td>$2,200,000</td>
<td>$1,750,000</td>
<td>$2,100,000</td>
<td>$1,960,000</td>
<td>$1,700,000</td>
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</table>

<table>
<thead>
<tr>
<th>Opening cash</th>
<th>$125,000</th>
<th>$161,000</th>
<th>$100,000</th>
<th>$113,000</th>
<th>$100,000</th>
<th>$100,000</th>
</tr>
</thead>
</table>

| Cash inflows | $320,000 | $440,000 | $350,000 | $420,000 | $392,000 | $340,000 |

| Collections of credit sales | 1,700,000 | 1,500,000 | 1,425,000 | 1,487,500 | 1,505,000 | 1,340,000 |
| Other cash inflows | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| Total cash inflows | $2,032,000 | $1,952,000 | $1,787,000 | $1,919,500 | $1,909,000 | $1,692,000 |

| Cash outflows | $432,000 | $594,000 | $472,500 | $567,000 | $529,200 | $459,000 |

| Direct labour costs | $400,000 | $550,000 | $437,500 | $525,000 | $490,000 | $425,000 |

| Other factory related costs | $410,000 | $500,000 | $432,500 | $485,000 | $464,000 | $425,000 |
| Selling costs | $80,000 | $110,000 | $87,500 | $105,000 | $98,000 | $85,000 |
| Administrative costs | $164,000 | $188,000 | $170,000 | $184,000 | $178,400 | $168,000 |
| Other costs | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Total cash outflows | $1,496,000 | $1,952,000 | $1,810,000 | $1,876,000 | $1,769,600 | $1,572,800 |

| Net operating cash flow | $536,000 | $0 | $177,000 | $43,500 | $139,400 | $120,000 |

| Fixed asset transactions | $0 | $-500,000 | $0 | $-250,000 | $0 | $-100,000 |
| Sales | 0 | $125,000 | 0 | 45,000 | 0 | 0 |
| Net fixed asset transactions | $0 | $-375,000 | $0 | $-205,000 | $0 | $-100,000 |

| Cash before financing transactions | $661,000 | $-214,000 | $277,000 | $-48,500 | $239,400 | $120,000 |

| Financing transactions | $0 | $0 | $0 | $0 | $0 | $0 |
| Long-term borrowings | $0 | $0 | $0 | $0 | $0 | $0 |
| Long-term repayments | $-250,000 | 0 | 0 | 0 | 0 | 0 |
| Net stock related transactions | 0 | 150,000 | 0 | 0 | 0 | 0 |
| Net financing transactions | $-250,000 | $150,000 | $0 | $0 | $0 | $0 |

| Cash before line of credit flows | $411,000 | $-64,000 | $277,000 | $-48,500 | $239,400 | $120,000 |

| Line of credit activities | $250,000 | $0 | $164,000 | $0 | $148,500 | $9,100 |
| Line of credit repayment | 250,000 | 0 | 164,000 | 0 | 139,400 | 9,100 |
| Line of credit increases | 0 | 164,000 | 0 | 148,500 | 0 | 0 |
| Ending line of credit balance | $0 | $164,000 | $0 | $148,500 | $9,100 | $0 |
| Cash yield from line of credit activities | $-250,000 | $164,000 | $-164,000 | $148,500 | $-139,400 | $-9,100 |
| Ending cash balance | $161,000 | $100,000 | $113,000 | $100,000 | $100,000 | $110,900 |

Summary:

Overall, budget plays an important role in planning and providing alignment and direction in an organization. There are important behavioural issues associated with budgeting and using budgets to provide a basis for accountability. Some of these issues will be discussed in the Strategic Leadership Program.
Management Accounting

Problems with Solutions

Multiple Choice Questions

Questions 1 – 2 refer to the following:

Mitchell Company had the following budgeted sales for the last half of 2009:

<table>
<thead>
<tr>
<th></th>
<th>Cash Sales</th>
<th>Credit Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$50,000</td>
<td>$150,000</td>
</tr>
<tr>
<td>August</td>
<td>55,000</td>
<td>170,000</td>
</tr>
<tr>
<td>September</td>
<td>45,000</td>
<td>130,000</td>
</tr>
<tr>
<td>October</td>
<td>50,000</td>
<td>145,000</td>
</tr>
<tr>
<td>November</td>
<td>60,000</td>
<td>200,000</td>
</tr>
<tr>
<td>December</td>
<td>80,000</td>
<td>350,000</td>
</tr>
</tbody>
</table>

The company is in the process of preparing a cash budget and must determine the expected cash collections by month. To this end, the following information has been assembled:

Collections on credit sales: 60% in month of sale, 30% in month following sale, 10% in second month following sale

1. Assume the accounts receivable balance on July 1, 2009, was $75,000. Of this amount, $60,000 represented uncollected June sales. Given this data, the total cash collected during July would be:
   a) $150,000
   b) $235,000
   c) $215,000
   d) $200,000

2. What is the budgeted accounts receivable balance on December 1, 2009?
   a) $80,000
   b) $140,000
   c) $94,500
   d) $131,300
3. Walman Company is budgeting sales of 42,000 units of product Y for March 2003. To make one unit of Product Y, three kilograms of direct Material A are required. Actual beginning and desired ending inventories of direct Material A and Product Y are:

<table>
<thead>
<tr>
<th></th>
<th>March 1</th>
<th>March 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Material A</td>
<td>100,000 kg</td>
<td>110,000 kg</td>
</tr>
<tr>
<td>Product Y</td>
<td>22,000 units</td>
<td>24,000 units</td>
</tr>
</tbody>
</table>

There is no work-in-process inventory for Product Y at the beginning and end of March. For the month of March, how many kilograms of direct Material A is Walman planning to purchase?

a) 126,000
b) 132,000
c) 136,000
d) 142,000

4. The first step in formulating next year's master budget for a manufacturing company is to project next year's:

a) Capital budget to decide which production machine to buy in order to increase productivity
b) Cash budget to decide if the company needs to take out a bank loan
c) Materials and labour budget to decide on next year's direct material costs and direct labour costs
d) Production budget to decide on next year's production schedule
e) Sales budget to decide next year's sales volume
5. Huang Company has budgeted sales and production over the next quarter as:

<table>
<thead>
<tr>
<th></th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales in units</td>
<td>100,000</td>
<td>120,000</td>
<td>?</td>
</tr>
<tr>
<td>Production in units</td>
<td>104,000</td>
<td>128,000</td>
<td>156,000</td>
</tr>
</tbody>
</table>

On April 1, the company has 20,000 units of product on hand. A minimum of 20% of the next month's sales needs (in units) must be on hand at the end of each month. July sales are expected to be 140,000 units. What would be the budgeted sales for June (in units)?

a) 128,000 units  
b) 160,000 units  
c) 184,000 units  
d) 188,000 units

6. BH Wholesalers has a sales budget for December of $800,000. Cost of merchandise sold is expected to be 30% of sales. 60% of all merchandise is paid in the month of purchase and the remaining 40% is paid in the following month. The merchandise inventory balance on November 30 is $24,000 and the December 31 merchandise inventory balance is budgeted to be $30,000. The merchandise accounts payable balance on November 30 is $102,000. The budgeted accounts payable balance for December 31 is:

a) $138,000  
b) $98,400  
c) $93,600  
d) $147,600  
e) $96,000
The following data apply to Questions 7 – 8:

Berol Company plans to sell 200,000 units of finished product in July of 2000 and anticipates a growth rate in sales of 5% per month. The desired monthly ending inventory in units of finished product is 80% of the next month's estimated sales. There are 150,000 finished units in inventory on June 30, 2000.

Each unit of finished product requires four pounds of direct material at a cost of $1.20 per pound. There are 800,000 pounds of direct material in inventory on June 30, 2000.

7. Berol Company's production requirement in units of finished product for the three month period ending September 30, 2000 is:
   a) 712,025 units
   b) 630,500 units
   c) 664,000 units
   d) 665,720 units
   e) 862,025 units

8. Without prejudice to your answer to Question 7, assume Berol Company plans to produce 600,000 units of finished product in the three-month period ending September 30, 2000 and have direct materials inventory on hand at the end of the three-month period equal to 25% of the use in that period. The estimated cost of direct material purchases for the three month period ending September 30, 2000 is:
   a) $2,200,000
   b) $2,400,000
   c) $2,640,000
   d) $2,880,000
   e) $3,600,000
The following data apply to Questions 9 – 10:

Esplanade Company has the following historical pattern for its credit sales:

- 70% collected in month of sale
- 15% collected in the first month after sale
- 10% collected in the second month after sale
- 4% collected in the third month after sale
- 1% uncollectible

The sales on open account have been budgeted for the past six months of 2000 as:

<table>
<thead>
<tr>
<th>Month</th>
<th>Budgeted Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$60,000</td>
</tr>
<tr>
<td>August</td>
<td>70,000</td>
</tr>
<tr>
<td>September</td>
<td>80,000</td>
</tr>
<tr>
<td>October</td>
<td>90,000</td>
</tr>
<tr>
<td>November</td>
<td>100,000</td>
</tr>
<tr>
<td>December</td>
<td>85,000</td>
</tr>
</tbody>
</table>

9. The estimated total cash collections during October 2000 from accounts receivable would be:
   a) $63,000
   b) $84,400
   c) $89,100
   d) $21,400
   e) $83,556

10. The estimated total cash collections during the fourth calendar quarter from sales made on open account during the fourth calendar quarter would be:
    a) $172,500
    b) $275,000
    c) $230,000
    d) $251,400
    e) $265,400
The following data apply to Questions 11 – 12:

Pardise Company budgets on an annual basis for its fiscal year. The following beginning and ending inventory levels (in units) are planned for the fiscal year of July 1, 2000, through June 30, 2001:

<table>
<thead>
<tr>
<th></th>
<th>July 1, 2000</th>
<th>June 30, 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct material*</td>
<td>40,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Work-in-process</td>
<td>10,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Finished goods</td>
<td>80,000</td>
<td>50,000</td>
</tr>
</tbody>
</table>

*Two (2) units of direct material are needed to produce each unit of finished product.

11. If Pardise Company plans to sell 480,000 units during the 2000 - x1 fiscal year, the number of units it would have to manufacture during the year would be:
   a) 440,000 units
   b) 480,000 units
   c) 510,000 units
   d) 450,000 units
   e) 460,000 units

12. If 500,000 complete units were to be manufactured during the 2000 - x1 fiscal year by Pardise Company, the units of raw material needed to be purchased would be:
   a) 1,000,000 units
   b) 1,020,000 units
   c) 1,010,000 units
   d) 990,000 units
   e) 950,000 units
Problem 1

Down East Planters provides reforestation services to large paper products companies. It must hire one planter for every 10,000 trees it has contracted to plant. The customer provides the trees.

New employees are hired on the first day of the month they are needed. Each employee receives one week of evaluation and training before being profitably employed and, therefore, works only three of the four weeks of the first month of employment. On average, for every five prospective employees who enter training, three are deemed suitable for employment. When cutbacks occur, employees are laid off on the first day of the month. Every employee laid off receives pay equal to one week’s salary, which, on average, is $400. The payment is independent of how long the layoff will last. Laid off employees inevitably drift away and new hires must be trained.

Down East Planters has two trained employees on staff on January 1.

Down East Planters has been offered the following contracts for the upcoming year. Each monthly contract is offered on an accept or reject basis. That is, if a monthly contract is accepted, it must be completed in full. The price paid to Down East Planters is $.20 per tree.

The required tree plantings each month is:

<table>
<thead>
<tr>
<th>Demand</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,692</td>
<td>5,765</td>
<td>8,134</td>
<td>34,400</td>
<td>556,729</td>
<td>8,32,251</td>
<td>1,296,300</td>
<td>895,449</td>
<td>733,894</td>
<td>20,525</td>
<td>20,525</td>
<td>20,525</td>
<td>9,827</td>
</tr>
</tbody>
</table>

Required:

Develop the cash flow budget for the first six months of the upcoming year.
Problem 2

Madill Company manufactures a single product which is produced by blending two chemicals, A and B. Chemicals A and B are mixed in batches to produce the final product. The batch size is not variable and each batch requires 200 litres of Chemical A, 50 litres of Chemical B, two labour hours, one set of protective sheets and one container, which is used for blending Chemicals A and B. The resulting product is packaged in one litre containers, therefore, each batch yields 250 (250/1) units of final product.

The following table summarizes the amount of each variable item required per batch of product and the total cost of that item per batch of product:

<table>
<thead>
<tr>
<th>Direct materials</th>
<th>200 litres</th>
<th>$900.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical A</td>
<td>200 litres</td>
<td>$900.00</td>
</tr>
<tr>
<td>Chemical B</td>
<td>50 litres</td>
<td>$400.00</td>
</tr>
<tr>
<td>Direct labour</td>
<td>5 hours</td>
<td>$140.00</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>4 units</td>
<td>$180.00</td>
</tr>
<tr>
<td>Protective sheets</td>
<td>4 units</td>
<td>$180.00</td>
</tr>
<tr>
<td>Container</td>
<td>1 unit</td>
<td>$120.00</td>
</tr>
</tbody>
</table>

Madill has signed a contract to deliver the following amounts over the next six months. Madill is paid $15 per unit for this product. Payment is 50% in the month of delivery and 50% in the month following delivery.

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
</tbody>
</table>

Since the product is unstable, Madill produces on demand and holds minimum inventories. All chemical purchases are paid 30% in the month of production, 40% in the second month and 30% in the third month following. Direct labour is paid in the month of production. Variable overhead items are paid in the month following the month of production.

Required:

a. Develop the cash collection budget for this product.
b. Develop the production budget for this product.
c. Develop the materials purchase budget for this product.
d. Develop the direct labour budget for this product.
e. Develop the variable overhead budget for this product.
f. Prepare a cash flow budget for this product.
g. Assume there is a production constraint and the maximum number of batches that can be produced in any month is 11. Develop a cash flow budget for this product.
Problem 3

Dish Inc., a distributor of fashion items, normally collects its receivables 45% in month of sale, 35% the subsequent month and 17% in the third month. Historically, 3% is not collected (is a bad debt).

Dish Inc. attempts to match its payments of payables closely to its receivables and pays for its purchases 40% in the month of purchase, 40% in the next month and 20% in the third month. Sales during February, March and April were $160,000, $195,000 and $168,000, respectively. Purchases during these three months were $198,000, $182,000 and $220,000 for February, March and April.

The company pays income tax instalments of $4,000 each month. Assuming the beginning balance of cash at February 1 is $39,800 and the company wishes to maintain a cash balance of $30,000, prepare a cash budget for February, March and April. Dish Inc. has a line of credit available at a rate of 10%. Interest is paid when the loan is repaid.

December and January sales were $250,000 and $175,000, respectively. December and January purchases were $195,000 and $200,000, respectively.

Required:

Prepare a cash budget for February, March and April.
Problem 4

The City of Loughborough had the following sales of water for the last half of 2009:

<table>
<thead>
<tr>
<th>Month</th>
<th>Sales Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>$120,000</td>
</tr>
<tr>
<td>August</td>
<td>85,000</td>
</tr>
<tr>
<td>September</td>
<td>115,000</td>
</tr>
<tr>
<td>October</td>
<td>75,000</td>
</tr>
<tr>
<td>November</td>
<td>150,000</td>
</tr>
</tbody>
</table>

- All sales are on credit. Historically, 40% is collected in the month of the sale, 40% during the first month following the sale and 20% in the second month following the sale.
- Cost of water averages 70% of sales revenue. Water is purchased in month of sale. All purchases are paid during the month following the purchase.
- Operating costs of $25,000 are paid each month.
- The September 1 cash balance is expected to be the minimum balance of $10,000.
- The minimum acceptable cash balance at the end of any month is $10,000. Money can be borrowed from a local bank in increments of $1,000. (Do not include interest charges in your budget.)

Required:

Prepare monthly a cash budget for September, October and November, 2009 and an overall cash budget for the three months together.
Problem 5

The following performance report is for the bottling department Moore Company for the month ending December 31, 2006.

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Budget</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (units)</td>
<td>75,000</td>
<td>90,000</td>
<td></td>
</tr>
<tr>
<td>Manufacturing costs:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>$156,000</td>
<td>$180,000</td>
<td>$24,000  (F)</td>
</tr>
<tr>
<td>Direct labour</td>
<td>835,000</td>
<td>900,000</td>
<td>65,000   (F)</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>360,000</td>
<td>450,000</td>
<td>90,000   (F)</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td>60,000</td>
<td>54,000</td>
<td>6,000    (U)</td>
</tr>
<tr>
<td>Total</td>
<td>$1,411,000</td>
<td>$1,584,000</td>
<td>$173,000 (F)</td>
</tr>
</tbody>
</table>

Required:

Evaluate the performance report.

Using a flexible budgeting approach, prepare a more appropriate performance report (i.e. produce a flexible budget and indicate planning and flexible budget variances).
Problem 6

The Storey Manufacturing Company makes two basic products, Cee and Dee. Data assembled by the managers follows:

<table>
<thead>
<tr>
<th></th>
<th>Cee</th>
<th>Dee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements for finished unit:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw Material 1</td>
<td>10 kg</td>
<td>8 kg</td>
</tr>
<tr>
<td>Raw Material 2</td>
<td></td>
<td>4 kg</td>
</tr>
<tr>
<td>Raw Material 3</td>
<td>2 units</td>
<td>1 unit</td>
</tr>
<tr>
<td>Direct labour</td>
<td>5 hours</td>
<td>8 hours</td>
</tr>
<tr>
<td>Sales price</td>
<td>$100</td>
<td>$150</td>
</tr>
<tr>
<td>Sales units</td>
<td>12,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Estimated beginning inventory</td>
<td>400</td>
<td>150</td>
</tr>
<tr>
<td>Desired ending inventory</td>
<td>300</td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Raw Materials</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$2.00 per kg</td>
<td>2.50 per kg</td>
<td>$.50 per unit</td>
</tr>
<tr>
<td>Estimated beginning inventory</td>
<td>3,000</td>
<td>1,500</td>
<td>1,000</td>
</tr>
<tr>
<td>Desired ending inventory</td>
<td>4,000</td>
<td>1,000</td>
<td>1,500</td>
</tr>
</tbody>
</table>

The direct labour wage rate is $4 per hour. Overhead is applied on the basis of direct labour hours. The tax rate is 40%.

The budgeted sales level is divided into quarters. Storey estimated that 20% of the annual sales will be in the first quarter, 30% in the second and 25% in the third and fourth quarters. The beginning inventory of finished products has the same cost per unit as the ending inventory. The work-in-process inventory is negligible.

<table>
<thead>
<tr>
<th></th>
<th>Cee</th>
<th>Dee</th>
<th>Total Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units</td>
<td>Dollars</td>
<td>Units</td>
</tr>
<tr>
<td>First quarter</td>
<td>2,400</td>
<td>$240,000</td>
<td>1,800</td>
</tr>
<tr>
<td>Second quarter</td>
<td>3,600</td>
<td>360,000</td>
<td>2,700</td>
</tr>
<tr>
<td>Third quarter</td>
<td>3,000</td>
<td>300,000</td>
<td>2,250</td>
</tr>
<tr>
<td>Fourth quarter</td>
<td>3,000</td>
<td>300,000</td>
<td>2,250</td>
</tr>
<tr>
<td>Total</td>
<td>12,000</td>
<td>1,200,000</td>
<td>9,000</td>
</tr>
</tbody>
</table>
Factory Overhead Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect materials</td>
<td>$10,000</td>
</tr>
<tr>
<td>Miscellaneous supplies and tools</td>
<td>5,000</td>
</tr>
<tr>
<td>Indirect labour</td>
<td>40,000</td>
</tr>
<tr>
<td>Supervision</td>
<td>20,000</td>
</tr>
<tr>
<td>Payroll taxes and fringe benefits</td>
<td>75,000</td>
</tr>
<tr>
<td>Maintenance costs – fixed</td>
<td>20,000</td>
</tr>
<tr>
<td>Maintenance costs – variable</td>
<td>10,000</td>
</tr>
<tr>
<td>Depreciation</td>
<td>70,000</td>
</tr>
<tr>
<td>Heat, light and power – fixed</td>
<td>8,710</td>
</tr>
<tr>
<td>Heat, light and power – variable</td>
<td>5,090</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$263,800</strong></td>
</tr>
</tbody>
</table>

Selling And Administrative Expenses

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertising</td>
<td>$60,000</td>
</tr>
<tr>
<td>Sales salaries</td>
<td>200,000</td>
</tr>
<tr>
<td>Travel and entertainment</td>
<td>60,000</td>
</tr>
<tr>
<td>Depreciation – warehouse</td>
<td>5,000</td>
</tr>
<tr>
<td>Office salaries</td>
<td>20,000</td>
</tr>
<tr>
<td>Executive salaries</td>
<td>250,000</td>
</tr>
<tr>
<td>Supplies</td>
<td>4,000</td>
</tr>
<tr>
<td>Depreciation – office</td>
<td>6,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$605,000</strong></td>
</tr>
</tbody>
</table>

Required:
- Prepare the following:
  a. Production budget
  b. Direct materials purchase budget
  c. Direct labour budget
  d. Cost of goods sold budget
  e. Budgeted income statement

Note: Because you are given inventory values for the beginning and the end of the year, it is impossible to construct budgets by quarter. The budgets should be presented for the whole year.
Problem 7

The Gowan Corporation manufactures and distributes wooden baseball bats. This is a seasonal business with a large portion of its sales occurring in late winter and early spring. The production schedule for the last quarter of the year is heavy in order to build up inventory to meet expected sales volume.

The company experiences a temporary cash strain during this heavy production period. Payroll costs rise during the last quarter because overtime is scheduled to meet the increased production needs. Collections from customers are low because the fall season produces only modest sales. This year the company's concern is intensified because prices are increasing during the current inflationary period. In addition, the sales department forecasts sales of fewer than one million bats for the first time in three years. This decrease in sales appears to be caused by the popularity of aluminum bats.

The cash account builds up during the first and second quarters as sales exceed production. The excess cash is invested in Treasury bills and other commercial paper. During the last half of the year, the temporary investments are liquidated to meet the cash needs. In the early years of the company, short-term borrowing was used to supplement the funds released by selling investments, but this has not been necessary in recent years. Because costs are higher this year, the treasurer asks for a forecast for December to judge if the $40,000 in temporary investments will be adequate to carry the company through the month with a minimum balance of $10,000. Should this amount ($40,000) be insufficient, she wants to begin negotiations for a short-term loan.

The unit sales volume for the past two months and the estimate for the next four months are:

<table>
<thead>
<tr>
<th>Month</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>October (actual)</td>
<td>70,000</td>
</tr>
<tr>
<td>November (actual)</td>
<td>50,000</td>
</tr>
<tr>
<td>December (estimated)</td>
<td>50,000</td>
</tr>
<tr>
<td>January (estimated)</td>
<td>90,000</td>
</tr>
<tr>
<td>February (estimated)</td>
<td>90,000</td>
</tr>
<tr>
<td>March (estimated)</td>
<td>120,000</td>
</tr>
</tbody>
</table>

The bats are sold for $5 each. All sales are made on account. Half of the accounts are collected in the month of the sale, 40% are collected in the month following the sale and the remaining 10% in the second month following the sale. Customers who pay in the month of the sale receive a 2% cash discount.

The production schedule for the six-month period beginning with October reflects the company's policy of maintaining a stable year-round work force by scheduling overtime to meet the following production schedules:
The bats are made from wooden blocks that cost $6 each. Ten bats can be produced from each block. The blocks are acquired one year in advance so they can be properly aged. Gowan pays the supplier one-twelfth the cost of this material each month until the obligation is retired. The monthly payment is $60,000.

The plant is normally scheduled for a 40-hour, five-day work week. During the busy production season, however, the work week may be increased to six 10-hour days. Workers can produce 7.5 bats per hour. Normal monthly output is 75,000 bats. Factory employees are paid $15 per hour for regular time and time and one-half for overtime.

Other manufacturing costs include variable overhead of $.30 per unit and annual fixed overhead of $280,000. Depreciation charges totalling $40,000 are included among the fixed overhead. Selling expenses include variable costs of $.20 per unit and annual fixed costs of $60,000. Fixed administrative costs are $120,000 annually. All fixed costs are incurred uniformly throughout the year.

The controller has accumulated the following additional information:

1. The balances of selected accounts as of November 30, 2004 are:

<table>
<thead>
<tr>
<th>Account</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>$12,000</td>
</tr>
<tr>
<td>Marketable securities, at market value</td>
<td>$40,000</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>$96,000</td>
</tr>
<tr>
<td>Prepaid expenses</td>
<td>$4,800</td>
</tr>
<tr>
<td>Accounts payable (arising from raw material purchases)</td>
<td>$300,000</td>
</tr>
<tr>
<td>Accrued vacation pay</td>
<td>$9,500</td>
</tr>
<tr>
<td>Equipment note payable</td>
<td>$102,000</td>
</tr>
<tr>
<td>Accrued income taxes payable</td>
<td>$50,000</td>
</tr>
</tbody>
</table>

2. Interest to be received from the company's temporary investments is estimated at $500 for December.

3. Prepaid expenses of $3,600 will expire during December and the balance of the prepaid account is estimated at $4,200 for the end of December.

4. Gowan purchased new machinery in 2004 as part of a plant modernization program. The machinery was financed by a 24-month note of $144,000. The terms call for equal principal payments over the next 24 months with interest paid at the rate of 1% per month.
on the unpaid balance at the first of the month. The first payment was made on May 1, 2004.

5. Old equipment, which has a book value of $8,000, is to be sold during December for $7,500.

6. Each month the company accrues $1,700 for vacation pay by charging vacation pay expense and crediting accrued vacation pay. The plant closes for two weeks in June when all plant employees take vacation.

7. Quarterly dividends of $.20 per share will be paid on December 15 to stockholders of record. Gowan Corporation has authorized 10,000 shares. The company has issued 7,500 shares and 500 of these are classified as treasury stock.

8. The quarterly income taxes payment of $50,000 is due on December 15, 2004.

Required:

Prepare a schedule that forecasts the cash position at December 31, 2004. What action, if any, will be required to maintain a $10,000 cash balance?
Multiple Choice Question Solutions

1. d From May sales:
   From June Sales: $60,000 ÷ .4
   = $150,000 x 30%
   From July sales
   Cash
   Credit: $150,000 x .6
   $200,000

2. c October sales: $145,000 x 10%
   November sales: $200,000 x 40%
   $94,500

3. d Product Y:
   Sales
   Ending inventory
   Total needs
   Less opening inventory
   44,000

Direct Material A:
   Required for production: 44,000 x 3 kg
   Ending inventory
   Total needs
   Less opening inventory
   142,000

4. e The sales forecast is the usual starting point for budgeting because production and inventory levels generally depend on the forecasted level of sales.

5. b Needs for June:
   Sales X
   + ending inventory: 140,000 x 20%
   - opening inventory
   = June production
   156,000
   X + 28,000 - .2X = 156,000
   0.8X = 128,000
   X = 160,000
6. b Budgeted cost of merchandise sold in December = $800,000 x 30%
   = $240,000
   Budgeted merchandise purchases in December = $240,000 + $30,000 ending
   inventory - $24,000 beginning inventory = $246,000
   Budgeted merchandise accounts payable balance = $246,000 x 40%
   = $98,400

7. d Sales: July: 200,000; Aug: 200,000 x 1.05 = 210,000
   September: 210,000 x 1.05 = 220,500; Total = 630,500
   September ending inventory requirement = $220,500 x 1.05 x 80%
   = 185,220
   Production: 630,500 sales + 185,220 ending inventory - 150,000 op. inv.
   = 665,720 units

8. c Ending inventory requirements: 600,000 units x 4 lbs x 25% = 600,000 lbs
   Unit purchases = (600,000 x 4) prod. + 600,000 ending inv. - 800,000 op. inv.
   = 2,200,000 x $1.20 = $2,640,000

9. b July – $60,000 x 4% $2,400
   August – $70,000 x 10% 7,000
   September – $80,000 x 15% 12,000
   October – $90,000 x 70% 63,000
   $84,400

10. c October – $90,000 x 95% $85,500
    November – $100,000 x 85% 85,000
    December – $85,000 x 70% 59,500
    $230,000

11. d 480,000 + 50,000 - 80,000 = 450,000

12. c (500,000 x 2) + 50,000 - 40,000 = 1,010,000 units
### Problem 1

The following is the cash flow budget for the entire year:

<table>
<thead>
<tr>
<th>End of month</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>5</th>
<th>73</th>
<th>87</th>
<th>143</th>
<th>90</th>
<th>74</th>
<th>21</th>
<th>3</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (d below)</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
<td>40,000</td>
<td>560,000</td>
<td>835,000</td>
<td>1,290,000</td>
<td>900,000</td>
<td>740,000</td>
<td>210,000</td>
<td>30,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Wages (e below)</td>
<td>$1,600</td>
<td>$1,600</td>
<td>$1,600</td>
<td>$6,400</td>
<td>$19,000</td>
<td>$13,000</td>
<td>$206,400</td>
<td>$14,400</td>
<td>$118,400</td>
<td>$33,600</td>
<td>$4,800</td>
<td>$1,600</td>
</tr>
<tr>
<td>Training costs (e below)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>280</td>
<td>45,600</td>
<td>560</td>
<td>37,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Layoff severance</td>
<td>400</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>21,200</td>
<td>6,400</td>
<td>21,200</td>
<td>7,200</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Total costs</td>
<td>$2,000</td>
<td>$1,600</td>
<td>$1,600</td>
<td>$9,200</td>
<td>$135,200</td>
<td>$143,200</td>
<td>$244,000</td>
<td>$165,200</td>
<td>$124,800</td>
<td>$54,800</td>
<td>$12,000</td>
<td>$2,400</td>
</tr>
</tbody>
</table>

- Net cash flow: $-$262, $-$447, $27, $-$2,320, $-$23,454, $23,250, $13,340, $13,890, $21,819, $-$14,095, $-$6,118, $-$435

| Beginning capacity | 20,000 | 10,000 | 10,000 | 10,000 | 50,000 | 730,000 | 870,000 | 1,430,000 | 900,000 | 740,000 | 210,000 | 30,000 |
| Demand shortage (excess) | -11,308 | -4,235 | -1,866 | 24,400 | 506,729 | 102,251 | 416,700 | -534,551 | -866,000 | -356,475 | -180,950 | -20,173 |

- New planters needed: 0, 0, 0, 4, 68, 14, 56, 0, 0, 0, 0, 0
- Training = 5/3 needed: 0, 0, 0, 7, 114, 24, 94, 0, 0, 0, 0, 0
- Planters laid off: 1, 0, 0, 0, 0, 0, 0, 53, 16, 53, 18, 2

(a) New planters needed: 0, 0, 0, 4, 68, 14, 56, 0, 0, 0, 0, 0
(b) Training = 5/3 needed: 0, 0, 0, 7, 114, 24, 94, 0, 0, 0, 0, 0
(c) Planters laid off: 1, 0, 0, 0, 0, 0, 0, 53, 16, 53, 18, 2

- Trainees add to capacity for only 3 weeks of their first month. For example in April, the capacity is \((1 \times 10,000) + (4 \times 10,000) = 100,000\).
- Trainees are hired at the beginning of the month and receive $400 for a week of training and 3 weeks of wages at $400 per week. Trained workers receive $1,600 a month.

### Problem 2

**a.**

<table>
<thead>
<tr>
<th>Sales (units)</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sales Collections</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>This Month</td>
<td>$15,750</td>
<td>$18,000</td>
<td>$23,250</td>
<td>$21,000</td>
<td>$17,250</td>
<td>$18,750</td>
</tr>
<tr>
<td>Last Month</td>
<td>0</td>
<td>15,750</td>
<td>18,000</td>
<td>23,250</td>
<td>21,000</td>
<td>17,250</td>
</tr>
</tbody>
</table>

Total collections $15,750 $33,750 $41,250 $44,250 $38,250 $36,000

**b.**

<table>
<thead>
<tr>
<th>Sales (units)</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening inventory</td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
<tr>
<td>Opening inventory</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum production</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batches required</td>
<td>9</td>
<td>9</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

Production 2,250 2,250 3,250 2,750 2,250 2,500

<table>
<thead>
<tr>
<th>Ending inventory</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ending inventory</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
### c.

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
<tr>
<td>Opening inventory</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Minimum production</td>
<td>2,100</td>
<td>2,250</td>
<td>3,100</td>
<td>2,650</td>
<td>2,200</td>
<td>2,450</td>
</tr>
<tr>
<td>Batches required</td>
<td>9</td>
<td>9</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Production</td>
<td>2,250</td>
<td>2,250</td>
<td>3,250</td>
<td>2,750</td>
<td>2,250</td>
<td>2,500</td>
</tr>
<tr>
<td>Ending inventory</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

**Materials purchase**

**Chemical A purchases**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$8,100</td>
<td>$8,100</td>
<td>$11,700</td>
<td>$9,900</td>
<td>$8,100</td>
<td>$9,000</td>
</tr>
</tbody>
</table>

**Chemical B purchases**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$3,600</td>
<td>$3,600</td>
<td>$5,200</td>
<td>$4,400</td>
<td>$3,600</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

**Total purchases**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$11,700</td>
<td>$11,700</td>
<td>$16,900</td>
<td>$14,300</td>
<td>$11,700</td>
<td>$13,000</td>
</tr>
</tbody>
</table>

**Payment**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$3,510</td>
<td>$8,190</td>
<td>$13,260</td>
<td>$14,560</td>
<td>$14,300</td>
<td>$12,870</td>
</tr>
</tbody>
</table>

### d.

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
<tr>
<td>Opening inventory</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Minimum production</td>
<td>2,100</td>
<td>2,250</td>
<td>3,100</td>
<td>2,650</td>
<td>2,200</td>
<td>2,450</td>
</tr>
<tr>
<td>Batches required</td>
<td>9</td>
<td>9</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Production</td>
<td>2,250</td>
<td>2,250</td>
<td>3,250</td>
<td>2,750</td>
<td>2,250</td>
<td>2,500</td>
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<tr>
<td>Ending inventory</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

**Labour hours**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$1,260</td>
<td>$1,260</td>
<td>$1,820</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
</tr>
</tbody>
</table>

**Payment**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$1,260</td>
<td>$1,260</td>
<td>$1,820</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
</tr>
</tbody>
</table>
### Management Accounting

#### e.

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
<tr>
<td>Opening inventory</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Minimum production</td>
<td>2,100</td>
<td>2,250</td>
<td>3,100</td>
<td>2,650</td>
<td>2,200</td>
<td>2,450</td>
</tr>
<tr>
<td>Batches required</td>
<td>9</td>
<td>9</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Production</td>
<td>2,250</td>
<td>2,250</td>
<td>3,250</td>
<td>2,750</td>
<td>2,250</td>
<td>2,500</td>
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<tr>
<td>Ending inventory</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable overhead items</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective sheets</td>
<td>36</td>
<td>36</td>
<td>52</td>
<td>44</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>Cost</td>
<td>$6,480</td>
<td>$6,480</td>
<td>$9,360</td>
<td>$7,920</td>
<td>$6,480</td>
<td>$7,200</td>
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<td>Containers</td>
<td>9</td>
<td>9</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Cost</td>
<td>$1,080</td>
<td>$1,080</td>
<td>$1,560</td>
<td>$1,320</td>
<td>$1,080</td>
<td>$1,200</td>
</tr>
<tr>
<td>Total purchases</td>
<td>$7,560</td>
<td>$7,560</td>
<td>$10,920</td>
<td>$9,240</td>
<td>$7,560</td>
<td>$8,400</td>
</tr>
<tr>
<td>Payment</td>
<td>0</td>
<td>$7,560</td>
<td>$7,560</td>
<td>$10,920</td>
<td>$9,240</td>
<td>$7,560</td>
</tr>
</tbody>
</table>
Management Accounting

f.

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (units)</td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
<tr>
<td>Opening inventory</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Minimum production</td>
<td>2,100</td>
<td>2,250</td>
<td>3,100</td>
<td>2,650</td>
<td>2,200</td>
<td>2,450</td>
</tr>
<tr>
<td>Batches required</td>
<td>9</td>
<td>9</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Production</td>
<td>2,250</td>
<td>2,250</td>
<td>3,250</td>
<td>2,750</td>
<td>2,250</td>
<td>2,500</td>
</tr>
<tr>
<td>Ending inventory</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Sales collections

<table>
<thead>
<tr>
<th></th>
<th>This month</th>
<th>Last month</th>
<th>Total collections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$15,750</td>
<td>$18,000</td>
<td>$33,750</td>
</tr>
<tr>
<td></td>
<td>$23,250</td>
<td>$18,000</td>
<td>$41,250</td>
</tr>
<tr>
<td></td>
<td>$21,000</td>
<td>23,250</td>
<td>$44,250</td>
</tr>
<tr>
<td></td>
<td>$17,250</td>
<td>21,000</td>
<td>$38,250</td>
</tr>
<tr>
<td></td>
<td>$18,750</td>
<td>17,250</td>
<td>$36,000</td>
</tr>
</tbody>
</table>

Materials purchase

Chemical A purchases

| Amount   | 1,800 | 1,800 | 2,600 | 2,200 | 1,800 | 2,000 |
| Cost     | $8,100 | $8,100 | $11,700 | $9,900 | $8,100 | $9,000 |

Chemical B purchases

| Amount   | 450   | 450   | 650   | 550   | 450   | 500   |
| Cost     | $3,600 | $3,600 | $5,200 | $4,400 | $3,600 | $4,000 |

Total purchases

|                   | $11,700 | $11,700 | $16,900 | $14,300 | $11,700 | $13,000 |

Payment

|                   | $3,510 | $8,190 | $13,260 | $14,560 | $14,300 | $12,870 |

Labour Hours

| Amount   | 45     | 45     | 65     | 55     | 45     | 50     |
| Cost     | $1,260 | $1,260 | $1,820 | $1,540 | $1,260 | $1,400 |

Payment

|                   | $1,260 | $1,260 | $1,820 | $1,540 | $1,260 | $1,400 |

Protective sheets

| Amount   | 36     | 36     | 52     | 44     | 36     | 40     |
| Cost     | $6,480 | $6,480 | $9,360 | $7,920 | $6,480 | $7,200 |

Containers

| Amount   | 9      | 9      | 13     | 11     | 9      | 10     |
| Cost     | $1,080 | $1,080 | $1,560 | $1,320 | $1,080 | $1,200 |

Total purchases

|                   | $7,560 | $7,560 | $10,920 | $9,240 | $7,560 | $8,400 |

Payment

|                   | 0      | $7,560 | $7,560  | $10,920| $9,240 | $7,560 |

Total disbursements

|                   | $4,770 | $17,010| $22,640 | $27,020| $24,800| $21,830|

Net cash flow

|                   | $10,980| $16,740| $18,610 | $17,230| $13,450| $14,170|
### g.

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales (units)</strong></td>
<td>2,100</td>
<td>2,400</td>
<td>3,100</td>
<td>2,800</td>
<td>2,300</td>
<td>2,500</td>
</tr>
<tr>
<td><strong>Opening inventory</strong></td>
<td>0</td>
<td>150</td>
<td>500</td>
<td>150</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td><strong>Minimum production</strong></td>
<td>2,100</td>
<td>2,250</td>
<td>2,600</td>
<td>2,650</td>
<td>2,200</td>
<td>2,450</td>
</tr>
<tr>
<td><strong>Batches required</strong></td>
<td>9</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td>2,250</td>
<td>2,750</td>
<td>2,750</td>
<td>2,750</td>
<td>2,250</td>
<td>2,500</td>
</tr>
<tr>
<td><strong>Ending inventory</strong></td>
<td>150</td>
<td>500</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

#### Sales collections

<table>
<thead>
<tr>
<th></th>
<th>This month</th>
<th>Last month</th>
<th>Total collections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$15,750</td>
<td>$15,750</td>
<td>$31,500</td>
</tr>
<tr>
<td></td>
<td>$18,000</td>
<td>$18,000</td>
<td>$36,000</td>
</tr>
<tr>
<td></td>
<td>$23,250</td>
<td>$23,250</td>
<td>$46,500</td>
</tr>
<tr>
<td></td>
<td>$21,000</td>
<td>$21,000</td>
<td>$42,000</td>
</tr>
<tr>
<td></td>
<td>$17,250</td>
<td>$21,000</td>
<td>$38,250</td>
</tr>
<tr>
<td></td>
<td>$18,750</td>
<td>$17,250</td>
<td>$36,000</td>
</tr>
</tbody>
</table>

#### Materials purchase

**Chemical A purchases**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,800</td>
<td>$8,100</td>
<td>$9,900</td>
<td>$9,900</td>
<td>$9,900</td>
<td>$8,100</td>
<td>$9,000</td>
</tr>
<tr>
<td>Cost $8,100</td>
<td>$9,900</td>
<td>$9,900</td>
<td>$9,900</td>
<td>$8,100</td>
<td>$9,000</td>
<td></td>
</tr>
</tbody>
</table>

**Chemical B purchases**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>$3,600</td>
<td>$4,400</td>
<td>$4,400</td>
<td>$4,400</td>
<td>$3,600</td>
<td>$4,000</td>
</tr>
<tr>
<td>Cost $3,600</td>
<td>$4,400</td>
<td>$4,400</td>
<td>$4,400</td>
<td>$3,600</td>
<td>$4,000</td>
<td></td>
</tr>
</tbody>
</table>

**Total purchases**

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$11,700</td>
<td>$14,300</td>
<td>$14,300</td>
<td>$14,300</td>
<td>$11,700</td>
<td>$13,000</td>
</tr>
<tr>
<td></td>
<td>$3,510</td>
<td>$8,970</td>
<td>$13,520</td>
<td>$14,300</td>
<td>$13,520</td>
<td>$12,870</td>
</tr>
</tbody>
</table>

**Payment**

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1,260</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
</tr>
<tr>
<td></td>
<td>$1,260</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
</tr>
</tbody>
</table>

**Labourhours**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>$1,260</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
</tr>
<tr>
<td>Cost $1,260</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
<td></td>
</tr>
</tbody>
</table>

**Payment**

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1,260</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
</tr>
<tr>
<td></td>
<td>$1,260</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,540</td>
<td>$1,260</td>
<td>$1,400</td>
</tr>
</tbody>
</table>

**Protective sheets**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>$6,480</td>
<td>$7,920</td>
<td>$7,920</td>
<td>$7,920</td>
<td>$6,480</td>
<td>$7,200</td>
</tr>
<tr>
<td>Cost $6,480</td>
<td>$7,920</td>
<td>$7,920</td>
<td>$7,920</td>
<td>$6,480</td>
<td>$7,200</td>
<td></td>
</tr>
</tbody>
</table>

**Containers**

<table>
<thead>
<tr>
<th>Amount</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>$1,080</td>
<td>$1,320</td>
<td>$1,320</td>
<td>$1,320</td>
<td>$1,080</td>
<td>$1,200</td>
</tr>
<tr>
<td>Cost $1,080</td>
<td>$1,320</td>
<td>$1,320</td>
<td>$1,320</td>
<td>$1,080</td>
<td>$1,200</td>
<td></td>
</tr>
</tbody>
</table>

**Total purchases**

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$7,560</td>
<td>$9,240</td>
<td>$9,240</td>
<td>$9,240</td>
<td>$7,560</td>
<td>$8,400</td>
</tr>
<tr>
<td></td>
<td>$7,560</td>
<td>$9,240</td>
<td>$9,240</td>
<td>$9,240</td>
<td>$7,560</td>
<td>$7,560</td>
</tr>
</tbody>
</table>

**Payment**

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>$7,560</td>
<td>$9,240</td>
<td>$9,240</td>
<td>$9,240</td>
<td>$7,560</td>
</tr>
</tbody>
</table>

**Total disbursements**

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$4,770</td>
<td>$18,070</td>
<td>$24,300</td>
<td>$25,080</td>
<td>$24,020</td>
<td>$21,830</td>
</tr>
</tbody>
</table>

**Net cash flow**

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$10,830</td>
<td>$15,680</td>
<td>$16,950</td>
<td>$19,170</td>
<td>$14,230</td>
<td>$14,170</td>
</tr>
</tbody>
</table>
Problem 3

Dish Company
Cash Budget
for the three months ended April 30, 2000

<table>
<thead>
<tr>
<th></th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash balance, beginning</td>
<td>$39,800</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Add cash receipts (Schedule 1)</td>
<td>175,750</td>
<td>173,500</td>
<td>171,050</td>
</tr>
<tr>
<td>Total cash available</td>
<td>215,550</td>
<td>203,500</td>
<td>201,050</td>
</tr>
<tr>
<td>Less: cash disbursements</td>
<td>$198,200</td>
<td>$192,000</td>
<td>$200,400</td>
</tr>
<tr>
<td>Cash disbursements from operations (Schedule 2)</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Income taxes</td>
<td>$202,200</td>
<td>$196,000</td>
<td>$204,400</td>
</tr>
<tr>
<td>Total disbursements</td>
<td>13,350</td>
<td>7,500</td>
<td>-3,350</td>
</tr>
<tr>
<td>Excess (deficiency) of total cash available over total disbursements</td>
<td>$16,650</td>
<td>22,500</td>
<td>33,350</td>
</tr>
<tr>
<td>Financing:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borrowings (at end of period) (Note 1)</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Cash balance, ending</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
</tbody>
</table>

Note 1: Dish Company requires a minimum cash balance of $30,000. Therefore, the company must borrow $16,650, $22,500 and $33,350 in February, March and April, respectively.

Schedule 1 - Cash Receipts

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$250,000</td>
<td>$175,000</td>
<td>$160,000</td>
<td>$195,000</td>
<td>$168,000</td>
<td></td>
</tr>
<tr>
<td>Collections from:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current month</td>
<td>45%</td>
<td>$72,000</td>
<td>$87,750</td>
<td>$75,600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last month</td>
<td>35%</td>
<td>$61,250</td>
<td>$56,000</td>
<td>$68,250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second to last month</td>
<td>17%</td>
<td>$42,500</td>
<td>$29,750</td>
<td>$27,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$175,750</td>
<td>$173,500</td>
<td>$171,050</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Schedule 2 - Cash Disbursements

<table>
<thead>
<tr>
<th>Percentage</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchases</td>
<td>$195,000</td>
<td>$200,000</td>
<td>$198,000</td>
<td>$182,000</td>
<td>$220,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Payments for purchases:</th>
<th>Current month 40%</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current month 40%</td>
<td>$79,200</td>
<td>$72,800</td>
<td>$88,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last month 40%</td>
<td>80,000</td>
<td>79,200</td>
<td>72,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second to last month 20%</td>
<td>39,000</td>
<td>40,000</td>
<td>39,600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$198,200</td>
<td>$192,000</td>
<td>$200,400</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Problem 4

<table>
<thead>
<tr>
<th></th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$120,000</td>
<td>$85,000</td>
<td>$115,000</td>
<td>$75,000</td>
<td>$150,000</td>
<td>$545,000</td>
</tr>
<tr>
<td>Cash balance beginning</td>
<td>$10,000</td>
<td>$29,500</td>
<td>$17,000</td>
<td>$10,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Plus: cash collections: | | | | | | |
|-------------------------|---|---|---|---|---|
| Month of sale 40%       | $46,000 | $30,000 | $60,000 | $136,000 |
| Month following 40%     | 34,000 | 46,000 | 30,000 | 110,000 |
| 2nd month 20%           | 24,000 | 17,000 | 23,000 | 64,000 |
| Total available         | $114,000 | $122,500 | $130,000 | $320,000 |

| Less cash disbursements | | | | | | |
|-------------------------|---|---|---|---|---|
| Water 70%               | $59,500 | $80,500 | $52,500 | $192,500 |
| Operating costs $25,000 | 25,000 | 25,000 | 25,000 | 75,000 |
| Total disbursements     | $84,500 | $105,500 | $77,500 | $267,500 |

| Cash balance ending     | $29,500 | $17,000 | $52,500 | $52,500 |
Problem 5

The performance report provided for the bottling department matches an actual budget for 75,000 units to a budget based on 90,000 units. The favourable variances are misleading because a budget based on 75,000 units would be more appropriate.

<table>
<thead>
<tr>
<th>Volume (units)</th>
<th>Master Budget</th>
<th>Planning Variance</th>
<th>Flexible Budget</th>
<th>Flexible Budget Variance</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90,000</td>
<td>15,000</td>
<td>75,000</td>
<td>0</td>
<td>75,000</td>
</tr>
</tbody>
</table>

Manufacturing costs:

<table>
<thead>
<tr>
<th></th>
<th>Master Budget</th>
<th>Planning Variance</th>
<th>Flexible Budget</th>
<th>Flexible Budget Variance</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$180,000</td>
<td>($30,000)</td>
<td>$150,000</td>
<td>$6,000 (U)</td>
<td>$156,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>900,000</td>
<td>(150,000)</td>
<td>750,000</td>
<td>85,000 (U)</td>
<td>835,000</td>
</tr>
<tr>
<td>Variable o/h</td>
<td>450,000</td>
<td>(75,000)</td>
<td>375,000</td>
<td>(15,000) (F)</td>
<td>360,000</td>
</tr>
<tr>
<td>Fixed o/h</td>
<td>54,000</td>
<td>0</td>
<td>54,000</td>
<td>6,000 (U)</td>
<td>60,000</td>
</tr>
<tr>
<td>Total</td>
<td>$1,584,000</td>
<td>($255,000)</td>
<td>$1,329,000</td>
<td>$82,000 (U)</td>
<td>$1,411,000</td>
</tr>
</tbody>
</table>
Problem 6

a. Needs: | Sales | Cee | 12,000 | Dee | 9,000 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ending inventory</td>
<td></td>
<td>300</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less: beginning inventory</td>
<td></td>
<td>(400)</td>
<td>(150)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Production budget</td>
<td></td>
<td>11,900</td>
<td>9,050</td>
<td></td>
</tr>
</tbody>
</table>

b. Needs: | Production | DM1 | 191,400 | DM2 | 36,200 | DM3 | 32,850 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(11,900 x 10) + (9,050 x 8)</td>
<td>9,050 x 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4,000</td>
<td>1,000</td>
</tr>
<tr>
<td>(11,900 x 2) + (9,050 x 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Less: beginning inventory</td>
<td>(3,000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Purchase budget – units</td>
<td>192,400</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Purchase price</td>
<td>$2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Purchase budget</td>
<td>$384,800</td>
</tr>
</tbody>
</table>

c. Hours: | 11,900 x 5 | 9,050 x 8 | Cee | 59,500 | Dee | 72,400 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hourly rate</td>
<td></td>
<td>$4</td>
<td>$4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Direct labour budget</td>
<td></td>
<td>$238,000</td>
<td>$289,600</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

d. Manufacturing cost per unit
<table>
<thead>
<tr>
<th>RM1: 10 x $2</th>
<th>8 x $2</th>
<th>Cee</th>
<th>$20.00</th>
<th>Dee</th>
<th>$16.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM2: 4 x $2.50</td>
<td></td>
<td></td>
<td></td>
<td>10.00</td>
<td></td>
</tr>
<tr>
<td>RM3: 2 x $.50</td>
<td>1 x $.50</td>
<td></td>
<td>1.00</td>
<td>.50</td>
<td></td>
</tr>
<tr>
<td>Direct labour: 5 hrs x $4</td>
<td>8 hrs x $4</td>
<td></td>
<td>20.00</td>
<td>32.00</td>
<td></td>
</tr>
<tr>
<td>Manufacturing overhead Rate: $263,800 / (59,500 + 72,400)</td>
<td></td>
<td></td>
<td>= $263,800 / 131,900 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>= $2 per DLH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 hrs x $2</td>
<td>8 hrs x $2</td>
<td></td>
<td>10.00</td>
<td>16.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$51.00</td>
<td>$74.50</td>
<td></td>
</tr>
</tbody>
</table>
## Management Accounting

### Cost of goods sold

<table>
<thead>
<tr>
<th></th>
<th>Cee</th>
<th>Dee</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opening inventory:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 x $51</td>
<td>150 x $74.50</td>
<td>$ 20,400</td>
</tr>
<tr>
<td><strong>Cost of goods manufactured</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11,900 x $51</td>
<td>9,050 x $74.50</td>
<td>606,900</td>
</tr>
<tr>
<td><strong>Ending inventory:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 x $51</td>
<td>200 x $74.50</td>
<td>(15,300)</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>$612,000</strong></td>
</tr>
</tbody>
</table>

### e.

<table>
<thead>
<tr>
<th></th>
<th>Cee</th>
<th>Dee</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales</strong></td>
<td>$1,200,000</td>
<td>$1,350,000</td>
<td>$2,550,000</td>
</tr>
<tr>
<td><strong>Cost of goods sold</strong></td>
<td>612,000</td>
<td>670,500</td>
<td>1,282,500</td>
</tr>
<tr>
<td><strong>Gross margin</strong></td>
<td>$ 588,000</td>
<td>$ 679,500</td>
<td>1,267,500</td>
</tr>
<tr>
<td><strong>Selling and administrative expenses</strong></td>
<td>605,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating income</strong></td>
<td></td>
<td></td>
<td>662,500</td>
</tr>
<tr>
<td><strong>Income taxes (40%)</strong></td>
<td></td>
<td></td>
<td>265,000</td>
</tr>
<tr>
<td><strong>Net income</strong></td>
<td></td>
<td></td>
<td><strong>$397,500</strong></td>
</tr>
</tbody>
</table>
Problem 7

Cash, November 30, 2004 $12,000

Cash collections:
- Oct. sales: 70,000 x $5 x 10% $35,000
- Nov. sales: 50,000 x $5 x 40% 100,000
- Dec. sales: 50,000 x $5 x 50% x .98 122,500 257,500
- Interest from investments 500
- Sale of equipment 7,500

Cash disbursements:
- Direct materials $60,000
- Direct labour
  - Regular time: 75,000 bats / 7.5 x $15 150,000
  - Overtime: 15,000 bats / 7.5 x $15 x 1.5 45,000
- Overhead
  - Variable: 90,000 bats x $.30 27,000
  - Fixed: ($280,000 – 40,000) / 12 20,000
- Selling
  - Variable: 50,000 x $.20 10,000
  - Fixed: $60,000 / 12 5,000
- Fixed administrative: $120,000 / 12 10,000
- Prepaid expenses: $4,200 Ending Balance
  - ($4,800 Opening Balance – 3,600 Expired in December) 3,000
- Income taxes 50,000
- Note payment: $144,000 / 24 6,000
- Interest on note payable:
  - [$144,000 - (6,000 x 7)] x 1% 1,020
- Dividend payment: 7,000 shares x $.20 1,400 (388,420)

Cash balance before financing (110,920)
- Liquidation of temporary investments 40,000
- Borrowing 80,920
- Cash balance, end $10,000
15. **Capital Budgeting**

**Learning Objectives**

After completing this chapter, you will:

1. Recognize and be able to explain the importance and role of capital budgeting in organizations.
2. Be able to explain and undertake the various approaches to capital budgeting.
3. Be able to integrate tax considerations, including the capital cost allowances, into capital budgeting analysis.
4. Recognize the role and importance of uncertainty and be able to undertake sensitivity analysis on capital budgeting results.

**The Role of Capital Budgeting in Organizations**

Capital budgeting involves the evaluation of the economic consequences of investments in fixed or capital assets. Since the acquisition of fixed assets usually involves large financial commitments that extend over significant periods of time and are costly to reverse or adjust, the focus of control on capital assets is at the time of acquisition rather than at the time of use, which is the case for non-capital assets such as inventory. Therefore, investment in long-term capital assets creates significant organization risk and merits careful consideration.

In most organizations, requests for significant expenditures are approved by a senior management committee and are subject to significant scrutiny that involves consideration, not only of the financial consequences of the capital investment, but the alignment of the acquisition with the organization’s strategic and operating plans.

The focus of this chapter is on the financial considerations in capital budgeting. The Strategic Leadership Program will develop the strategic and operational considerations, which are equally relevant in the capital budgeting process.

There are two classes of approach to capital budgeting: those that do not consider time value of money and those that do. Each of the various methods of approaching capital budgeting will be considered using the following example.

Angus Company is considering the investment of $3,600,000 for a machine to replace an existing machine currently being used to produce a product that provides an incremental cash flow of $1,800,000 per year. The new machine, by improving product quality, would increase the product’s incremental cash flow to $2,900,000 per year. The life of the product is five years at which time the existing machine could be sold for an expected net salvage value of $50,000. The net realizable value of the existing machine now is $100,000 and the new machine is estimated to be $250,000 in five years.
In effect, this investment requires an incremental investment of $3,500,000 ($3,600,000 - $100,000) that produces a five year annuity of $1,100,000 ($2,900,000 - $1,800,000) with a terminal incremental salvage of $200,000 ($250,000 - $50,000).

The Non-Discounted Approaches

Payback

The payback method computes the number of years, called the payback period, taken to recover the initial investment in a capital asset. If the project’s payback period is less than a criterion or target value, the project is deemed acceptable.

The payback method continues to be the most widely used approach in capital budgeting. The proponents of payback argue that the payback period is a good proxy for risk in a capital investment and, therefore, the payback method is a valid and useful approach to capital budgeting. The target payback period varies widely across industries and even among organizations within an industry. However, for most projects a common payback target is two to three years or less.

In the case of an annuity, the payback period calculation is simply the initial investment divided by the annuity.

Therefore, for Angus Company the payback period would be:

$$\frac{3,500,000}{1,100,000} = 3.18 \text{ years}$$

In order to accommodate non-uniform cash flows, the payback period is usually computed using a net cash flow schedule as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Incremental cash flow this period</th>
<th>Incremental cash flow to date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-3,500,000</td>
<td>-3,500,000</td>
</tr>
<tr>
<td>1</td>
<td>1,100,000</td>
<td>-2,400,000</td>
</tr>
<tr>
<td>2</td>
<td>1,100,000</td>
<td>-1,300,000</td>
</tr>
<tr>
<td>3</td>
<td>1,100,000</td>
<td>-200,000</td>
</tr>
<tr>
<td>4</td>
<td>1,100,000</td>
<td>900,000</td>
</tr>
<tr>
<td>5</td>
<td>1,300,000</td>
<td>2,200,000</td>
</tr>
</tbody>
</table>

Note that the cumulative net cash flow turns from negative to positive during the third year. The conventional assumption in payback is cash flows occur uniformly during the year so the payback period would be three years plus the proportion of the fourth year where the cumulative cash flow is still negative. That proportion is computed by dividing the amount required to turn the cumulative cash flow to zero by the incremental cash flow during the period. In this case, the calculation is:

$$\frac{200,000}{1,100,000} = .18$$

Therefore, the payback period is $3 + .18 = 3.18 \text{ years}$.
The payback method favours projects with short payback periods and ignores cash flows after the payback period. Therefore, projects that have longer payback periods but significant cash flows after the payback period will be rejected using the payback method. Moreover, the payback method ignores the time value of money so two projects could have the same payback period but with different cash flows, for example, one with increasing cash flows and one with decreasing cash flows.

The Accounting Rate of Return

The accounting rate of return method is a derivative of numbers found in the financial statements. The accounting rate of return method is only occasionally used and most often by accountants.

The accounting rate of return method is computed by dividing the average annual income by the average annual investment. The estimate of annual investment is the initial investment plus the salvage value divided by two. The estimate of annual income is the average annual income provided by the investment, which is approximated by subtracting straight-line depreciation from the average cash flow.

In the case of Angus Company the incremental investment is $3,500,000 and the incremental salvage value is $200,000. Therefore, the estimate of the annual average investment would be computed as follows:

\[
\frac{($3,500,000 + 200,000)}{2} = $1,850,000
\]

The annual straight-line depreciation in Angus Company would be:

\[
\frac{($3,500,000 - 200,000)}{5} = $660,000
\]

Therefore, the average income would be $440,000 \(1,100,000 - 660,000\) and the accounting rate of return for Angus Company would be computed as follows:

\[
\frac{440,000}{1,850,000} = 23.8\%
\]

The accounting rate of return method has two significant deficiencies. First it does not focus on cash flows but rather uses periodic income and second, it ignores the timing of cash flows by using average values over the life of the project.
The Discounted Cash Flow Approaches

The discounted cash flow approaches have two important characteristics that differ from either or both of the non-discounted cash flow approaches: The discounted cash flow approaches discount the actual periodic cash flows to reflect the time value of money.

To continue our discussion of Angus Company, we now introduce the requirement that Angus Company requires a pre-tax return of 12% on this capital investment.

Net Present Value Method

The net present value method is the approach to capital budgeting most often recommended in financial management texts. The net present value method computes present value of all the project cash flows and sums them to determine the project’s overall net present value.

If the project’s net present value is greater than zero, the project is acceptable from a financial perspective since the net present value is the return expected by the project that is in excess of the return required to compensate the providers of capital. Economists call net present value economic income and it is sometimes referred to as residual income in accounting literature.

In practice, the net present value method is often used in combination with the payback method reflecting a dual approach to project evaluation that combines a complete financial analysis (net present value) with a metric (payback period). This is a proxy for risk.

Given the 12% pre-tax return requirement, the following is the net present value analysis for Angus Company:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial investment</td>
<td>($3,500,000)</td>
</tr>
<tr>
<td>Present value of incremental annual cash flows</td>
<td></td>
</tr>
<tr>
<td>[ N = 5, I = 12, PMT = 1,100,000 ]</td>
<td>3,965,254</td>
</tr>
<tr>
<td>Present value of incremental salvage value</td>
<td></td>
</tr>
<tr>
<td>[ N = 5, I = 12, FV = 200,000 ]</td>
<td>113,485</td>
</tr>
<tr>
<td>Net present value</td>
<td>$578,739</td>
</tr>
</tbody>
</table>

Internal Rate of Return Method

A project’s internal rate of return is equal to the discount rate that sets the project’s net present value equal to zero. If the internal rate of return is greater than the required return on investment, the project is accepted.

Most spreadsheets provide a tool that will compute a project’s internal rate of return. Computing the internal rate of return without a computer requires some trial and error.

Returning to the Angus Company example, remember, in exchange for an initial net outlay of $3,500,000, the project provides an annuity of $1,100,000 per year plus a lump sum payment after five years of $200,000. So the internal rate of return method requires finding a discount rate so the present value of a five year annuity of $1,100,000 and a lump sum payment of $200,000 in five years equals the initial outlay of $3,500,000.
The internal rate of return can be calculated using your financial calculator by entering the cash flows in the calculator and then solving for the interest rate (see page 14 of the Corporate Finance lesson notes). The IRR in this example is 13.34%.

The advantage of the internal rate of return approach is it considers both the time value of money and all the cash flows associated with a project. There are two significant disadvantages of the internal rate of return approach.

The first disadvantage is the internal rate of return approach assumes cash flows are reinvested at the internal rate of return during the life of the project. This can be resolved by calculating the modified internal rate of return (MIRR). The MIRR calculations assume all intermediate cash flows get reinvested at the WACC throughout the project's life. MIRR calculations are beyond the scope of this course.

The second disadvantage is the internal rate of return approach may lead to inappropriate choices when mutually exclusive projects are being considered.

Consider the following two mutually exclusive projects. Project 1 requires an initial investment of $150,000 and provides a five year annuity of $50,000. Project 2 requires an initial investment of $250,000 and provides a five year annuity of $80,000. The weighted average cost of capital is 12%. Project 1 has an internal rate of return of 20% and a net present value of $30,238.81. Project 2 has an internal rate of return of 18% and a net present value of $38,382.10. If projects are selected using the internal rate of return, then Project 1 would be selected. However, if the funds are available to make either investment Project 2 should be chosen because it provides the larger increment to shareholder wealth.

<table>
<thead>
<tr>
<th>Project</th>
<th>Initial Investment</th>
<th>5 year annuity</th>
<th>Internal Rate of Return</th>
<th>Net Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$150,000</td>
<td>$50,000</td>
<td>20%</td>
<td>$30,238.81</td>
</tr>
<tr>
<td>2</td>
<td>$250,000</td>
<td>$80,000</td>
<td>18%</td>
<td>$38,382.10</td>
</tr>
</tbody>
</table>

A third issue is if cash flows can vary between positive and negative values, multiple internal rates of return might be found. The maximum number of internal rates of return is equal to the number of sign changes.

Consider a project with the following cash flows. This project exhibits two sign changes, first from negative to positive and then from positive to negative:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$600,000</td>
</tr>
<tr>
<td>1</td>
<td>$500,000</td>
</tr>
<tr>
<td>2</td>
<td>$525,000</td>
</tr>
<tr>
<td>3</td>
<td>$550,000</td>
</tr>
<tr>
<td>4</td>
<td>-$1,000,000</td>
</tr>
</tbody>
</table>
The following is a graph of the net present value of this project for various discount rates:

There are two discount rates that cause the net present value to be zero. (These rates are 3.94% and 28.31%). Note that if the required return on the investment is anywhere between these two extreme values, the project net present value would be positive and the project would be accepted.
Profitability Index

The profitability index is computed by dividing the present value of the project’s future cash flows by the initial investment. If the profitability index is greater than one, then the project is accepted. By rearranging the formula for the profitability index we can write:

\[
\text{Profitability index} = \frac{\text{Present value of a project's future cash flows}}{\text{Initial investment}}
\]

Therefore, if the project’s net present value is zero, the profitability index will equal one. If the project’s net present value is greater (less) than zero, the profitability index is greater (less) than one. Therefore, the profitability index and the net present value criterion will evaluate projects the same way when there is an initial investment.

Uncertainty in Capital Budgeting

The widespread availability of powerful desktop and laptop computers combined with full featured spreadsheet programs such as Open Office’s Calc and Microsoft’s Excel have enabled increasingly powerful capital budgeting tools.

One particularly valuable tool is the ability to manipulate the parameters of a capital budgeting analysis to determine how sensitive a decision is to the various estimated parameters and, in particular, the parameter that creates the greatest risk in the project decision.

Such tools are beyond the scope of this course, but will be covered to a limited extent in the Strategic Leadership Program. In this course, we will cover two basic approaches to dealing with uncertainty in capital budgeting: basic what-if analysis and a simple form of real options analysis.

What-if Analysis

When a capital budgeting exercise is formulated on spreadsheet, the various parameters in the capital budget can be manipulated in order to test the sensitivity of the decision to the parameter estimates. This type of analysis, which is called ‘what-if analysis’ is a common application in practice.

As a practical matter, what-if analysis needs to be undertaken using computer. However, the following is a simple example that extends the data in Angus Company. What is the minimum amount of incremental net cash flow provided by the new machine that justifies its acquisition?

We begin by computing the present value of the incremental machine transactions.

\[
\begin{align*}
\text{Initial investment} & \quad ($3,500,000) \\
\text{Present value of incremental salvage value} & \\
N = 5, I = 12, FV = 200,000 & \quad 113,485 \\
\hline
\text{($3,386,515)}
\end{align*}
\]
Therefore, the minimum present value of the annuity of incremental operating cash flows will be -$3,386,515. Therefore, the minimum amount of the annual annuity will be $939,452:

\[ N = 5, \ I = 12, \ PV = 3,386,515 \]

\[ CPT \ PMT = 939,452 \]

In practice, uncertainty analysis can be combined with probability estimates to compute the probability of a project earning a target net present value.

Real Options

Real options analysis, which is sometimes called wait and see analysis, involves postponing a decision while information is gathered. To provide a simple example of this approach, consider the following example.

Return to the Angus Company and assume the annual incremental cash flows are uncertain. However, management believes the probability is .7 that the annual incremental cash flows will be $1,250,000 and .3 that the annual incremental cash flows will be $750,000. The expected value of the annual incremental cash flows is $1,100,000 \((1,250,000 \times .7 + 750,000 \times .3)\), which is the value we used in the original discussion of this example. Therefore, the expected net present value of this project is $578,739 and it would be undertaken if the decision is based on expected value.

The following table identifies the project net present value for each of the two possible values of the incremental annual cash flows. If the incremental annual cash flows are $1,250,000, the project is acceptable. If the incremental annual cash flows are $750,000, the project would be turned down.

<table>
<thead>
<tr>
<th>Initial investment</th>
<th>($3,500,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present value of incremental annual cash flows</td>
<td></td>
</tr>
<tr>
<td>[ N = 5, \ I = 12, \ PMT = 1,250,000 ]</td>
<td>4,505,970</td>
</tr>
<tr>
<td>Present value of incremental salvage value</td>
<td></td>
</tr>
<tr>
<td>[ N = 5, \ I = 12, \ FV = 200,000 ]</td>
<td>113,485</td>
</tr>
<tr>
<td>Net present value</td>
<td>$1,119,455</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial investment</th>
<th>($3,500,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present value of incremental annual cash flows</td>
<td></td>
</tr>
<tr>
<td>[ N = 5, \ I = 12, \ PMT = 750,000 ]</td>
<td>2,703,582</td>
</tr>
<tr>
<td>Present value of incremental salvage value</td>
<td></td>
</tr>
<tr>
<td>[ N = 5, \ I = 12, \ FV = 200,000 ]</td>
<td>113,485</td>
</tr>
<tr>
<td>Net present value</td>
<td>($682,933)</td>
</tr>
</tbody>
</table>
Assume the decision makers at Angus Company could wait for one month to make their decision and during that time could undertake a detailed study of the proposed machine in order to determine with certainty, what the incremental annual cash flows would be.

If it turns out the cash flows would be $750,000, the project would be rejected and Angus Company would continue with the existing machine. If the cash flows turned out to be $1,250,000, the new machine would be purchased. The following table summarizes the results:

<table>
<thead>
<tr>
<th>Study Result</th>
<th>Decision</th>
<th>Incremental NPV over Present</th>
<th>Probability</th>
<th>Expected Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental cash flow will be $750,000</td>
<td>Do not buy new machine</td>
<td>$0</td>
<td>30%</td>
<td>$0</td>
</tr>
<tr>
<td>Incremental cash flow will be $1,250,000</td>
<td>Buy new machine</td>
<td>$1,129,456</td>
<td>70%</td>
<td>$790,619</td>
</tr>
</tbody>
</table>

Therefore, the expected value of decision making with this information is $790,619. Recall from above that the expected value of decision making without this information was $578,739. Therefore, the expected value of the option of waiting and undertaking the study is $211,880 ($790,619 – 578,739). Recall from your work in Chapter 12 that $211,880 is called the expected value of perfect information. In practice, waiting might involve purchasing an option to set the machine price while information is gathered. For this reason, the decision to delay a purchase and using an option to purchase to fix the price while information is gathered is a common one and is often called the wait and see option or approach to decision making.

Operating Considerations in Capital Budgeting

Sometimes there are opportunity cost issues that are considered in capital budgeting. The following is a simple example to illustrate this concept.

Giant Motors is considering a project to redesign its factory floor layout in order to move from batch oriented production to an assembly line layout. The cost of the project is estimated to be $50,000,000 and the remaining life of the plant is estimated to be 20 years. The revised layout is expected to reduce work-in-process from its current levels by about $100,000,000 per year. Giant Motors has a weighted average cost of 10%. Therefore, the opportunity cost 20 year annuity provided by the revised plant layout is $10,000,000 (100,000,000 * 10%). The present value of this 20 year annuity is $85,135,637 (N = 20, I =10, PMT = 10,000,000). Therefore, the present value of the project would be $35,135,637 ($85,135,637 – 50,000,000) and the project would be accepted.

The net present value of this project would be presented as:

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial investment</td>
<td>($50,000,000)</td>
</tr>
<tr>
<td>Reduction in working capital</td>
<td>100,000,000</td>
</tr>
<tr>
<td>Increase in working capital at the end of the project's life</td>
<td>14,864,363</td>
</tr>
<tr>
<td>N = 20, I = 10, FV = 100,000,000</td>
<td></td>
</tr>
<tr>
<td>Net present value</td>
<td>$35,135,637</td>
</tr>
</tbody>
</table>

This example illustrates two important additional issues relating to capital budgeting. First, capital budgeting analyses can often involve considerations of the effect of the project on working capital levels and those effects must be considered in the analysis. The incremental
working capital investment resulting from the project is made at the start of the project (as inventory and accounts receivable are increased as the project gets underway) and is liquidated at the end of the project (as inventory and accounts receivable related to the project are eliminated).

Second, capital budgeting analyses often must consider the strategic implications associated with a project. For example, in the Giant Motors case, if the revised plant layout would also result in improving product quality, which, in turn, would affect sales and profits, then those considerations should be factored into the analysis as well as so called soft benefits of the project. (As opposed to operating cost savings, which are often called hard benefits of a project.)

**Tax Considerations in Capital Budgeting**

In practice, capital budgeting is undertaken in the presence of taxes. In the presence of taxes, we need to convert all operating cash flows to after tax cash flows. Capital transactions, such as the purchase and disposal of fixed assets, are not converted to after tax flows. Rather, their effect is through capital cost allowance.

You have studied the capital cost allowance concept previously so it will not be reviewed in these notes. Rather, we will apply the capital cost allowance in the capital budgeting context.

The Present Value of the Tax Shield Provided by an Investment

Following below is the formula for the present value of the tax shield provided by an investment. (This formula is provided on the formula sheet for the Entrance Examination and also on the case examination in the Strategic Leadership Program.) In other words, this is not a formula you need to memorize.

This formula identifies the present value of all the future tax reduction benefits provided by the investment, assuming in each tax period the organization claims the maximum capital cost allowance and, therefore, receives the maximum tax benefit:

\[
\text{Present Value of tax shield provided by investment} = \left[ \frac{Cdt}{(d + k)} \right] \left[ \frac{(1 + 0.5k)}{(1 + k)} \right]
\]

Where:

- \( C \) is the investment in the asset eligible for capital cost allowance
- \( d \) is the capital cost allowance rate for the asset
- \( t \) is the organization’s marginal tax rate
- \( k \) is the required return on the investment
Present Value of Tax Shield Lost on Disposal

When an asset is sold, the remaining tax shield that would have accrued to the asset if it were kept is lost. The formula for computing the tax shield lost on disposal (assuming assets remain in the class and the class balance remains positive after disposal is:

\[
\text{Present Value of tax shield lost on salvage} = \frac{S}{(1 + k)^n} \left[ \frac{(dt)}{(d + k)} \right]
\]

Where the variables are defined the same as above with the following additions:

- \( S \) is the salvage value of the asset
- \( n \) is the number of years in the future when the asset is sold

We will illustrate these formulas by continuing the Angus Company example with the additional assumption that Angus Company faces a marginal tax rate of 30% and management requires an after tax return of 8% on its investment.

Recall that the incremental investment in the new machine is $3,400,000 ($3,500,000 - $100,000) and the incremental salvage value is $200,000 ($250,000 - $50,000). The machine is a Class 8 asset with a corresponding capital cost allowance rate of 20%.

The investment provides a five year annuity of $1,100,000.

Following are the tax shield calculations (note that the incremental investment and salvage amounts are used in the calculations).

The present value of the tax shield is:

\[
\frac{(3,500,000 \times 0.20 \times 0.30)}{(0.20 + 0.08)} + \frac{1.04}{1.08} = 722,222
\]

The present value of the tax shield lost is:

\[
\frac{(136,117 \times 0.20 \times 0.30)}{(0.20 + 0.08)} = 29,168
\]

(Note that the $136,117 is the present value of the incremental salvage value at WACC of 8%)
We can now compute the net present value of this investment as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial investment</td>
<td>($3,500,000)</td>
</tr>
<tr>
<td>Tax shield on investment</td>
<td>722,222</td>
</tr>
<tr>
<td>Present value of incremental annual cash flows</td>
<td>3,074,387</td>
</tr>
<tr>
<td>N = 5, I = 8, PMT = 1,100,000*0.7 = 770,000</td>
<td></td>
</tr>
<tr>
<td>Present value of incremental salvage value</td>
<td>136,117</td>
</tr>
<tr>
<td>N = 5, I = 8, FV = 200,000</td>
<td></td>
</tr>
<tr>
<td>Tax shield lost on salvage value</td>
<td>(29,168)</td>
</tr>
<tr>
<td>Net present value</td>
<td>$246,442</td>
</tr>
</tbody>
</table>

Conclusion:

Capital budgeting is a pervasive management tool that relies critically on information provided by the management accountant. It is important that management accountants understand the scope and limitations of capital budgeting so they can ensure appropriate data is developed and provided to the capital budgeting decision.

Recall also the comment made above that a project’s financial considerations, such as its net present value, is only part of any capital budgeting decision. The other part is comprised of the qualitative facets of the decision and concern the relationship of the project to the organization’s strategic and operating plans.
Problems with Solutions

Multiple Choice Questions

1. Company D is considering an investment in a new more efficient machine to replace an existing machine to produce Product Q. Product Q is in the mature stage of its life cycle and Company D expects to produce and sell it for only five more years. Data pertaining to the two machines are:

<table>
<thead>
<tr>
<th></th>
<th>New Machine</th>
<th>Existing Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current cost</td>
<td>$60,000</td>
<td>NA</td>
</tr>
<tr>
<td>Current disposal value</td>
<td>$60,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Disposal value in five years</td>
<td>$25,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Annual amortization</td>
<td>$7,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>Annual cash operating costs</td>
<td>$8,000</td>
<td>$15,000</td>
</tr>
<tr>
<td>Other cash costs to produce Product Q</td>
<td>$82 per unit</td>
<td>$85 per unit</td>
</tr>
</tbody>
</table>

The company expects to produce and sell 2,500 units of Product Q per year for the next five years. Its required rate of return is 12%. For tax purposes, the two machines are considered to be in the same asset class, together with many other of the company’s assets.

Assume neither the existing machine nor the new machine will have any disposal value at the end of five years. Ignoring income taxes, what is the payback period for the potential investment in the new machine?

a) 4.2 years  
b) 10 years  
c) 2.1 years  
d) 3.8 years  
e) 2.6 years

2. Ultraviolet Purifiers Ltd. purchased a patent for a new water treatment process for $130,000. The patent has a legal life of 40 years and a terminal disposal price of nil. Patents are Class 14 assets and the CCA is straight-line over the legal life.

Assuming the marginal tax rate is 40%, what is the effect on the company's after-tax cash flow from the patent's CCA in the year of acquisition?

a) $650  
b) $975  
c) $1,300  
d) $1,625
3. Garfield Inc. is considering a 10 year capital investment project with forecasted annual cash revenues of $40,000 and forecasted annual cash operating costs of $29,000. The initial cost of the new equipment is $23,000 and Garfield expects to sell the equipment for $9,000 at the end of the tenth year. The equipment's CCA rate is 20%. The project requires a working capital investment of $7,000 at its inception and another $5,000 at the end of year five. Assuming a 40% marginal tax rate, the cash flow, net of income taxes, from the project for the second year is:
   a) $4,116
   b) $520
   c) $8,256
   d) $8,440

4. Which one of the following is included when calculating the cash flow in a capital budgeting decision?
   a) Depreciation on old equipment
   b) Depreciation on new equipment
   c) Net book value of old equipment
   d) Tax effect of CCA
The following information pertains to Questions 5 and 6:

LeBlanc Co. must choose between two projects, both of which require a $400,000 investment. Each project has a three year life and yields different annual net cash flows depending on the actions of a major competitor. Management at LeBlanc Co. has estimated the probability of the competitor's actions and the associated net annual cash flows for each project as:

<table>
<thead>
<tr>
<th>Action of Competitor</th>
<th>Probability</th>
<th>Project A Cash Flows</th>
<th>Project B Cash Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20%</td>
<td>$200,000</td>
<td>$500,000</td>
</tr>
<tr>
<td>II</td>
<td>30%</td>
<td>$250,000</td>
<td>$300,000</td>
</tr>
<tr>
<td>III</td>
<td>50%</td>
<td>$550,000</td>
<td>$200,000</td>
</tr>
</tbody>
</table>

5. The payback period for Project A is:
   a) .73 years
   b) 1.03 years
   c) 1.2 years
   d) 1.6 years
   e) 2 years

6. Assuming an after-tax cost of capital of 8%, up to how much should LeBlanc Co. be willing to spend to know, with certainty, which action the major competitor will take?
   a) $193,282
   b) $225,000
   c) $257,700
   d) $300,000
   e) $644,250
Problem 1
Canon Company is evaluating the purchase of a machine that will provide a 10-year net cash flow annuity of $200,000. The incremental net cash flows relating to the acquisition and disposition of the machine are $1,000,000 and $100,000 respectively. In addition, the machine will require maintenance of $100,000 at the end of the fourth year and $150,000 at the end of the seventh year. The project requires an investment in working capital at the beginning of the project of $50,000. For all parts except (c) and (d), ignore income taxes.

Required:

a. What is the payback period for this project?
b. What is the accounting rate of return for this project if depreciation is computed on a straight-line basis?
c. If Woodstock Company has a WACC of 11%, what is the net present value of this project? For this part, assume the tax rate is 35% and the machine is subject to 20% CCA. Assume the maintenance costs are deductible.
d. What is the minimum amount of the annual annuity that will allow Canon Company to achieve its target 11% return on investment? Assume the same facts as part c.

Problem 2
Compute using your calculator the IRR and the NPV at 15% for each of these projects:

<table>
<thead>
<tr>
<th>Project</th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-100,000</td>
<td>30,000</td>
<td>30,000</td>
<td>30,000</td>
<td>30,000</td>
<td>30,000</td>
</tr>
<tr>
<td>2</td>
<td>-100,000</td>
<td>40,000</td>
<td>35,000</td>
<td>30,000</td>
<td>25,000</td>
<td>20,000</td>
</tr>
<tr>
<td>3</td>
<td>-100,000</td>
<td>20,000</td>
<td>25,000</td>
<td>30,000</td>
<td>35,000</td>
<td>40,000</td>
</tr>
<tr>
<td>4</td>
<td>-100,000</td>
<td>60,000</td>
<td>20,000</td>
<td>20,000</td>
<td>40,000</td>
<td>10,000</td>
</tr>
<tr>
<td>5</td>
<td>-100,000</td>
<td>30,000</td>
<td>80,000</td>
<td>-30,000</td>
<td>50,000</td>
<td>20,000</td>
</tr>
</tbody>
</table>
Problem 3

National Teleco is considering two different options for providing fibre to home communications services. The first option would involve an initial investment of $2 billion dollars and, best estimates are, it would provide a 20 year net cash flow annuity of $300,000,000. The second option, which would provide lower quality and, therefore, less attractive service, would involve an initial investment of $1.5 billion and would provide a smaller cash flow. The residual value of both investments after 20 years will be $0.

Required:

a. If Northern Teleco requires pre-tax return on investment projects is 12%, what is the minimum cash flow the second project would need to provide to be as attractive as the first?

b. Assume an initial study has determined the following relating to the second project:

- There is a 30% probability the annual net cash flow will be $210,000,000
- There is a 30% probability the annual net cash flow will be $230,000,000
- There is a 40% probability the annual net cash flow will be $260,000,000

Given this information and assuming decisions at National Teleco are made on an expected value basis, which project should be accepted?

Problem 4

Pat Toste, the owner manager of Nith Taxi Company, is considering purchasing a new automobile to add to his taxi fleet. The new taxi will be driven by Pat’s daughter Justine, who is looking for a job to finance her next four years in university.

The automobile would cost $20,000 (CCA class 16 CCA rate 40%) and would have zero salvage value at the end of the fourth year. Based on past experience, Pat projects incremental annual revenues of $110,000 associated with this new taxi and annual incremental operating costs of $60,000 per year for incremental fuel and maintenance and $40,000 for the wage he will pay Justine.

Nith Taxi Company faces a marginal tax rate of 35% and Pat expects a minimum after-tax return of 14% on taxi investments. Compute the net present value of this investment.
Problem 5

West River Company is considering purchasing a machine (Class 8, CCA rate 20%) that will cost $1,000,000.

The machine would replace an existing machine. The advantage of the new machine is it will reduce the variable cost per unit of the product produced on these machines from $15 to $12.50. This product is sold under contract and the annual production and sales is 130,000 units.

The contract’s remaining life is five years, at which time the existing machine would be sold for $5,000 and the new machine, if it is purchased now, would be sold for $100,000. In either case, there would be assets remaining in this class. If the existing machine is sold now, the net realizable value would be $50,000.

West River Company faces a tax rate of 32% on incremental income and requires an after-tax return of 12% on this investment.

The plant accountant advises that because of the improved efficiency of the new machine, average inventory levels in the plant will be reduced by $15,000 during the life of the project.

What is the net present value of the proposed investment in the new machine?
SOLUTIONS

Multiple Choice Questions

1. c
Annual savings in cash operating costs ($15,000 - $8,000) $  7,000
Annual savings in other production costs ($85 - $82) x 2,500 7,500
Annual cash savings 14,500

Payback period = net investment ÷ annual cash savings
= $30,000 ÷ $14,500 = 2.1 years

2. c
$130,000 / 40 x 40% = $1,300

3. c
CCA in year 1 = $23,000 x 20% x 1/2 = $2,300
UCC at end of year 2 = $23,000 - 2,300 = $20,700
Tax shield in year 2 = $20,700 x 20% x 40% = $1,656
Cash flow from operations = ($40,000 - 29,000).6 + 1,656 = $8,256

4. d
Only (d) is a relevant cash flow to the capital budgeting decision.

5. b
Expected value of cash flows: .2(200,000) + .3(250,000) + .5(550,000)
= 390,000
Payback = $400,000 / 390,000 = 1.03 years

6. a
Expected value of cash flows: .2(500,000) + .3(300,000) + .5(200,000)
= $290,000
Thus with uncertainty, we choose Project A with an NPV of:
-400,000 + (N = 3, I = 8, PMT = $390,000, Solve for PV)
= -400,000 + 1,005,068
= $605,068

Expected cash flows with perfect information:
.2(500,000) + .3(300,000) + .5(550,000) = $465,000

PV of expected cash flows with perfect information:
= -400,000 + (N = 3, I = 8, PMT = $465,000, Solve for PV)
= -$400,000 + 1,198,350 = $798,350

Expected value of perfect information = $798,350 - 605,068 = $193,282
Problem 1

a. 

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
<th>Cumulative Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>2</td>
<td>200,000</td>
<td>400,000</td>
</tr>
<tr>
<td>3</td>
<td>200,000</td>
<td>600,000</td>
</tr>
<tr>
<td>4</td>
<td>100,000</td>
<td>700,000</td>
</tr>
<tr>
<td>5</td>
<td>200,000</td>
<td>900,000</td>
</tr>
<tr>
<td>6</td>
<td>200,000</td>
<td>1,100,000</td>
</tr>
</tbody>
</table>

The initial investment is $1,050,000 (initial investment of $1,000,000 plus working capital of $50,000). The payback period = 5 + 150/200 = 5.75 years

b. The total income for this project will be $850,000 (10 * 200,000) – 100,000 – 150,000 – (1,000,000-100,000). Therefore, the average income per year will be $85,000 (850,000 / 10). The average investment level is $550,000 (1,000,000+100,000) / 2. Therefore, the accounting rate of return is 15.45% (85,000 / 550,000).

c. Initial investment
   - Machine: $1,000,000
   - Working capital: $50,000

   Tax shield on machine:
   \[
   \frac{(1,000,000 \times .20 \times .35)}{(.20 + .11) \times (1.055 / 1.11)} = 214,618
   \]

   Annual operating cash flows:
   \[
   N = 10, I = 11, PMT = 200,000 \times .65 = 130,000
   \]
   \[
   765,600
   \]

   Maintenance costs
   - End of fourth year: \[ N = 4, I = 11, FV = 100,000 \times .65 = 65,000 \]
   \[ (42,818) \]
   - End of seventh year: \[ N = 7, I = 11, FV = 150,000 \times .65 = 97,500 \]
   \[ (46,962) \]

   Salvage value
   \[ N = 10, I = 11, FV = 100,000 \]
   \[ 35,218 \]

   Tax shield lost:
   \[ (35,218 \times .20 \times .35) / (.20 + .11) = (7,953) \]

   Recovery of working capital
   \[ N = 10, I = 11, FV = 50,000 \]
   \[ 17,609 \]

   Net present value
   \[ (\$114,688) \]

d. The annual cash flows would have to result in a total present value of $765,600 + 114,688 = $880,288. The annual cash flow that results in this present value is:

   \[ N = 10, I = 11, PV = 880,288, CPT PMT = \$149,474 \]

   Before tax amount of \( \$149,474 / .65 = \$229,960 \)
Management Accounting

Problem 2

Project 1  Initial investment  ($100,000)
PV of annual cash flows:
   N = 5, I = 15, PMT = 30,000
NPV                           100,565
   NPV                           $565

   IRR: N = 5, PV = -100,000, PMT = 30,000
   CPY I/Y = 15.24%

Project 2  Initial investment  ($100,000)
PV of annual cash flows:
   Year 1: N = 1, I = 15, FV = 40,000
   Year 2: N = 2, I = 15, FV = 35,000
   Year 3: N = 3, I = 15, FV = 30,000
   Year 4: N = 4, I = 15, FV = 25,000
   Year 5: N = 5, I = 15, FV = 20,000
   $5,211

   Try it using the cash flow function of the financial calculator.
   IRR = 17.47%

Project 3  NPV = ($4,081)  IRR = 13.45%

Project 4  NPV = $8,289     IRR = 19.31%

Project 5  NPV = $5,384     IRR = 17.57%
Problem 3

a. NPV of first project:
   
   Initial investment: 
   \[ \text{($2,000,000,000)} \]

   PV of annual cash flows:
   \[ N = 20, I= 12, \text{PMT } = 300,000,000 \]
   \[ 2,240,833,087 \]
   \[ $ 240,833,087 \]

   The present value of the cash flows of second project need to be equal to $1,500,000,000 + 240,833,087 = $1,740,833,087

   Annual cash flows need to be:
   \[ N = 20, I = 12, \text{PV} = 1,740,833,087 \]
   \[ \text{CPT PMT } = $233,060,610 \]

b. Expected value of cash flows =
   \[ $210,000,000(.3) + 230,000,000(.3) + 260,000,000(.4) \]
   \[ = $236,000,000 \]

   NPV of second investment:
   
   Initial investment: 
   \[ ($1,500,000,000) \]

   PV of annual cash flows:
   \[ N = 20, I = 12, \text{PMT } = 236,000,000 \]
   \[ 1,762,788,695 \]
   \[ $ 262,788,695 \]

   Since this exceeds the expected net present value of the larger project, the smaller project would be chosen.
Problem 4

Initial investment ($20,000)
Tax shield: \( (20,000 \times .40 \times .35) / (.40 + .14) \times (1.07 / 1.14) \) 4,867

Present value of operating cash flows
Annual cash flows = $110,000 - 60,000 - 40,000 = $10,000 x .65 = $6,500
N = 4, I = 14, PMT = 6,500

18,939

Net present value $3,806

Problem 5

Initial investment
Machine = $1,000,000 50,000 ($950,000)
Reduction in working capital 15,000
Tax shield: \( (950,000 \times .20 \times .32) / (.20 + .12) \times (1.06 / 1.12) \) 179,821
Salvage value: N = 5, I = 12, FV = 95,000 53,905
Tax shield lost – \( (53,905 \times .20 \times .32) / (.20 + .12) \) (10,781)
Annual cash flows: N = 5, I = 12, PMT = 130,000 x $2.50 x .68 = $221,000 796,656
Working capital – end of project: N = 5, I = 12, FV = 15,000 (8,511)

Net present value $76,090
16. Lease vs. Buy Decision

Learning Objectives

After completing this chapter, you will:

1. Recognize the characteristics of leases defined by the Canada Revenue Agency (CRA).
2. Understand and be able to compute the tax implications and, therefore, the net present value implications of purchasing or leasing an asset.

What are Leases?

A lease is a contractual relationship between a lessor and a lessee. The contract conveys from the lessor (the asset’s owner) to the lessee (the asset’s user) the right to use an asset for a specified period of time in exchange for period payments called lease payments. Therefore, in a leasing arrangement the lessor retains ownership of the asset being leased but the lessee has the use of the asset.

Why Do Organizations Lease?

The major advantage of leasing, in general, is the lessee avoids having to make the capital investment to buy the asset and, by not owning the asset, avoids any risk associated with the asset becoming obsolete.

However, there are other considerations. Lessors may use leases to price discriminate between buyers and lessees. Lessors and lessees may face different capital costs. In the case of a capital lease where the lessor and the lessee swap the capital cost allowance tax shields, the lease is advantageous when the lessor faces a higher marginal tax rate than the lessee. Sometimes, middle managers in organizations will use a lease to circumvent capital expenditure controls in their organization.

Research suggests that lessors tend to avoid leasing assets where the value of the asset can be significantly impaired by excessive use or poor maintenance by the lessee.

Assume you have completed the net present value analysis of a project and have concluded that you should be acquiring the asset. The next step is to decide how to finance the asset:

- You can purchase the asset (in this section, we will assume the asset will be financed through debt), or
- You can lease the asset.

This chapter deals with the financing decision to lease or buy an asset after the decision to acquire the asset has been made (i.e. we are concerned with the financing element of the transaction only).
Allowable Leases from the Canada Revenue Agency's Perspective

The Canada Revenue Agency stipulates that lease payments are deductible as long as the lease agreement does not contain any of the following four provisions:
- There is an automatic transfer of ownership at any time,
- The lessee is required to purchase the asset,
- The lessee has the option of purchasing the asset at a price substantially below the fair market value of the asset (a bargain purchase option), or
- The lessee has the option of purchasing the asset at a price that would lead a reasonable observer to conclude the lessee would buy the asset.

So, if there is an expectation that the asset will not revert to the lessor during or at the end of the lease term, then the lease payments are not deductible. On the other hand, if the asset reverts back to the lessor at the end of the lease term, then the lease payments are deductible. In this section, we are only concerned with leases whose lease payments are deductible and we will call these allowable leases.

If a company chooses to lease the asset, then, from a cash flow perspective, the following occurs:
1. They do not have to pay for the asset,
2. They forgo the tax shield on the asset (i.e. they cannot deduct CCA),
3. They have to make annual lease payments (which are tax deductible).

The lease vs. buy decision is a discounted cash flow analysis that essentially discounts the above cash flows. Because this is a financing decision, all cash flows are discounted at the after-tax borrowing rate.

Example 1:

Assume you wish to purchase a machine costing $600,000. You can finance the asset through a bank loan costing you 6.5% or you can lease the machine for eight annual lease payments of $93,500. The machine will revert back to the lessor at the end of the lease term (which is also equal to the asset’s useful life). If you purchased the asset, it would qualify as a Class 8 asset (CCA rate = 20%). Assume a tax rate of 40%.

The net advantage to leasing is as follows. Note that the analysis is done from the perspective of leasing (i.e. the original cost of the asset is avoided and thus is positive). Also note that all cash flows are discounted at the after-tax borrowing rate of 3.9% (6.5% x .6).
Cost of machine saved $600,000

Tax shield lost because asset is leased:
\[
\frac{600,000 \times (0.2) \times (0.4)}{(0.2 + 0.039) \times (1.0195 / 1.039)} = 197,068
\]

Present value of lease payments (recall that leases are annuity dues, the first lease payment is due on signing the lease):

First lease payment: $93,500 x .6 (56,100)

Next seven lease payments:
\[
PMT = \frac{93,500 \times 0.6}{1 - (1 + 0.039)^{-7}} = 563,272
\]

Net advantage to leasing $8,869

The net advantage to leasing is positive, so the company should proceed with the leasing arrangements.

A note on the effect of taxes: by multiplying the lease payment by (1 - t), we are implicitly assuming the tax benefit related to the lease payment is realized at the time the lease payment is made (i.e. at the beginning of the year). Because corporations are required to make monthly instalments on their income taxes and the deductibility of lease payments is taken into consideration in the calculation of the instalments, then the tax benefit of the lease payment theoretically occurs every month (or if taken on an annual basis, midway through the year). If one assumes the tax benefit of the lease payments occurs at the end of the year, then the calculation of the net advantage to leasing in the previous example becomes:

Cost of machine saved $600,000

Tax shield lost because asset is leased:
\[
\frac{600,000 \times (0.2) \times (0.4)}{(0.2 + 0.039) \times (1.0195 / 1.039)} = 197,068
\]

Present value of lease payments

First lease payment: (93,500)

Next seven lease payments:
\[
PMT = \frac{93,500 \times 0.6}{1 - (1 + 0.039)^{-7}} = 563,272
\]

Tax benefit on lease payments:
\[
N = 8, i = 3.9, PMT = 93,500 \times 0.4 = 37,400, PV = 252,848
\]

Net advantage to leasing $(992)

Clearly, the assumption we make with regards to the timing of the tax benefits related to the lease payment matters. In reality, the true net advantage to leasing in this situation would be somewhere in the middle.
Example 2:

Provence Company needs to replace a piece of safety machine, a Class 8 asset with a CCA rate of 20% that costs $350,000, will last for 10 years and will have no salvage value at that time. The machine can be purchased using a 6% bank loan or acquired using a lease requiring 10 annual lease payments of $50,000. Provence Company’s marginal tax rate is 35%.

Note that the after-tax cost of debt is 3.9% (6%*(1-.35)) and the after-tax cost of each lease payment is $32,500 ($50,000 *(.35))

Cost of machine saved $350,000

Tax shield lost because asset is leased:  
\[ \frac{350,000 \times 2 \times 0.35}{2 + 0.039} \times \frac{1.0195}{1.039} = (100,587) \]

Present value of lease payments:
- First lease payment (32,500)
- Next seven lease payments:
  \[ PMT = 32,500, \ n=9, \ i=3.9\%, \ PV = (242,753) \]

Net advantage to leasing (25,840)

In this case, we would be better off buying the asset and financing it with a bank loan.
Problems with Solutions

Multiple Choice Questions

1. Fred Company faces a marginal tax rate of 38%. The company's after-tax weighted average cost of capital is 8% and its capital structure includes equity with an imputed cost of 12% and debt with a pre-tax cost of 6%. The appropriate rate for Fred Company to use to discount the lease payments on its operating lease is:

   a) 6%
   b) 8%
   c) 12%
   d) None of the above

2. Banner Company, which has a marginal tax rate of 25%, has just signed an operating lease that calls for lease payments of $5,000 per year for five years. Banner Company can currently borrow at the rate of 4%. The present value of the lease payments is approximately:

   a) $16,694
   b) $17,362
   c) $17,689
   d) None of the above

3. Fred Company has just signed a lease that CRA has designated as a capital lease. The stated value of the lease is $350,000 and the required lease payments are $50,040 for 10 years. Ignoring income taxes, the implied interest rate in the lease is:

   a) 9%
   b) 14.30%
   c) 33.33%
   d) Cannot be determined from the facts given

4. Mayflower Company has just signed a lease whose asset has a fair value of $100,000 and will be making payments of $12,000. Ignoring income taxes, if the implied interest rate on the lease is 10%, the interest portion of the third lease payment will be:

   a) $8,480
   b) $8,800
   c) $10,000
   d) None of the above
Problem 1

The Jamey Corporation is considering the purchase of a new dye spreading machine for its manufacturing operations and is faced with two possibilities:

- Machine A is available only on a lease basis. The annual lease payments are $2,500 for five years. This machine will save the Jamey Corporation $7,000 a year through reductions in electricity costs in each of the five years.

- As an alternative, Jamey can purchase a more energy efficient machine (Machine B) for $15,000. This machine will save $9,000 in electricity costs. Jamey’s bank has offered to finance the machine with a $15,000 loan. The interest rate on the loan will be 8% on the remaining balance with five annual principal payments of $3,000.

The tax rate is 40% and the CCA rate for the machine is 30%. Both machines have a useful life of five years and no salvage value. Should Jamey lease the Machine A or purchase the more efficient Machine B?

Problem 2

Friendship Airlines proposes to lease a $10 million aircraft. The terms require six annual lease payments of $2 million. Friendship pays tax at 40%. If it purchases the aircraft, it would put the aircraft cost in a 25% CCA class. The aircraft will be worthless after six years. The interest rate is 8%. Should the aircraft be purchased or leased?

Problem 3

Central College needs a new computer. It can either buy it for $250,000 or lease it from Lessor Inc. The lease terms require Central College to make six annual payments of $50,000. Central College, being a non-profit organization pays no tax. Lessor Inc. pays tax at 36%. Lessor Inc. would place the computer in Class 10 (30%) with all its other computers. The computer will have no residual value at the end of year 5. Central College’s borrowing rate is 8%.

Required:

a. What is the NPV of the lease for Central College?

b. What is the NPV for Lessor Inc.?

c. What is the overall gain to the two parties if the lease is undertaken?

Problem 4

Trak Laboratories will purchase a new machine used in blood analysis. The machine costs $1,200,000 and will have a useful life of six years at which time it is expected to be obsolete and valueless. Trak Laboratories faces a marginal tax rate of 36% and can borrow money at the rate of 6%. The asset qualifies for a CCA rate of 30%. The asset can be leased for six annual payments of $240,000. Should Trak Laboratories buy or lease this machine?
Problem 5

Roger Company is considering automating its paint shop. The new machine would cost $280,000 and would last eight years and have no terminal salvage value. The expected materials and labour savings would be $70,000 per year over the life of the machine. These savings are known with certainty since they have been guaranteed by the machine vendor. Roger Company can borrow money at 7% and faces a marginal tax rate of 32%. The machine would be eligible for a CCA rate of 20%. Angus Company has offered to lease the machine to Roger Company for $45,000 per year for the life of the asset. Should Roger Company acquire this machine and, if so, should it buy the machine or lease it? Assume the Roger Company’s weighted average cost of capital is 10%.
Multiple Choice Question Solutions

1. d The appropriate rate to use is 3.72% (6% * (1-.38)

2. c The after-tax lease payment is $3,750 ($5,000 * (1-.25)).
   Present value = 3,750 + \([N = 4, I = 3, PMT = 3,750, PV = 13,939]\) = $17,689

3. a In this case, the net value of the loan is $299,960 ($350,000 minus the initial payment of $50,040).
   \(N = 9, PV = 299,960, PMT = -50,040\)
   CPT I/Y = 9%

4. a The first payment is made on signature of the lease and the lease balance will be $100,000 - 12,000 = $88,000.

   The balance of the lease after the second payment will be: $88,000 - [12,000 - (88,000 x 10%)] = 88,000 - 3,200 = $84,800.

   The interest portion of the third payment will be $84,800 x 10% = $8,480
Problem 1

Cost of machine saved $15,000
Tax shield foregone – $15,000(.3)(.4) / (.3 + .048) * (1.024 / 1.048) -5,054
PV of lease payments: 1st payment: $2,500 x .6 -1,500
Next four lease payments: PMT = $1,500, n=4, i=4.8%, PV = -5,344
PV of incremental electricity costs:
  PMT = $2,000 x .6, n=5, i=4.8%, PV= -5,224
Net advantage to leasing -$2,122

The Jamey Corporation should purchase Machine B since the cost of leasing is higher.

Problem 2

Cost of aircraft $10,000,000
Tax shield foregone - $10,000,000(.25)(.4) / (.25 + .048) * (1.024 / 1.048) -3,278,856
PV of lease payments
  First lease payment: $2,000,000 x .6 -1,200,000
  Last five payments: PMT = $1,200,000, n=5, i = 4.8%, -5,224,221
Incremental cost of owning relative to leasing $296,923

Lease the aircraft

Problem 3

a. Cost of equipment $250,000
  PV of lease payments: first payment -50,000
  Next five: PMT = 50,000, n=5, i=8%, PV= -199,636
  $364

  Lease

b. r = 8%(.64) = 5.12%

  Cost of equipment -$250,000
  Tax shield: $250,000(.3)(.36) / (.30 + .0512)
    * (1.0256 / 1.0512) 75,007
  PV of lease payments: first payment: $50,000 x .64 32,000
  Next five: PMT = 50,000 x .64, n=5, i=5.12%, PV= 138,085
  -$4,908

c. Overall loss = 364 – 4,908 = $4,544. Not likely to happen.
Problem 4

Discount rate = 6% (.64) = 3.84%

Cost of machine saved $1,200,000
Tax shield foregone – $1,200,000(.3)(.36) / (.3 + .0384)  
* (1.0192 / 1.0384) (375,897)
PV of lease payments: first lease payment: $240,000 x .64 (153,600)
Next five payments: PMT = $153,600, n=5, i = 3.84%, PV= (686,884)
Net advantage to leasing (16,381)

The asset should be purchased.

Problem 5

The first thing we need to do is determine if the machine should be acquired in the first place. This requires a standard NPV analysis:

Cost of machine $(280,000)
Tax shield: $280,000(.2)(.32) / (.2 + .1) * (1.05 / 1.10) 57,018
PV of annual operating cash flows:
  N = 8, I = 10, PMT = 70,000 x .68 = 47,600 253,942
Net present value $30,930

Given that the net present value is positive, the asset should be acquired. The next step is to determine whether or not the asset should be leased or purchased:

Discount rate = 7% (.68) = 4.76%

Cost of machine saved $280,000
Tax shield foregone: $280,000(.2)(.32) / (.2 + .0476) * (1.0238 / 1.0476) (70,731)
PV of lease payments: first lease payment: $45,000 x .68 (30,600)
Next seven payments: PMT = $30,600, n=7, i = 4.76%, PV= (178,613)
Net advantage to leasing $56

The asset should be leased (theoretically anyways... but the NAL is so small, one could go either way).
17. Cost Variances

Learning Objectives

After completing this chapter, you will:

1. Understand the role and insights provided by static and flexible budgets
2. Be able to construct flexible budgets for simple organizations
3. Be able to compute and explain the insights of manufacturing cost variances.

Chapter example:

The following example will be used throughout this chapter to illustrate the role and nature of manufacturing cost variances.

Buddy Company produces cloth jackets. The following is the planned use per jacket for materials, labour and variable overhead for the upcoming year:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials (cloth)</td>
<td>1.5 metres</td>
<td>$14 per metre</td>
<td>$21.00</td>
</tr>
<tr>
<td>Direct labour</td>
<td>.40 hours</td>
<td>$28 per hour</td>
<td>11.20</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>.40 hours</td>
<td>$15 per hour</td>
<td>6.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$38.20</td>
</tr>
</tbody>
</table>

During the upcoming year, Buddy Company plans on producing and selling 500,000 units at $50 per unit.

Fixed manufacturing costs are budgeted at $2,000,000 for the upcoming year. Since planned production is 500,000 jackets and planned labour use is .4 per jacket, planned labour hours is 200,000 (500,000 * .4). Therefore, fixed overhead manufacturing costs will be applied to jackets at the rate of $10 ($2,000,000 / 200,000) per direct labour hour.
The following exhibit summarizes this information.

<table>
<thead>
<tr>
<th></th>
<th>Per Jacket</th>
<th>Static Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>$50.00</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>21.00</td>
<td>10,500,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>11.20</td>
<td>5,600,000</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>6.00</td>
<td>3,000,000</td>
</tr>
<tr>
<td></td>
<td>38.20</td>
<td>19,100,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$11.80</td>
<td>5,900,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td></td>
<td>2,000,000</td>
</tr>
<tr>
<td>Gross margin</td>
<td></td>
<td>$3,900,000</td>
</tr>
</tbody>
</table>

The actual results are:

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>450,000</td>
</tr>
<tr>
<td>Revenue: 450,000 x $50</td>
<td>$22,500,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
</tr>
<tr>
<td>Direct materials – 690,000 metres @ 13.50/metre</td>
<td>9,315,000</td>
</tr>
<tr>
<td>Direct labour – 175,000 hours @ $29/hour</td>
<td>5,075,000</td>
</tr>
<tr>
<td>Variable overhead – 175,000 hours @ $15/hour</td>
<td>2,625,000</td>
</tr>
<tr>
<td></td>
<td>17,015,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>5,485,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>2,100,000</td>
</tr>
<tr>
<td>Gross margin</td>
<td>$3,385,000</td>
</tr>
</tbody>
</table>
One of the oldest approaches to control in management accounting is to compare actual results with planned results to compute a difference or variance. Variances are then evaluated to identify why plans were not realized. In addition, managers are often assigned responsibility for the resulting variances.

A basic variance analysis can be conducted by comparing actual results with the static budget. By convention, management accountants compute variances by subtracting the budget amount from the actual amount. The following is the result for this year. Note that variances that have a favourable impact on income are labelled 'F' whereas variances that have an unfavourable impact on income are labelled 'U':

<table>
<thead>
<tr>
<th></th>
<th>Per Jacket</th>
<th>Static Budget</th>
<th>Actual</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>500,000</td>
<td>450,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>$50.00</td>
<td>$25,000,000</td>
<td>$22,500,000</td>
<td>$2,500,000 U</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>21.00</td>
<td>10,500,000</td>
<td>9,315,000</td>
<td>1,185,000 F</td>
</tr>
<tr>
<td>Direct labour</td>
<td>11.20</td>
<td>5,600,000</td>
<td>5,075,000</td>
<td>525,000 F</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>6.00</td>
<td>3,000,000</td>
<td>2,625,000</td>
<td>375,000 F</td>
</tr>
<tr>
<td></td>
<td>38.20</td>
<td>19,100,000</td>
<td>17,015,000</td>
<td>2,085,000 F</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$11.80</td>
<td>5,900,000</td>
<td>5,485,000</td>
<td>415,000 U</td>
</tr>
<tr>
<td>Fixed costs</td>
<td></td>
<td>2,000,000</td>
<td>2,100,000</td>
<td>100,000 U</td>
</tr>
<tr>
<td>Gross margin</td>
<td>$3,900,000</td>
<td>$3,385,000</td>
<td>$515,000 U</td>
<td></td>
</tr>
</tbody>
</table>

We can summarize the results for this year as follows. Revenues were $2.5 million less than planned. However, that was offset by variable costs being $2.085 million less than planned resulting in a contribution margin shortfall of $415,000 ($2.5 million - $2.085 million). Fixed costs were $100,000 more than planned, resulting in the gross margin shortfall of $515,000 ($415,000 + $100,000).

The problem with this analysis is it provides little insights into how well costs were controlled since the budgeted and actual costs reflect different activity levels. Therefore, in order to provide a benchmark to compare actual results, the static budget amounts are converted to a flexible budget that shows the planned values for the achieved level of production and sales.

The following schedule shows this:
The variance analysis above decomposes the total variance of -$515,000 into two components: a variance of -$590,000 called a sales volume variance and a variance of $75,000 called a flexible budget variance.

Note that the sales volume variance is simply the change in profit resulting from a change in volume holding all the per jacket standard price and standard use of direct materials, direct labour and variable overhead constant. Therefore, the sales volume variance is easily computed by multiplying the contribution margin per jacket by the difference in volume between the static budget and the flexible budget. In this case we have $11.80 * (450,000-500,000) = -$590,000.

Therefore, we would expect a fall of $590,000 in gross margin to follow directly from underachieving the target production and sales level by 50,000 units.

We are left to explain the $75,000 variance which we have called the flexible budget variance. But first, we need to make a detour and explain where the direct materials, direct labour and variable overhead per jacket value were derived.

Standard Costs

Underlying the static budget is per unit standards for all variable costs. We can see above that there are both price and quantity standards for each of the variable items in the static budget. In practice these standards are derived from many sources. The following are some alternative sources for quantity standards used in practice:

- An average over the past several years
- Last year’s value plus an adjustment (usually a tightening of the standard)
- Predetermined values based on engineering studies
- Performance levels achieved by best in class competitors
Manufacturing Cost Variances

Flexible cost variances arise for one or both of two reasons: differences between quantity consumed and the budgeted quantity for a given level of output and differences between the standard price and the actual price paid. Therefore, as you will see, the flexible budget variance for each item is factored into a price related variance and a quantity relative variance. We will now turn to consider the flexible cost variances for materials, labour and variable overhead.

Direct Materials

The direct material standard usage is 1.5 metres for each unit of output. Therefore, the flexible budget allowance for direct materials will be 675,000 metres (450,000 jackets * 1.5 metres per jacket). The standard price per metre of direct material is $14. The actual price paid per metre was $13.50 (9,315,000 / 690,000).

Following are the formulas to factor the direct materials flexible budget variances into its two components:

- Price variance = actual quantity purchased x (actual price - standard price)
- Quantity variance = standard price x (actual quantity used
  - standard quantity allowed for output produced)

Price variance = 690,000 * (13.50 – 14) = $345,000 F
Since the actual price was less than the standard price, the variance was favourable.

Quantity variance = 14 * (690,000 – 675,000) = $210,000 U
Since the actual quantity was more than the quantity allowed for the output produced, the variance is unfavourable.

Total flexible budget materials variance = price variance + quantity variance = $135,000 F

There are a number of things to note about these variances:

1. The materials price variance is isolated at the time of purchase not at the time of use.
2. There is often a relationship between the materials price and quantity variances. For example, one explanation for the results above might be that lower quality than budgeted materials were purchased resulting in a lower price. However, the lower quality materials resulted in higher than budgeted materials use.
Direct Labour

The direct labour use is .4 hours per jacket. Therefore, the flexible budget allowance for direct labour will be 180,000 hours (450,000 jackets *.4 hours per jacket). The standard rate for direct labour is $28 per hour. The actual rate paid for direct labour was $29 per hour (5,075,000 / 175,000).

Following are the formulas to factor the direct labour flexible budget variances into its two components:

- Rate variance = actual hours x (actual rate - standard rate)
- Efficiency variance = standard rate x (actual hours - standard hours allowed for output produced)

Rate variance = 175,000 * (29 – 28) = $175,000 U
Since the actual rate was more than standard rate, the variance is unfavourable.

Efficiency variance = 28 * (175,000 – 180,000) = $140,000 F
Since the actual quantity was less than the quantity allowed for the output produced, the variance is favourable.

Total flexible budget labour variance = $175,000 - $140,000 = $35,000 U
Note that as in the case of the direct materials variance, there are often interrelationships between the labour rate and efficiency variance. In this case, a higher class of labour might have been used causing the higher labour rate and the improved efficiency.

Variable Manufacturing Overhead

Before we discuss the variable manufacturing overhead flexible budget variances at Buddy Company, we have to make a small detour to discuss the nature of variable manufacturing overhead at Buddy Company. The variable overhead items are actually materials and labour costs that are too expensive to track as direct costs and are, therefore, treated as variable manufacturing (overhead) costs.

Assume a study of the jacket assembly operations at Buddy Company has yielded the following information. For each hour workers spend producing the jackets, they consume the following items:

- Three units of thread costing $1 per unit – a total of $3 (3 * 1)
- .75 helper hours costing $16 per hour – a total of $12 (.75 * 16)

Therefore, the standard total cost of these variable overhead items is $15 (3 + 12) per direct labour hour worked.

Now, assume the actual use of these variable overhead items per direct labour hour during the last year was:

- Thread – 2.8 units @ $.90 per unit – a total of $2.52
- Helper hours – .80 @ $15.60 – a total of $12.48
Therefore, the actual total cost of these variable overhead items per direct labour hour during the past year was $15 per direct labour hour worked. Note that there were both price and use variances for both variable overhead items but the actual variable manufacturing overhead rate per direct labour hour equalled the standard rate variable manufacturing overhead rate.

Following are the formulas to factor the variable manufacturing flexible budget variances into its two components:

- **Rate variance** = actual hours x (actual rate - standard rate)
- **Efficiency variance** = standard rate x (actual hours – standard hours allowed for output produced)

Rate variance = 175,000 * (15 – 15) = $0
Efficiency variance = 15 * (175,000 – 180,000) = $75,000 F
Because the workers used 5,000 fewer hours than allowed for the achieved level of output they used, at standard cost, $75,000 fewer variable overhead items, which is a favourable variance.

**Fixed Manufacturing Overhead**

Since fixed manufacturing overhead does not vary in the short-term with the level of production, the static budget and flexible budget amounts for fixed manufacturing will be the same. In Buddy Company, the amount is $2,000,000.

Fixed manufacturing overhead is applied to production using direct labour hours. The rate of $10 per direct labour hour was computed by dividing the budgeted fixed manufacturing overhead of $2,000,000 by the static budget allowance for direct labour hours, which was 200,000 hours. The following are the fixed manufacturing overhead variances:

- Fixed manufacturing overhead budget variance = actual fixed manufacturing overhead – budgeted fixed manufacturing overhead.
- Fixed manufacturing overhead volume variance = (budgeted fixed manufacturing overhead – applied fixed manufacturing overhead)

Fixed manufacturing overhead budget variance = $2,100,000 - $2,000,000 = $100,000 U
Fixed manufacturing overhead volume variance = $2,000,000 - (180,000 * 10) = $200,000 U
Note that the fixed manufacturing overhead volume variance arises when the denominator value used to compute the fixed manufacturing overhead rate differs from the flexible budget volume.

We can see this by rewriting the production volume variance as follows:

Fixed manufacturing overhead volume variance = (static budget direct labour hours – flexible budget direct labour hours) * fixed manufacturing overhead rate = (200,000 – 180,000) * $10 = $200,000 unfavourable
Variance Analysis with Substitutable Inputs

Many manufacturing settings organizations can vary the mix of direct materials or direct labour when implementing a production plan. For example, the organization may deviate from the planned mix of skilled and unskilled labour or it might vary the mix of different direct materials.

The Birdy Delight Company manufactures bird seed using three grains as the direct materials:

- Grain A – cost $2.80 per kilogram (planned use is 40% of total)
- Grain B – cost $3.30 per kilogram (planned use is 35% of total)
- Grain C – cost $4.50 per kilogram (planned use is 25% of total)

With this information, we can compute the weighted average cost per kilogram of direct material as $3.40 (.4 * $2.80 + .35 * $3.30 + .25 * $4.50).

The total budgeted direct materials are 56,000 kilograms. Therefore, the planned use of each type of grain (in kilograms) will be:

- Grain A = 56,000 * 40% = 22,400
- Grain B = 56,000 * 35% = 19,600
- Grain C = 56,000 * 25% = 14,000

Assume the actual use of each type of grain (in kilograms) was:

- Grain A = 19,950
- Grain B = 25,650
- Grain C = 11,400

With this information, we can compute the actual percentage use of each type of grain:

- Grain A = 35% (19,950 / 57,000)
- Grain B = 45% (25,650 / 57,000)
- Grain C = 20% (11,400 / 57,000)

We are now ready to decompose the quantity variance for direct materials into two components, a mix variance and a yield variance.

**Mix variance:**

\[(\text{actual mix percentage} - \text{standard mix percentage})\times \frac{\text{actual total units of inputs used}}{\text{actual total units of inputs used}}\times \frac{\text{standard price per unit of input}}{\text{standard price per unit of input}}\]

In this case the mix variances are:

- Grain A: (.35 – .40) * 57,000 * $2.80 = $7,980 F
- Grain B: (.45 - .35) * 57,000 * $3.30 = $18,810 U
- Grain C: (.20 – .25) * 57,000 * $4.50 = $12,825 F

Total mix variance: $1,995 F
Yield variance:

\[(\text{actual total units of input used} - \text{standard total units of input allowed for actual output}) \times \text{standard weighted average input price}\]

In this case, the yield variance is:

\[(57,000 - 56,000) \times \$3.40 = $3,400 \ U\]

Note that, as required, mix variance + yield variance = direct materials quantity variance = $1,405 \ U.

Investigating variances:

Management accountants use variances to signal situations where actual results differ from planned results. The question that arises is whether the variance signals that the process has gone out of control or whether the variance is simply an observation that reflects normal variation in the process. Clearly, it would be prohibitively expensive to investigate all variances.

There are three broad approaches management accountants use to decide whether or not to investigate variances:

1. Did the variance amount exceed a predetermined critical value? If so, investigate the variance. The critical value is often developed based on past experience or with reference to an industry benchmark.
2. Plot the variances on a control chart and, if the process seems to be going out of control or appears to be out of control, then investigate the variance. The nature and design of control charts is beyond the scope of these notes.
3. A decision analysis approach to deciding whether to investigate a variance.

**Decision Analysis Approach to Investigating a Variance:**

There are three parameters involved in the decision analysis approach to whether to investigate a variance:

1. What is the cost of the investigation?
2. What is the cost of resetting the process if an investigation finds it to be out of control?
3. What is the incremental cost of the process running out of control relative to the cost when the process is in control?

Referring back to our discussions in Chapter 12, the decision analysis approach to investigating a variance is a setting where there are two decisions (investigate or do not investigate the variance) and two states of nature (the process is in control or out of control).
It is useful to introduce the following notation:

Let:

- **I** The cost of investigating whether the process is in or out of control. We will assume the investigation will identify whether the process is in or out of control accurately.

- **C** The cost of correcting the process if the investigation finds it to be out of control. We will assume that if the process is corrected, it remains in control to the end of the planning cycle.

- **E** The incremental cost, relative to the cost when the process is in control, of the process operating out of control to the end of the planning cycle.

- **P** The probability the process is in control. (Therefore, the assessed probability that the process is operating out of control is (1-p).

This set up results in the following decision matrix showing the cost for each pair of possibilities:

<table>
<thead>
<tr>
<th></th>
<th>Process is in control (p)</th>
<th>Process is out of control (1-p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigate variance</td>
<td>I</td>
<td>I+C</td>
</tr>
<tr>
<td>Do not investigate variance</td>
<td>0</td>
<td>E</td>
</tr>
</tbody>
</table>

Note that rationality requires that $E > I + C$. In other words, the incremental cost of operating out of control must always exceed the cost of investigating and fixing the variance or it would never pay to investigate.

The expected costs are:

- Expected cost of investigating the variance $= p * I + (1-p) * (I + C) = I + (1-p) * C$
- Expected cost of not investigating the variance $= p * 0 + (1-p) * E = (1-p) * E$

We would only investigate if the expected cost of not investigating the variance is higher than the expected cost of investigating the variance. That is:

$$(1-p) * E > I + (1-p) * C$$

Rearranging, we would investigate if $p$, the probability of in control, is less than the following ratio:

$$P < \frac{E - I - C}{E - C}$$

Observe that because $E > I + C$ the numerator and denominator will always be positive and the numerator will always be less than or equal to the denominator. Therefore, the fraction will always lie on the interval zero to one.
Example:

Cook Company is operating a production line to complete a special order and is wondering if the process is operating in or out of control. The factory accountant has estimated the following costs:

- Cost of investing whether the process is in or out of control – $1,000
- Cost of resetting the process if it is found to be out of control – $5,000
- Incremental cost when the process is operating out of control – $10,000

The factory accountant has observed a cost variance that suggests the probability the process is in control is about 60%. Should the process be investigated?

First set up the payoff table:

<table>
<thead>
<tr>
<th></th>
<th>Process is in control</th>
<th>Process is out of control</th>
<th>Expected Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigate variance</td>
<td>$1,000</td>
<td>$6,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>Do not investigate variance</td>
<td>0</td>
<td>$10,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

Since the expected cost of investigating the variance is less than not investigating, the variance should be investigated.

Conclusion:

Variance analysis is one of the oldest and perhaps most widely used management accounting tools. When a computed variance has been identified as significant, it signals the process is not operating as expected and it is out of control. The decision then has to be made whether to investigate the variance.

In practice, managers are usually assigned accountability for managing a process and keeping it in control. Managers are responsible for explaining the source of variances, one of which may be a standard that is inappropriate, and acting to bring the process back in control. Cost variances are widely used in manufacturing settings, but they are also used in service organizations and service departments in manufacturing organizations.
Appendix – Cost Variance Formulas

Direct materials:
• Price variance = actual quantity purchased x (actual price - standard price)
• Quantity variance = standard price x (actual quantity used - standard quantity allowed for output produced)

Direct labour and variable overhead:
• Rate variance = actual hours x (actual rate - standard rate)
• Efficiency variance = standard rate x (actual hours - standard hours allowed for output produced)

Quantity/efficiency variance = yield + mix variances

Yield variance:
(\text{actual units of input used} - \text{standard units of input allowed for actual output})
\times \text{standard average price per unit of input}

Mix variance:
(\text{actual mix percentage} - \text{standard mix percentage})
\times \text{standard price per unit of input}
\times \text{actual total units of inputs used}
\times (\text{standard average price per unit of input} - \text{budgeted price/unit})
\text{or: (actual mix} \% - \text{budgeted mix} \%) \times \text{actual total quantities} \times \text{budgeted price/unit}

Fixed overhead budget variance = \text{actual FOH} - \text{budgeted FOH}
Fixed overhead volume variance = \text{budgeted FOH} - \text{applied FOH}
Problems with Solutions

Multiple Choice Questions

The following information pertains to Questions 1 – 2:

Dartmouth Company uses two interchangeable raw materials, A and B, in the manufacture of its only product, Gizbo. The standard proportions for the manufacture of a unit of Gizbo are two units of A and three units of B. The unit standard prices of A and B are $10 and $8, respectively. During the month of May, the company used 450 units of A and 750 units of B to produce 230 units of Gizbo.

1. The yield variance of raw materials was:
   a) $450 U
   b) $440 F
   c) $450 F
   d) $440 U

2. The mix variance of raw materials was:
   a) $36.00 F
   b) $60.00 F
   c) $12.00 F
   d) $57.50 F
The following information pertains to items 3 – 5:

Acme Inc. uses a standard cost system in which direct materials inventory is carried at standard cost. The following information pertains to Acme's direct materials standards and actual production for November:

<table>
<thead>
<tr>
<th>Standard quantity of direct material per unit of output</th>
<th>8 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard price per kilogram</td>
<td>$1.80</td>
</tr>
<tr>
<td>Quantity of direct materials purchased</td>
<td>160,000 kg</td>
</tr>
<tr>
<td>Actual cost of direct materials purchased</td>
<td>$304,000</td>
</tr>
<tr>
<td>Quantity of direct materials placed into production</td>
<td>142,500 kg</td>
</tr>
<tr>
<td>Units of output produced</td>
<td>19,000</td>
</tr>
</tbody>
</table>

3. The direct materials price variance for November is:
   a) $14,250 unfavourable
   b) $15,200 unfavourable
   c) $16,000 unfavourable
   d) $30,400 unfavourable
   e) $47,500 unfavourable

4. The direct materials efficiency (usage, quantity) variance for November is:
   a) $31,500 unfavourable
   b) $14,400 unfavourable
   c) $2,850 favourable
   d) $17,100 favourable
   e) $18,050 favourable

5. Acme's policy is to investigate only those unfavourable variances that exceed $16,000 or 5% of standard and favourable variances that exceed $20,000 or 7% of standard, whichever is lower. What are the upper and lower control limits for the direct materials price variance for November?
   a) Lower limit – $16,000 unfavourable; Upper limit – $20,000 favourable
   b) Lower limit – $15,200 unfavourable; Upper limit – $20,000 favourable
   c) Lower limit – $14,400 unfavourable; Upper limit – $20,000 favourable
   d) Lower limit – $13,680 unfavourable; Upper limit – $19,152 favourable
   e) Lower limit – $12,825 unfavourable; Upper limit – $17,955 favourable
6. A company uses an absorption costing system with standard costs. For the year just ended, it showed a $28,775 unfavourable production volume variance. The unfavourable production volume variance occurred because:
   a) Budgeted fixed production overhead was less than applied fixed production overhead
   b) Budgeted fixed production overhead was less than actual fixed production overhead
   c) Actual production volume was greater than denominator volume
   d) Actual production volume was less than denominator volume
   e) Both b and c above

7. Buddy Company produces various lighting products, including lamps and lampshades. The following data pertains to the direct labour costs associated with the production of 3,000 lampshades during January:

   - Actual direct labour costs incurred $14,685
   - Standard direct labour cost allowed for actual units produced $12,375
   - Direct labour efficiency variance $3,300 unfavourable

   The actual direct labour rate was $2 per hour lower than the budgeted direct labour rate.

   What was the actual amount of direct labour time used to produce one lampshade in January?
   a) .385 hour per unit
   b) 1.1 hours per unit
   c) .165 hour per unit
   d) .935 hour per unit
   e) .55 hour per unit
8. One of the products produced by Maggie Manufacturing is Product G. For Year 10, the budgeted sales volume for Product G was 30,000 units and the budgeted contribution margin was $25 per unit. Actual sales of Product G for Year 10 were 28,000 units and actual contribution margin was $29 per unit. There were no selling price or fixed cost variances for Product G. Which of the following statements regarding variances for Product G in Year 10 is true?
   a) The flexible budget variance is unfavourable because the actual sales volume was less than the budgeted sales volume.
   b) The sales volume variance is unfavourable because the company actually sold fewer units than it budgeted.
   c) The flexible budget variance is favourable because the actual contribution margin was greater than the budgeted contribution margin.
   d) Both b) and c) above are true.
   e) All of a), b) and c) above are true.

The following relates to Questions 9 and 10:

A certain production process recently produced a significant unfavourable variance. The supervisor determined there is a 20% chance it was caused by a defect in the machinery and an 80% chance the variance was caused by random factors. To investigate the cause of the variance would require the process be shut down for an hour at a cost of $4,050. If a major defect is found, it would cost an additional $2,000 to correct. If a defect exists and is not corrected, the net cost to the company until the machinery’s regularly scheduled maintenance adjustments will be $13,000.

9. If management decides to investigate the cause of the variance, the expected cost would be:
   a) $1,210
   b) $4,450
   c) $4,840
   d) $5,560
   e) $6,050

10. If management decides not to investigate the cause of the variance, the expected cost would be:
    a) $0
    b) $2,600
    c) $4,600
    d) $10,400
    e) $13,000
Problem 1

Complete the following table:

<table>
<thead>
<tr>
<th></th>
<th>Static Budget</th>
<th>Flexible Budget</th>
<th>Actual</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>12,000</td>
<td>10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>$120,000</td>
<td>$105,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>36,000</td>
<td>30,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct labour</td>
<td>24,000</td>
<td>19,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable overhead</td>
<td>12,000</td>
<td>11,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>72,000</td>
<td>61,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution margin</td>
<td>48,000</td>
<td>44,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed costs</td>
<td>50,000</td>
<td>51,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross margin</td>
<td>($2,000)</td>
<td>($7,000)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the sales volume variance?

Problem 2

Information relating to direct labour during the last period at King Company follows:

- Actual direct labour hours – 5,100
- Direct labour efficiency variance – $1,600 unfavourable
- Direct labour price variance – $2,550 favourable
- Total direct labour cost – $160,650

Required:

a) What was the actual direct labour hourly rate?
b) What was the standard direct labour hourly rate?
c) What was the direct labour hours allowance for the number of units produced?
Problem 3

The Copper Bottom Pot Company Ltd., (CBPC), manufactures only one product, called The Big Pot. The company uses a standard cost system and has established the following standards per unit of The Big Pot:

<table>
<thead>
<tr>
<th></th>
<th>Standard Quantity</th>
<th>Standard Price</th>
<th>Standard Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>6 kilograms</td>
<td>$14 per kilogram</td>
<td>$84</td>
</tr>
<tr>
<td>Direct labour</td>
<td>1.5 hours</td>
<td>$20 per hour</td>
<td>$30</td>
</tr>
</tbody>
</table>

The following activities were recorded by CBPC for the production of The Big Pot in January 2000.

The company produced 600 units during the month.
A total of 4,000 kilograms of material were purchased at a cost of $52,000.
On January 1, 2000, there was no beginning inventory of materials on hand; 200 kilograms of materials remained in the warehouse unused at the end of the month.
The company employs 12 people to produce The Big Pot. In January, each worked an average of 65 hours at an average of $21 per hour.

Required:

a. For direct materials used in the production of The Big Pot:
   Compute the direct materials purchase price variance and the direct materials usage variance.
   The direct materials were purchased from a new supplier who is anxious to enter into a long-term purchase contract. Would you recommend the company sign the contract? Explain.

b. For the direct labour employed in the production of The Big Pot:
   i. Compute the direct labour rate variance and the direct labour efficiency variance.
   ii. In the past, the 12 people employed in the production of The Big Pot consisted of four experienced workers and eight inexperienced assistants. During January, the company experimented with shifting the labour mix to six experienced workers and six inexperienced assistants. Would you recommend the new labour mix be continued? Explain.
Problem 4

Addy Company's direct labour costs are:

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard direct labour hours</td>
<td>30,000</td>
<td></td>
</tr>
<tr>
<td>Actual direct labour hours</td>
<td>29,000</td>
<td></td>
</tr>
<tr>
<td>Direct labour efficiency variance, favourable</td>
<td>$4,000</td>
<td></td>
</tr>
<tr>
<td>Direct labour rate variance, favourable</td>
<td>$5,800</td>
<td></td>
</tr>
<tr>
<td>Total gross wages</td>
<td>$110,200</td>
<td></td>
</tr>
</tbody>
</table>

Required:

a. What was Addy's standard direct labour rate?
b. What was Addy's actual direct labour rate?

Problem 5

Andres industries employ a standard cost system. Andres has established the following standards for the prime costs of its Hunters' Bow product line:

<table>
<thead>
<tr>
<th></th>
<th>Standard Quantity</th>
<th>Standard Price</th>
<th>Standard Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>8 kg</td>
<td>$1.80/kg</td>
<td>$14.40</td>
</tr>
<tr>
<td>Direct labour</td>
<td>.25 DLH</td>
<td>$8.00/DLH</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$16.40</td>
</tr>
</tbody>
</table>

During November, Andres purchased 160,000 kg of direct materials at a total cost of $304,000. The total factory wages for November were $42,000, 90% of which were for direct labour. Andres manufactured 19,000 Hunters' Bows during November using 142,500 kg of direct materials and 5,000 direct labour hours.

Required:

a. What was the direct materials purchase price variance for November?
b. What was the direct materials usage variance for November?
c. What was the direct labour rate variance for November?
d. What was the direct labour efficiency variance for November?
Problem 6

Brien Manufacturing Company has a process cost accounting system. A monthly analysis compares actual results with both a monthly plan and a flexible budget. Standard direct labour rates used in the flexible budget are established at the time the annual plan is formulated and held constant for the entire year. Standard direct labour rates in effect for the fiscal year ending June 30 and standard hours allowed for the output in April are:

<table>
<thead>
<tr>
<th>Labour Class</th>
<th>Standard Rate per Hour</th>
<th>Standard DLH Allowed for Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class III</td>
<td>$8</td>
<td>500</td>
</tr>
<tr>
<td>Class II</td>
<td>$7</td>
<td>500</td>
</tr>
<tr>
<td>Class I</td>
<td>$5</td>
<td>500</td>
</tr>
</tbody>
</table>

The wage rates for each labour class increased on January 1 under the terms of a new union contract negotiated in December of the previous fiscal year. The standard wage rates were not revised to reflect the new contract. The actual direct labour hours worked and the actual direct labour rates per hour experienced for the month of April were:

<table>
<thead>
<tr>
<th>Labour Class</th>
<th>Actual Direct Labour Rate per Hour</th>
<th>Actual Direct Labour Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class III</td>
<td>$8.50</td>
<td>550</td>
</tr>
<tr>
<td>Class II</td>
<td>$7.50</td>
<td>650</td>
</tr>
<tr>
<td>Class I</td>
<td>$5.40</td>
<td>375</td>
</tr>
</tbody>
</table>

Required:

a. What is the total direct labour variance?
b. What is the direct labour rate variance?
c. What is the direct labour efficiency variance?
d. What is the direct labour yield variance? (round all standard prices to four decimal places)
e. What is the direct labour mix variance for April?
Problem 7

Boutin Glass Works' production budget for the year ended November 30, 2004, in Department C was based on 200,000 units. Each unit requires two standard hours of labour for completion. Total overhead was budgeted at $900,000 for the year and the fixed overhead rate was estimated to be $3 per unit. Both fixed and variable overhead are applied to the product on the basis of direct labour hours. The actual data for the year ended November 30, 2004, are:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual production in units</td>
<td>198,000</td>
</tr>
<tr>
<td>Actual direct labour hours</td>
<td>440,000</td>
</tr>
<tr>
<td>Actual variable overhead</td>
<td>$352,000</td>
</tr>
<tr>
<td>Actual fixed overhead</td>
<td>$575,000</td>
</tr>
</tbody>
</table>

Required:

a. What were the standard hours allowed for actual production for the year ended November 30, 2004?
b. What was the VOH efficiency variance for the year?
c. What was the VOH spending variance for the year?
d. What was the FOH spending variance for the year?
e. What was the FOH applied to Boutin's production for the year?
f. What was the FOH production volume variance for the year?
Problem 8

Galaxy Company makes a product with the following per unit standard values:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$50</td>
</tr>
<tr>
<td>Direct materials</td>
<td>20</td>
</tr>
<tr>
<td>Direct labour</td>
<td>10</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>5</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td>10</td>
</tr>
<tr>
<td>Gross margin</td>
<td>$5</td>
</tr>
</tbody>
</table>

This product is produced at the rate of 60 units per machine hour. After 50 more machine hours, this production line will be shut down and set up to produce another product. Galaxy Company can sell all the product it can produce.

When the process is operating out of control, direct materials costs increase by $1 per unit. If the line is shut down to investigate whether it is in control, one hour of production time is lost and the out-of-pocket cost is $200. If the line has to be reset, another hour of production time is lost and another incremental cost of $400 is incurred.

The production supervisor has just observed a direct materials variance that causes her to believe there is a 60% chance that the process is in control.

Should the process be investigated?
Multiple Choice Question Solutions

1.  
   d  
   Standard average cost = \(\frac{(2)(10) + (3)(8)}{5}\) = $8.80  
   Yield variance = 8.80 x (1,200 - 1,150) = $440 U

2.  
   b  
   A: (.4 - .375) x 1,200 x $10 = 300 F  
   B: (.6 - .625) x 1,200 x $8 = 240 U  
   $60 F

3.  
   c  
   Direct material price variance = (standard price x quantity purchased) - actual cost of direct materials purchased  
   = ($1.80 x 160,000 kg) - $304,000  
   = $288,000 - $304,000  
   = $16,000 unfavourable.

4.  
   d  
   Direct material efficiency variance = (standard quantity allowed for actual output - actual quantity placed into production) x standard price  
   = [(8 kg x 19,000) - 142,500] x $1.80  
   = (152,000 - 142,500) x $1.80  
   = $17,100 favourable.

5.  
   c  
   Lower limit – $1.80 x 160,000 kg x 5% = $288,000 x 5% = $14,400. This is lower than $16,000; therefore, the lower limit is $14,400 unfavourable.  
   Upper limit – $1.80 x 160,000 kg x 7% = $288,000 x 7% = $20,160. This is higher than $20,000; therefore, the upper limit is $20,000 favourable.

6.  
   d  
   An unfavourable volume variance results when actual production volume is less than the expected (denominator) production volume. Fixed overhead is applied at the predetermined rate, but since production is less than estimated, less overhead is charged to production than anticipated, leaving some overhead unallocated. This can be viewed as the cost of idle capacity.

7.  
   c  
   Total flexible budget variance = $12,375 - 14,685 = $2,310 U  
   Rate variance = $2,310 U - 3,300 U = 990 F
   
   Using the rate variance formula:  
   $990 F = AH(2)  
   AH = $990 / 2 = 495 hours
   
   Actual hours per unit = 495 / 3,000 = .165
8. **d**  a is false since flexible budget variances do not arise because of differences between the static budget volume and the flexible budget volume.

   b is true since this is effectively the definition of the sales volume variance.

   c is true because differences between the actual and budgeted contribution margin arise because of flexible budget variances in revenues and costs.

9. **b**  \[(4,050 \times 80\%) + [(4,050 + 2,000) \times 20\%] = $4,450\]

10. **b**  \[(0 \times 80\%) + (13,000 \times 20\%) = $2,600\]
Problem 1

<table>
<thead>
<tr>
<th></th>
<th>Static Budget</th>
<th>Flexible Budget</th>
<th>Actual</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>12,000</td>
<td>10,000</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>$120,000</td>
<td>$100,000</td>
<td>$105,000</td>
<td>$5,000 F</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>36,000</td>
<td>30,000</td>
<td>30,500</td>
<td>500 U</td>
</tr>
<tr>
<td>Direct labour</td>
<td>24,000</td>
<td>20,000</td>
<td>19,500</td>
<td>500 F</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>12,000</td>
<td>10,000</td>
<td>11,000</td>
<td>1,000 U</td>
</tr>
<tr>
<td></td>
<td>72,000</td>
<td>60,000</td>
<td>61,000</td>
<td>1,000 U</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>48,000</td>
<td>40,000</td>
<td>44,000</td>
<td>4,000 F</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>50,000</td>
<td>50,000</td>
<td>51,000</td>
<td>1,000 U</td>
</tr>
<tr>
<td>Gross margin</td>
<td>($2,000)</td>
<td>($10,000)</td>
<td>($7,000)</td>
<td>$3,000 F</td>
</tr>
</tbody>
</table>

The sales volume variance is the difference between the static budget and flexible budget gross margins = $8,000 U

Using the formula: budgeted CM/unit x (actual sales volume - budgeted sales volume)
= $4 (12,000 - 10,000)
= $8,000 U

Problem 2

a) Actual direct labour hourly rate = 160,650 / 5,100 = $31.50
b) Standard direct labour hourly rate = 31.50 + (2,550 / 5,100) = $32
c) Standard direct labour hours allowed = 5,100 – (1,600 / 32) – 5,050
Problem 3

a. i. Direct materials purchase variance:
   \[
   \text{Direct materials purchase variance:} = (\text{AP} - \text{SP}) \times \text{AQ purchased}
   \]
   \[
   = \left(\frac{\$52,000}{4,000} - \$14\right) \times 4,000
   \]
   \[
   = (\$13 - \$14) \times 4,000
   \]
   \[
   = \$4,000 \text{ favourable}
   \]

Direct materials usage variance:
   \[
   \text{Direct materials usage variance:} = (\text{AQ used} - \text{SQ}) \times \text{SP}
   \]
   \[
   = (4,000 - 200) - (600 \times 6) \times \$14
   \]
   \[
   = (3,800 - 3,600) \times \$14
   \]
   \[
   = \$2,800 \text{ unfavourable}
   \]

ii. No, the contract should not be signed. Although the new supplier is offering the materials at only $13 per kilogram, the materials do not seem to hold up well in production as shown by the large unfavourable direct material usage variance.

b. i. Direct labour rate variance:
   \[
   \text{Direct labour rate variance:} = (\text{AR} - \text{SR}) \times \text{AH}
   \]
   \[
   = (\$21 - \$20) \times (65 \times 12)
   \]
   \[
   = \$1 \times 780
   \]
   \[
   = \$780 \text{ unfavourable}
   \]

Direct labour efficiency variance:
   \[
   \text{Direct labour efficiency variance:} = (\text{AH} - \text{SH}) \times \text{SR}
   \]
   \[
   = (65 \times 12 - 1.5 \times 600) \times \$20
   \]
   \[
   = (780 - 900) \times \$20
   \]
   \[
   = \$2,400 \text{ Favourable}
   \]

ii. Yes, the new labour mix should be continued. Although it increases the average hourly labour cost from $20 to $21, thereby causing a $780 unfavourable direct labour rate variance, this is more than offset by greater efficiency of labour time. Note the direct labour efficiency variance is $2,400 favourable, thus, the new labour mix reduces overall labour costs.
Problem 4

a. DL efficiency variance = SR (AH – SHA)
   \[ 4,000 \text{F} = \text{SR} (29,000 – 30,000) \]
   \[ \text{SR} = \frac{4,000}{1,000} = $4 \]

b. DL rate variance = AH (AR – SR)
   \[ $5,800 \text{F} = 29,000(\text{AR} – 4) \]
   \[ \text{AR} = $4 – \frac{5,800}{29,000} \]
   \[ \text{AR} = $4 – .20 \]
   \[ = $3.80 \]

Problem 5

a. DM price variance = AQP (AR – SR)
   \[ = 160,000 ($1.90 – 1.80) \]
   \[ = $16,000 \text{U} \]

b. DM usage variance = SP (AQU – SQA)
   \[ = $1.80 [142,500 – (19,000 \times 8 \text{kg})] \]
   \[ = $1.80 (142,500 – 152,000) \]
   \[ = $17,100 \text{F} \]

c. DL rate variance = AH (AR – SR)
   \[ = 5,000 (7.56^\ast - 8) \]
   \[ = $2,200 \text{F} \]
   \[ ^\ast \frac{$42,000 \times 90\%}{5,000 \text{ hours}} \]

d. DL efficiency variance = SR (AH – SHA)
   \[ = $8 [5,000 – (.25 \times 19,000)] \]
   \[ = $8 (5,000 – 4,750) \]
   \[ = $2,000 \text{U} \]
Problem 6

a. Actual direct labour cost
   \((550 \times 8.50) + (650 \times 7.50) + (375 \times 5.40)\) $11,575

   Standard direct labour cost
   1,500 hours $6.66667
   \(1\,000\) Variance $1,575 \text{ U}

b.  \(\text{AH} (\text{AR} – \text{SR})\)
   Class III $550 (8.50 – 8) $275 \text{ U}
   Class II $650 (7.50 – 7) 325 \text{ U}
   Class I $375 (5.40 – 5) 150 \text{ U}
   \(\text{Total} \) $750 \text{ U}

c.  \(\text{SR} (\text{AH} – \text{SHA})\)
   Class III $8 (550 – 500) $400 \text{ U}
   Class II $7 (650 – 500) 1,050 \text{ U}
   Class I $5 (375 – 500) 625 \text{ F}
   \(\text{Total} \) $825 \text{ U}

d.  (Total AH - total SHA) average standard rate
   \((1,575 – 1,500) \times 6.66667\) $500 \text{ U}

e.  \((\text{A Mix\%} - \text{B Mix \%}) \times \text{AH} \times \text{bud. rate}\)
   Class III (.34921 – .33333) 1,575 \times 8 200 \text{ U}
   Class II (.41279 – .33333) 1,575 \times 7 876 \text{ U}
   Class I (.23810 – .33333) 1,575 \times 5 750 \text{ F}
   \(\text{Total} \) $326 \text{ U}
Problem 7

a. 198,000 units x 2 hours = 396,000 hours

b. VOH efficiency variance = SR (AH – SHA)
   = $.75* (440,000 – 396,000)
   = $33,000 U

   * Total variable overhead = $900,000 – (200,000 x $3 fixed component)
     = $900,000 – 600,000 FOH
     = $300,000
     Variable overhead rate at standard = $300,000 / (200,000 x 2) = $.75

c. VOH spending variance = AH (AR – SR)
   = 440,000 (.80* -.75)
   = $22,000 U

   * $352,000 actual variable overhead / 440,000 actual direct labour hours

d. FOH budget variance = actual FOH - budgeted FOH
   = $575,000 - $600,000
   = $25,000 F

e. Applied FOH = 198,000 x $3 = $594,000

f. FOH volume variance = budgeted FOH - applied FOH
   = $600,000 – 594,000
   = $6,000 U
Problem 8

<table>
<thead>
<tr>
<th>Process out of control p = .40</th>
<th>Process in control p = .60</th>
<th>Expected Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigate</td>
<td>$2,400*</td>
<td>$1,100**</td>
</tr>
<tr>
<td>Do not investigate</td>
<td>$3,000***</td>
<td>$0</td>
</tr>
</tbody>
</table>

Do not investigate.

Number of units = 50 hours x 60 units per hour = 3,000

* $200 + $400 + (120 units x $15 CM/unit)
** $200 + (60 units x $15 CM/Unit) = $1,100
*** 3,000 units x $1
18. Revenue Variances

Learning Objectives
After completing this chapter, you will understand, be able to compute and interpret the following variances relating to the sales volume variance:

- Sales mix variance
- Sales quantity variance
- Market share variance
- Market size variance

The Sales Related Variances
Recall from our discussion in Chapter 17 that actual financial results are reconciled to the static budget using the flexible budget to calibrate for differences in volume between actual results and volume used in the static budget.

Chapter 17 looked at cost variances. In this chapter, we focus on revenue and price variances.

There are two revenue and price variances isolated in the reconciliation between the actual results and the static budget. Comparing the actual results and the flexible budget isolates the price variance, which is computed as follows:

\[
\text{Flexible budget price variance} = (\text{actual price} - \text{standard price}) \times \text{actual sales volume}
\]

All the other flexible budget variances relate to the cost variances discussed in Chapter 17.

The formula for computing the sales volume variance is:

\[
\text{Sales volume variance} = (\text{actual sales} - \text{static budget sales}) \times \text{standard contribution margin per unit}
\]

In comparing the static budget and the flexible budget, all the variances are summarized by the sales volume variance. In this chapter, we will partition the sales volume variance into its four components

1. Sales mix variance
2. Sales quantity variance, which can be further broken down into:
   a. Market share variance
   b. Market size variance

The following diagram summarizes this partition and the balance of the discussion for the remainder of this chapter.
Chapter example:

Foster Company sells three products. Data for the three products during the most recent period were:

<table>
<thead>
<tr>
<th>Product</th>
<th>Budgeted CM Per unit</th>
<th>Budgeted Sales Volume</th>
<th>Actual Sales Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$50</td>
<td>5,000</td>
<td>3,000</td>
</tr>
<tr>
<td>B</td>
<td>25</td>
<td>2,000</td>
<td>6,000</td>
</tr>
<tr>
<td>C</td>
<td>35</td>
<td>3,000</td>
<td>2,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10,000</td>
<td>11,000</td>
</tr>
</tbody>
</table>
Sales Volume Variance

The sales volume variance is the difference between the static budget contribution margin and the flexible budget contribution margin in Foster Company.

The static budget total CM = (5,000 x $50) + (2,000 x $25) + (3,000 x $35) = $405,000

The flexible budget total CM = (3,000 x $50) + (6,000 x $25) + (2,000 x $35) = $370,000

The sales variance equals $35,000 ($370,000 – 405,000) unfavourable since the flexible budget contribution margin is less than the static budget contribution margin.

Alternatively, the sales volume variance can be calculated using the following formula:

\[ \text{Budgeted CM/unit x (actual sales volume - budgeted sales volume)} \]

<table>
<thead>
<tr>
<th>Product</th>
<th>Budgeted CM Per unit</th>
<th>Budgeted Sales Volume</th>
<th>Actual Sales Volume</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$50</td>
<td>5,000</td>
<td>3,000</td>
<td>$100,000 U</td>
</tr>
<tr>
<td>B</td>
<td>25</td>
<td>2,000</td>
<td>6,000</td>
<td>100,000 F</td>
</tr>
<tr>
<td>C</td>
<td>35</td>
<td>3,000</td>
<td>2,000</td>
<td>35,000 U</td>
</tr>
</tbody>
</table>

Sales Quantity Variance

The formula for computing the sales quantity variance is:

\[ \text{Sales quantity variance} = (\text{actual sales volume} - \text{budgeted sales volume}) \times \text{budgeted average contribution per unit} \]

In this case:

\[ \text{Sales quantity variance} = (11,000 – 10,000) \times 40.50 = $40,500 \text{ favourable} \]
Sales Mix Variance

The formula for computing the sales mix variance is:

\[
\text{Sales mix variance (for each product)} = (\text{actual mix \%} - \text{budgeted mix \%}) \times \text{actual total sales volume} \times \text{budgeted contribution margin per unit}
\]

Product A: (.2727 - .5000) * 11,000 * 50 = $125,000 unfavourable
Product B: (.5455 - .2000) * 11,000 * 25 = $95,000 favourable
Product C: (.1818 - .3000) * 11,000 * 35 = $45,500 unfavourable

Total mix variance = $75,500 unfavourable

Total sales quantity + sales mix variance =

\[\$40,500 \text{ favourable} + \$75,500 \text{ unfavourable} = \$35,000 \text{ unfavourable}\]

Note that while the total sales increased, the budgeted contribution margin fell because Product B, the lowest contribution margin product, comprised a much larger portion of the sales mix than planned. Therefore, the sales quantity variance holds the mix constant and looks at how the budgeted contribution margin should change given the volume difference between the static budget and the flexible budget. The mix variance looks at the effect of the mix change between the static budget and the flexible budget, given the achieved level of sales.

Market Size Variance

The market size variance looks at the effect on budgeted contribution margin caused by increases in market size. The market size variance computes the effect on organization sales as the total market volume changes, assuming the organization maintains its share of the total market.

The formula for the market size variance is:

\[
\text{Budgeted market share \%} \times (\text{actual industry sales volume} - \text{budgeted industry sales volume}) \times \text{budgeted average CM per unit}
\]

Returning to Foster Company, assume the estimated total market size underlying the static budget was 1,000,000 units and the actual total market volume was 1,200,000 units. The budgeted market share percentage was 1\% (10,000 / 1,000,000). Therefore, the market size variance in this case would be:

\[\text{Market size variance} = 1\% \times (1,200,000 - 1,000,000) \times \$40.50 = \$81,000 \text{ favourable}\]
This means if Foster Company maintained its share of the total market and achieved its target mix, the flexible budget contribution margin would be $81,000 higher than the static budget contribution margin.

Market Share Variance

The market share variance looks at the effect, given the actual industry level of sales, of differences between the actual and budgeted market share. The formula for the market share variance is:

\[
\text{Market share variance} = (\text{actual market share } \% - \text{budgeted market share } \%) \\
\times \text{actual industry sales volume in units} \\
\times \text{budgeted average contribution margin per unit}
\]

Note that the actual market share percentage was .917% (11,000 / 1,200,000). Therefore, for Foster Company the market share variance is:

\[
\text{Market share variance} = (.00917 – .01) \times 1,200,000 \times 40.50 = $40,500 \text{ unfavourable}
\]

This means because Foster Company failed to maintain its 10% market share of the actual total market sales, it lost $40,500 in total contribution margin.

Note that the total of the market size variance and the market share variance is $40,500 favourable ($81,000 favourable minus $40,500 unfavourable), which, as required, equals the sales quantity variance.

----------

Although accountants have traditionally focused on identifying and reporting on cost variances, the monitoring and evaluation of revenue variances can be equally important in promoting effective performance. This chapter has focused on the standard contribution margin losses or gains that arise when actual volumes differ from static budget volumes. These variances reflect the gains or losses resulting from market opportunities and the performance of the organization’s sales force.

As a summary of Chapters 17 and 18, it is important to note the different roles and purposes of the static budget, the flexible budget and the actual results.

The static budget has two major roles. First, it summarizes the expected financial consequences of management’s planned operations for the upcoming period. The Board approves the static budget and it provides a basis of accountability between senior management and the Board. Second, once approved by the Board, senior management conveys the financial implications of the static budget to the market in some form, for example, sales, profit or earnings per share.
projections. This sets market expectations about the organization’s financial performance and can affect the share price of a publicly traded organization.

At the end of the period covered by the static budget, the flexible budget is prepared. Senior management is held accountable by the Board for differences between the static budget it approved and the actual results.

As we have seen in the past two chapters, the reconciliation between the static budget and the actual results will use, explicitly or implicitly, the flexible budget. Remember, since fixed costs do not change as we move from the static budget to the flexible, all changes between the two are driven by volume effects. Therefore, discussion of unexpected strategic (market) conditions will underlie the reconciliation of the static budget to the flexible budget and is usually done at a high level of aggregation.

Discussion of operating conditions will reflect price and efficiency issues. With outsiders, reconciliation between flexible budget and the actual results will be done at an aggregate level. For example, the organization might note unexpectedly high prices for raw materials or fuel prices.

Senior management will discuss in detail significant flexible budget variances with middle and lower management who will be held accountable for any variances deemed to be material. This reconciliation between the actual results and the flexible budget amounts, as we have seen in Chapter 17, provides a detailed basis for accountability in operations.
Appendix – Revenue Variance Formulas

Sales price variance = actual quantity x (actual sales price - budgeted sales price)

Sales volume variance = sales quantity + sales mix variances
   (actual sales volume - budgeted sales volume)
   x budgeted individual product contribution margin per unit

Sales quantity variance = market size + market share variances
   (actual sales volume - budgeted sales volume)
   x budgeted average contribution margin per unit

Sales mix variance:
   { (actual sales mix % - budgeted sales mix %) x actual total sales volume }
   x (budgeted individual CM per unit - budgeted average CM per unit)
   or (actual mix % - budgeted mix %) x actual total sales volume x budgeted CM/unit

Market size variance:
   Budgeted market share %
   x (actual industry sales volume - budgeted industry sales volume)
   x budgeted average CM per unit

Market share variance:
   (actual market share % - budgeted market share %)
   x actual industry sales volume in units
   x budgeted average CM per unit
Problems with Solutions

Multiple Choice Questions

The following information pertains to Questions 1 – 2:

Given for Irvington Enterprises Inc.:

| Budgeted industry volume in units | 5,500,000 |
| Actual industry volume in units   | 5,600,000 |
| Budgeted market share percentage  | 16%       |
| Actual market share percentage    | 15%       |
| Budgeted average unit contribution margin | $2 |

1. What is the market size variance?
   a) $112,000 F
   b) $112,000 U
   c) $32,000 F
   d) $32,000 U

2. What is the market share variance?
   a) $112,000 F
   b) $112,000 U
   c) $32,000 F
   d) $32,000 U
The following information pertains to 3 – ():

Acme Beds Inc. produces two models of beds: regular and majestic. Budget and actual data for 2002 were:

<table>
<thead>
<tr>
<th></th>
<th>2002 Budget</th>
<th></th>
<th>2002 Actual</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regular</td>
<td>Majestic</td>
<td>Regular</td>
<td>Majestic</td>
</tr>
<tr>
<td>Selling price per unit</td>
<td>$300</td>
<td>$800</td>
<td>$325</td>
<td>$700</td>
</tr>
<tr>
<td>Sales volume in units</td>
<td>4,500</td>
<td>5,500</td>
<td>7,200</td>
<td>4,800</td>
</tr>
<tr>
<td>Variable costs per unit</td>
<td>$220</td>
<td>$590</td>
<td>$238</td>
<td>$583</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Master Budget</th>
<th></th>
<th>Actual</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$5,750,000</td>
<td>$5,700,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable costs</td>
<td>4,235,000</td>
<td>4,512,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution margin</td>
<td>1,515,000</td>
<td>1,188,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed costs</td>
<td>882,500</td>
<td>919,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating income</td>
<td>$ 632,500</td>
<td>$ 268,500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Market data for 2002:
- Expected total sales of beds: 500,000 beds
- Actual total market sales of beds: 666,667 beds

3. The sales price variance is:
   a) $437,500 U
   b) $300,000 U
   c) $50,000 U
   d) $660,000 U
   e) $69,000 F

4. The sales volume (activity) variance is:
   a) $300,000 U
   b) $250,000 F
   c) $153,000 F
   d) $69,000 F
   e) $234,000 U
5. The sales mix variance is:
   a) $303,000 F
   b) $54,000 U
   c) $202,000 U
   d) $207,000 F
   e) $234,000 U

6. The sales quantity variance is:
   a) $303,000 F
   b) $54,000 U
   c) $202,000 U
   d) $207,000 F
   e) $234,000 U

7. The market share variance is:
   a) $303,000 F
   b) $505,000 F
   c) $202,000 U
   d) $151,500 U
   e) $132,000 U

8. The market size variance is:
   a) $303,000 F
   b) $505,000 F
   c) $202,000 U
   d) $454,500 F
   e) $330,000 F

9. The lower than budgeted 2002 operating income for Acme beds was partially a result of:
   a) Selling less of the model with the higher contribution margin
   b) Decreased average contribution margin
   c) Increased average variable costs
   d) Both b and c
   e) Both a and b
Problem 1

Harry's Inc. produces and sells two lines of jackets: nylon and leather. The market for nylon jackets is large and competitive, but the leather jacket market has traditionally been small, with only a few competing manufacturers.

The operating budget for Harry's for the year 2007 was:

<table>
<thead>
<tr>
<th></th>
<th>Nylon Jackets</th>
<th>Leather Jackets</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume</td>
<td>95,000</td>
<td>5,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$3,325,000</td>
<td>$750,000</td>
<td>$4,075,000</td>
</tr>
<tr>
<td>Total variable costs</td>
<td>2,161,250</td>
<td>517,500</td>
<td>2,678,750</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$1,163,750</td>
<td>$232,500</td>
<td>$1,396,250</td>
</tr>
</tbody>
</table>

The actual results for the year 2007 are:

<table>
<thead>
<tr>
<th></th>
<th>Nylon Jackets</th>
<th>Leather Jackets</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume</td>
<td>93,500</td>
<td>16,500</td>
<td>110,000</td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$3,366,000</td>
<td>$2,442,000</td>
<td>$5,808,000</td>
</tr>
<tr>
<td>Total variable costs</td>
<td>2,127,125</td>
<td>1,707,750</td>
<td>3,834,875</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$1,238,875</td>
<td>$734,250</td>
<td>$1,973,125</td>
</tr>
</tbody>
</table>

Additional information:

<table>
<thead>
<tr>
<th></th>
<th>Nylon Jackets</th>
<th>Leather Jackets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market size (units):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007 budget</td>
<td>475,000</td>
<td>12,500</td>
</tr>
<tr>
<td>2007 actual</td>
<td>425,000</td>
<td>125,000</td>
</tr>
</tbody>
</table>

Required:

Calculate all relevant revenue variances and comment on the performance of the marketing department.
Problem 2

Despite years of ineptitude, the Hogtown Bashers hockey club continues to attract large crowds. The following are the results relating to the home games during the most recent season:

<table>
<thead>
<tr>
<th>Seats</th>
<th>Average per game</th>
<th>Contribution Margin Per Ticket</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Budget</td>
<td>Actual</td>
</tr>
<tr>
<td>Blue</td>
<td>8,000</td>
<td>11,000</td>
</tr>
<tr>
<td>Red</td>
<td>6,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Gold</td>
<td>4,000</td>
<td>4,000</td>
</tr>
</tbody>
</table>

There are 40 home games per season. Management was quite pleased that total average attendance equalled the budget amount despite another dismal season.

Required:

Show by computing all relevant sales variances whether management’s conclusion was justified. You can assume actual contribution margins per ticket equalled the standard contribution margin per ticket.

Problem 3

Media Company produces two types of memory chips, regular and deluxe. The following information was reported for the most recent period.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Static budget contribution margin</td>
<td>$2,080,000</td>
</tr>
<tr>
<td>Budgeted total media unit sales</td>
<td>200,000</td>
</tr>
<tr>
<td>Budgeted contribution margin per unit of regular</td>
<td>$8 per unit</td>
</tr>
<tr>
<td>Budgeted contribution margin per unit of deluxe</td>
<td>$14 per unit</td>
</tr>
<tr>
<td>Total sales – quantity variance</td>
<td>$208,000 unfavourable</td>
</tr>
<tr>
<td>Actual sales – mix percentage of regular</td>
<td>2/3</td>
</tr>
</tbody>
</table>

Required:

a) Compute the individual product and total sales volume variances.
b) Compute the sales quantity variance for each product.
c) Compute the individual product and total sales mix variances.
Problem 4

Following are the static budget planned and actual sales for the three products produced by Best Company:

<table>
<thead>
<tr>
<th>Product</th>
<th>Contribution Margin</th>
<th>Actual Units</th>
<th>Static Budget Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>$3.00</td>
<td>250,000</td>
<td>450,000</td>
</tr>
<tr>
<td>Beta</td>
<td>$4.50</td>
<td>250,000</td>
<td>325,000</td>
</tr>
<tr>
<td>Gamma</td>
<td>$6.25</td>
<td>450,000</td>
<td>225,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>950,000</td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

Required:

a) Compute the individual product and total sales volume variances.
b) Compute the sales quantity variance for each product.
c) Compute the individual product and total sales mix variances.
d) The budgeted sales for Best Company were based on estimated total market sales of 20,000,000 units. Total actual market sales were 18,000,000. Compute the market share and market size variances for Best Company.
Problem 5 – Comprehensive Variance Analysis Problem

Mark Ferguson, the president of Ferguson Foundry Limited (FFL), sat in his office early on June 2, 2005, reviewing the financial statements of FFL for the fiscal year ended May 31, 2005. The results for the year were both a shock and a disappointment.

Mr. Ferguson had called Carl Holitzner, CMA, an independent consultant, to meet him in his office. When Carl arrived, Mr. Ferguson described his concerns.

"I don't know what went wrong last year. Everybody kept telling me that we were selling more woodstoves than we thought we would and I knew from attending the trade shows the sales of woodstoves throughout the province were rising. When I saw the statements for last year, I couldn't believe the drop in profits.

"This company began in 1905. My grandfather used to make farm implements and sled runners, my father produced mostly trailers. I've dabbled in a few product lines like sewer grates and staircase railings, but, for the past five years, we've concentrated solely on woodstoves. Sales were slow at first and there were many producers in the market. But we have a good sales force and things have been steadily improving for the past two years. In 2004, we achieved record profits.

"In addition to profits dropping, we have lost our management team. The sales manager took early retirement last month, the production manager is in the hospital for major surgery and the accountant quit after we discussed the kind of information I felt he should be providing. He kept telling me that everything was running smoothly. Boy, was he wrong!

"I called you here this morning because I need some help in understanding what went wrong last year. I want to be sure similar mistakes are not made in the future. I'll be hiring some new people, but I need some answers quickly. The following is the statement of budgeted and actual results (Exhibit 1). I was also able to dig up a statement of standard costs (Exhibit 2) that was prepared last year plus some market and job cost data, which the accountant had prepared before he left (Exhibit 3). The standard costs are an accurate reflection of what it should cost to make either of the woodstove models."

Required:

Assume the role of Carl Holitzner and provide an explanation for FFL's lower than budgeted profit for the fiscal year ended May 31, 2005. Support your explanation with a detailed variance analysis.
Exhibit 1
Ferguson Foundry Limited
Static Budget and Actual Results
for the year ended May 31, 2005

Static Budget

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Deluxe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume (in units)</td>
<td>4,500</td>
<td>5,500</td>
<td>10,000</td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$1,350,000</td>
<td>$4,400,000</td>
<td>$5,750,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>315,000</td>
<td>1,045,000</td>
<td>1,360,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>405,000</td>
<td>1,320,000</td>
<td>1,725,000</td>
</tr>
<tr>
<td>Overhead</td>
<td>202,500</td>
<td>660,000</td>
<td>862,500</td>
</tr>
<tr>
<td>Selling and administration</td>
<td>67,500</td>
<td>220,000</td>
<td>287,500</td>
</tr>
<tr>
<td></td>
<td>990,000</td>
<td>3,245,000</td>
<td>4,235,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$360,000</td>
<td>$1,155,000</td>
<td>1,515,000</td>
</tr>
<tr>
<td>Fixed costs:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td>750,000</td>
<td></td>
</tr>
<tr>
<td>Selling and administration</td>
<td>132,500</td>
<td></td>
<td>882,500</td>
</tr>
<tr>
<td>Operating income</td>
<td></td>
<td></td>
<td>$632,500</td>
</tr>
</tbody>
</table>

Actual Results

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Deluxe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume (in units)</td>
<td>7,200</td>
<td>4,800</td>
<td>12,000</td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$2,340,000</td>
<td>$3,360,000</td>
<td>$5,700,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>860,000</td>
<td>820,800</td>
<td>1,360,800</td>
</tr>
<tr>
<td>Direct labour</td>
<td>748,800</td>
<td>1,190,400</td>
<td>1,939,200</td>
</tr>
<tr>
<td>Overhead</td>
<td>374,400</td>
<td>595,200</td>
<td>969,600</td>
</tr>
<tr>
<td>Selling and administration</td>
<td>108,000</td>
<td>192,000</td>
<td>300,000</td>
</tr>
<tr>
<td></td>
<td>1,717,200</td>
<td>2,798,400</td>
<td>4,515,600</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$622,800</td>
<td>$ 561,600</td>
<td>1,184,400</td>
</tr>
<tr>
<td>Fixed costs:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
<td>780,000</td>
</tr>
<tr>
<td>Selling and administration</td>
<td>139,500</td>
<td></td>
<td>919,500</td>
</tr>
<tr>
<td>Operating income</td>
<td></td>
<td></td>
<td>$264,900</td>
</tr>
</tbody>
</table>
Exhibit 2
Ferguson Foundry Limited
Unit Cost Standards
for the year ended May 31, 2005

<table>
<thead>
<tr>
<th></th>
<th>Basic Woodstove</th>
<th>Deluxe Woodstove</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct materials:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard quantity per unit</td>
<td>70 kg</td>
<td>190 kg</td>
</tr>
<tr>
<td>Standard price per kilogram</td>
<td>$1</td>
<td>$1</td>
</tr>
<tr>
<td><strong>Direct labour:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard quantity per unit</td>
<td>6 hrs.</td>
<td>16 hrs.</td>
</tr>
<tr>
<td>Standard rate per hour</td>
<td>$15</td>
<td>$15</td>
</tr>
<tr>
<td><strong>Variable overhead:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard quantity per unit</td>
<td>6 hrs.</td>
<td>16 hrs.</td>
</tr>
<tr>
<td>Standard rate per hour</td>
<td>$7.50</td>
<td>$7.50</td>
</tr>
<tr>
<td><strong>Variable selling and administrative rate per unit</strong></td>
<td>$15</td>
<td>$40</td>
</tr>
</tbody>
</table>

Exhibit 3
Ferguson Foundry Limited
Market and Job-Cost Data
for the year ended May 31, 2005

**Market data:**
- Expected total market sales of woodstoves: 100,000 units
- Actual total market sales of woodstoves: 133,333 units

**Summary of job cost sheets:**

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Deluxe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units of woodstoves produced</td>
<td>7,200</td>
<td>4,800</td>
<td>12,000</td>
</tr>
<tr>
<td>Direct materials:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual quantity used in kilograms</td>
<td>540,000</td>
<td>912,000</td>
<td>1,452,000</td>
</tr>
<tr>
<td>Actual price per kilogram</td>
<td></td>
<td></td>
<td>$.90</td>
</tr>
<tr>
<td>Direct labour:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual direct labour hours worked</td>
<td>46,800</td>
<td>74,400</td>
<td>121,200</td>
</tr>
<tr>
<td>Actual rate per hour</td>
<td></td>
<td></td>
<td>$16.00</td>
</tr>
<tr>
<td>Actual variable overhead allocated on the basis of direct labour hours</td>
<td>$374,400</td>
<td>$595,200</td>
<td>$969,600</td>
</tr>
</tbody>
</table>
Multiple Choice Question Solutions

1. c \[0.16(5,600,000 - 5,500,000) \times \$2 = \$32,000\]

2. b \[(0.15 - 0.16) \times 5,600,000 \times \$2 = \$112,000\]

3. b Sales price variance = actual SV x (ASP - BSP)
   R: 7,200 (325 - 300) = $180,000 F
   M: 4,800 (700 - 800) = $480,000 U
   Total = $300,000 U

4. d Sales volume variance = (ASV - BSV) x budgeted CM/Unit
   R: (7,200 - 4,500) x $80 = $216,000 F
   M: (4,800 - 5,500) x $210 = $147,000 U
   = $69,000 F

5. e (Act mix % - budgeted mix %) x act tot SV x budgeted CM
   R: (.6 - .45) x 12,000 x $80 = $144,000 F
   M: (.4 - .55) x 12,000 x $210 = $378,000 U
   = $234,000 U

6. a (Act total SV - budgeted tot SV) x budgeted average CM
   (12,000 - 10,000) x 151.50 = $303,000 F

7. c (Act MS % - budgeted MS %) x act ind SV x budgeted average CM
   (.018 - .020) x 666,667 x $151.50 = $202,000 U

8. b Budgeted MS% x (act ind SV - budgeted ind SV) x budgeted average CM
   .02 x (666,667 - 500,000) x 151.50 = $505,000 F

9. e
Problem 1

Sales price variance:

<table>
<thead>
<tr>
<th></th>
<th>Actual Sales</th>
<th>Budgeted Sales</th>
<th>Actual Sales</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume</td>
<td>Price/Unit</td>
<td>Price/Unit</td>
<td></td>
</tr>
<tr>
<td>Nylon</td>
<td>93,500</td>
<td>$35</td>
<td>$36</td>
<td>$93,500 F</td>
</tr>
<tr>
<td>Leather</td>
<td>16,500</td>
<td>150</td>
<td>148</td>
<td>33,000 U</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$60,500 F</td>
</tr>
</tbody>
</table>

Sales volume variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted Sales</th>
<th>Actual Sales</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CM/Unit</td>
<td>Volume</td>
<td>Volume</td>
</tr>
<tr>
<td>Nylon</td>
<td>$12.25</td>
<td>95,000</td>
<td>93,500</td>
</tr>
<tr>
<td>Leather</td>
<td>46.50</td>
<td>5,000</td>
<td>16,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sales quantity variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted Total Sales</th>
<th>Actual Total Sales</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average CM/Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$13.9625</td>
<td>100,000</td>
<td>110,000</td>
</tr>
</tbody>
</table>

Sales mix variance:

<table>
<thead>
<tr>
<th></th>
<th>Actual Total Sales</th>
<th>Bud CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mix %</td>
<td>Mix %</td>
<td></td>
</tr>
<tr>
<td>Nylon</td>
<td>.85</td>
<td>.95</td>
<td>110,000</td>
</tr>
<tr>
<td>Leather</td>
<td>.15</td>
<td>.05</td>
<td>110,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Market size variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted Market Share %</th>
<th>Actual Total Industry Sales</th>
<th>Budgeted Total Industry Sales</th>
<th>Budgeted Average CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Volume</td>
<td>Volume</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>.20</td>
<td>425,000</td>
<td>475,000</td>
<td>13.9625</td>
<td>$139,625.00  U</td>
</tr>
<tr>
<td>L</td>
<td>.40</td>
<td>125,000</td>
<td>12,500</td>
<td>13.9625</td>
<td>628,312.50   F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$488,687.50  F</td>
</tr>
</tbody>
</table>

### Market share variance:

<table>
<thead>
<tr>
<th></th>
<th>Actual Total Industry Sales</th>
<th>Budgeted Market Share %</th>
<th>Actual Market Share %</th>
<th>Budgeted Average CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>425,000</td>
<td>.20</td>
<td>.22</td>
<td>13.9625</td>
<td>$118,681.25  F</td>
</tr>
<tr>
<td>L</td>
<td>125,000</td>
<td>.40</td>
<td>.132</td>
<td>13.9625</td>
<td>467,743.75   U</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$349,062.50  U</td>
</tr>
</tbody>
</table>

The difference between the budgeted and actual contribution margins can be summarized by the following variances (actual variable costs behaved as budgeted):

- Sales price variance: $60,500 F
- Sales mix variance: $376,750 F
- Market size variance: $488,687 F
- Market share variance: $349,063 U

The marketing department should be held accountable for the sales price, sales mix and market share variances. The sum of these variances total only $78,187 F. Although the marketing department managed to increase CM by changes to the sales price and shifting the mix to leather jackets, they were unable to keep their planned market share of the leather jackets.
Problem 2

Sales volume variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted CM/Unit</th>
<th>Budgeted Sales Volume</th>
<th>Actual Sales Volume</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>$40</td>
<td>8,000</td>
<td>11,000</td>
<td>$120,000 F</td>
</tr>
<tr>
<td>Red</td>
<td>$70</td>
<td>6,000</td>
<td>3,000</td>
<td>210,000 U</td>
</tr>
<tr>
<td>Gold</td>
<td>$100</td>
<td>4,000</td>
<td>4,000</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 90,000 U</td>
</tr>
</tbody>
</table>

Sales quantity variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted Average CM/Unit</th>
<th>Budgeted Total Sales</th>
<th>Actual Total Sales</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$63.333</td>
<td>18,000</td>
<td>18,000</td>
<td>0</td>
</tr>
</tbody>
</table>

* $(8,000 \times $40) + (6,000 \times $70) + (4,000 \times $100) / (8,000 + 6,000 + 4,000) 
= $1,140,000 / 18,000 
= $63.333

Sales Mix Variance

<table>
<thead>
<tr>
<th></th>
<th>Actual Mix %</th>
<th>Budget Mix %</th>
<th>Actual Total Sales</th>
<th>Bud CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>.4444</td>
<td>.6111</td>
<td>18,000</td>
<td>$40</td>
<td>$120,000 F</td>
</tr>
<tr>
<td>Red</td>
<td>.3333</td>
<td>.1667</td>
<td>18,000</td>
<td>$70</td>
<td>210,000 U</td>
</tr>
<tr>
<td>Gold</td>
<td>.2222</td>
<td>.2222</td>
<td>18,000</td>
<td>$100</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$90,000 U</td>
</tr>
</tbody>
</table>

No, he should not be pleased. As shown above, although the sales quantity variance is zero (since the total sales quantity budget was achieved), there was a significant shift from the higher contribution margin red seats to the lower contribution margin blue seats. This resulted in total sales mix variance of $90,000 unfavourable comprised of blue favourable of $120,000 and red unfavourable $210,000.
Problem 3

Let \( x \) be the number of regular units sold and \( y \) be the number of deluxe units sold.

We have \( x + y = 200,000 \) (1) and \( 8x + 14y = 2,080,000 \) (2).

If we multiply the first equation by 8, we get: \( 8x + 8y = 1,600,000 \) (1a)

Subtracting equation (1a) from (2), we get:

\[
8x + 14y = 2,080,000 \\
- \quad 8x + 8y = 1,600,000 \\
\]

\( 6y = 480,000 \)

\( y = 80,000 \)

\( x = 120,000 \)

Sales volume variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted CM/Unit</th>
<th>Budgeted Sales Volume</th>
<th>Actual Sales Volume</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular</td>
<td>8</td>
<td>120,000</td>
<td>120,000</td>
<td>-</td>
</tr>
<tr>
<td>Deluxe</td>
<td>14</td>
<td>80,000</td>
<td>60,000</td>
<td>280,000 U</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$280,000 U</td>
</tr>
</tbody>
</table>

Sales quantity variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted Average CM/Unit</th>
<th>Budgeted Total Sales</th>
<th>Actual Total Sales</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$10.40</td>
<td>200,000</td>
<td>180,000</td>
<td>$208,000 U</td>
</tr>
</tbody>
</table>

* \((120,000 \times $8) + (80,000 \times $14) / 200,000 = $10.40\)*

Sales mix variance:

<table>
<thead>
<tr>
<th></th>
<th>Actual Mix %</th>
<th>Bud Mix %</th>
<th>Actual Total Sales</th>
<th>Bud CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>.6667</td>
<td>.60</td>
<td>180,000</td>
<td>$8</td>
<td>$96,000 F</td>
</tr>
<tr>
<td>D</td>
<td>.3333</td>
<td>.40</td>
<td>180,000</td>
<td>14</td>
<td>168,000 U</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$72,000 U</td>
</tr>
</tbody>
</table>


Problem 4

Sales volume variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted CM/Unit</th>
<th>Budgeted Sales Volume</th>
<th>Actual Sales Volume</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>$3.00</td>
<td>450,000</td>
<td>250,000</td>
<td>$600,000 U</td>
</tr>
<tr>
<td>Beta</td>
<td>4.50</td>
<td>325,000</td>
<td>250,000</td>
<td>337,500 U</td>
</tr>
<tr>
<td>Gamma</td>
<td>6.25</td>
<td>225,000</td>
<td>450,000</td>
<td>1,406 250 F</td>
</tr>
</tbody>
</table>

$468,750 F

Sales quantity variance:

<table>
<thead>
<tr>
<th></th>
<th>Budgeted Average CM/Unit</th>
<th>Budgeted Total Sales</th>
<th>Actual Total Sales</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$4.21875</td>
<td>1,000,000</td>
<td>950,000</td>
<td>$210,938 U</td>
</tr>
</tbody>
</table>

* (450,000 x $3) + (325,000 x $4.50) + (225,000 x $6.25) / 1,000,000 = 4.21875

Sales mix variance:

<table>
<thead>
<tr>
<th></th>
<th>Actual Mix %</th>
<th>Bud Mix %</th>
<th>Actual Total Sales</th>
<th>Bud Total Sales CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>.2632</td>
<td>.450</td>
<td>950,000</td>
<td>$3.00</td>
<td>$532,500 U</td>
</tr>
<tr>
<td>B</td>
<td>.2632</td>
<td>.325</td>
<td>950,000</td>
<td>4.50</td>
<td>264,375 U</td>
</tr>
<tr>
<td>G</td>
<td>.4736</td>
<td>.225</td>
<td>950,000</td>
<td>6.25</td>
<td>1,476,563 F</td>
</tr>
</tbody>
</table>

$679,688 F
Market size variance:

<table>
<thead>
<tr>
<th>Budgeted Market Share %</th>
<th>Actual Total Industry Sales Volume</th>
<th>Budgeted Total Industry Sales Volume</th>
<th>Budgeted Average CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>.05</td>
<td>18,000,000</td>
<td>20,000,000</td>
<td>$4.21875</td>
<td>$421,875 U</td>
</tr>
</tbody>
</table>

Market share variance:

<table>
<thead>
<tr>
<th>Actual Total Industry Sales Volume</th>
<th>Budgeted Market Share %</th>
<th>Actual Market Share %</th>
<th>Budgeted Average CM/Unit</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>18,000,000</td>
<td>.05</td>
<td>.05278</td>
<td>$4.21875</td>
<td>$210,938 F</td>
</tr>
</tbody>
</table>
Problem 5

Flexible Budget
for the year ended May 31, 2005

<table>
<thead>
<tr>
<th>Units costs:</th>
<th>Basic</th>
<th>Deluxe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$300</td>
<td>$800</td>
</tr>
</tbody>
</table>

Variable costs:

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Deluxe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>70</td>
<td>190</td>
</tr>
<tr>
<td>Direct labour</td>
<td>90</td>
<td>240</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>45</td>
<td>120</td>
</tr>
<tr>
<td>Variable S&amp;A</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>220</td>
<td>590</td>
</tr>
</tbody>
</table>

Contribution margin $80 $210

Flexible budget

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales volume</td>
<td>7,200</td>
</tr>
<tr>
<td></td>
<td>12,000</td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$2,160,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>504,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>648,000</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>324,000</td>
</tr>
<tr>
<td>Variable S&amp;A</td>
<td>108,000</td>
</tr>
<tr>
<td></td>
<td>1,584,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$576,000</td>
</tr>
</tbody>
</table>

Fixed costs

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>750,000</td>
</tr>
<tr>
<td>Selling and administration</td>
<td>132,500</td>
</tr>
<tr>
<td></td>
<td>882,500</td>
</tr>
</tbody>
</table>

Operating income $701,500
Sales volume variance
= (actual sales volume - budgeted sales volume) x budgeted CM/unit

Basic: (7,200 - 4,500) x $80 $216,000 F
Deluxe: (4,800 - 5,500) x $210 147,000 U
$ 69,000 F

Budgeted average CM/unit = $1,515,000 ÷ 10,000 units = $151.50

Sales quantity variance
= (actual sales volume - budgeted sales volume) x budgeted average CM/unit
= (12,000 - 10,000) x $151.50 $303,000 F

Sales mix variance
= (actual sales-mix % - budgeted sales-mix %) x actual total units sold x budgeted CM/unit

Basic: (.6 - .45) x 12,000 x $80 $144,000 F
Deluxe: (.4 - .55) x 12,000 x $210 378,000 U
$234,000 U

Market size variance
= budgeted market share % x (actual industry sales volume - budgeted industry sales volume) x budgeted average CM per unit
= .10 (133,333 - 100,000) x 151.50 $505,000 F

Market share variance
= (actual market share % - budgeted market share %) x actual industry sales volume in units x budgeted average CM per unit
= (.10 - .09) x 133,333 x $151.50 $202,000 U

Sales price variance
= actual quantity x (actual sales price - budgeted sales price)

Basic: 7,200 (325 - 300) $180,000 F
Deluxe: 4,800 (700 - 800) 480,000 U
$300,000 U

Direct materials price variance
= actual quantity purchased x (actual price - standard price)

Basic: 540,000 x (.90 - 1) 54,000 F
Deluxe: 912,000 x (.90 - 1) 91,200 F
$145,200 F
Direct materials quantity variance
= standard price \( \times \) (actual quantity used - standard quantity allowed)

Basic: \( $1 \times (540,000 - 504,000*) \) 36,000 U
Deluxe: \( $1 \times (912,000 - 912,000*) \) -

\* 7,200 x 70 = 504,000
4,800 x 190 = 912,000

Direct labour rate variance
= actual hours \( \times \) (actual rate - standard rate)

Basic: \( 46,800 \times (16 - 15) \) 46,800 U
Deluxe: \( 74,400 \times (16 - 15) \) 74,400 U

$121,200 U

Direct labour efficiency variance
= standard rate \( \times \) (actual hours - standard hours allowed)

Basic: \( $15 \times (46,800 - 43,200*) \) 54,000 U
Deluxe: \( $15 \times (74,400 - 76,800*) \) 36,000 F
$15 (121,200 - 120,000*) 18,000 U

\* 7,200 x 6 = 43,200
4,800 x 16 = 76,800

Variable overhead spending variance
= actual hours \( \times \) (actual rate - standard rate)

Basic: \( 46,800 \times (7.5 - 8*) \) 23,400 U
Deluxe: \( 74,400 \times (7.5 - 8**) \) 37,200 U

60,600 U

\* $374,400 total actual variable overhead \( \div \) 46,800 actual DLH
\** $595,200 \( \div \) 74,400

Variable overhead efficiency variance
= standard rate \( \times \) (actual hours - standard hours allowed)

Basic: \( $7.50 \times (46,800 - 43,200) \) 27,000 U
Deluxe: \( $7.50 \times (74,400 - 76,800) \) 18,000 F

$ 9,000 U
Variance summary:

Sales volume
Sales quantity
  Market size  505,000
  Market share -202,000  303,000
  Sales mix -234,000
  \[\text{Total: } -69,000\]

Sales price variance
  Basic 180,000
  Deluxe -480,000 -300,000

Direct materials
  Price variance 145,200
  Quantity variance -36,000 109,200

Direct labour
  Rate variance -121,200
  Efficiency variance -18,000 -139,200

Variable overhead
  Spending variance -60,600
  Efficiency variance -9,000 -69,600

Variable selling and administrative 0

Fixed costs
  Manufacturing -30,000
  Selling and administrative -7,000 -37,000

Total variances = difference between static budget net income and actual net income

\[\text{-367,600}\]
Explanation of Profit Decline

Marketing Related Factors:

1. Decreased Market Share in a Growing Total Market

   The total market for woodstoves grew by 33% during the year and, had FFL maintained its market share, it should have achieved a $505,000 increase in its contribution margin over the budget. Instead, FFL’s market share decreased by 1%, which reduces the previously mentioned expected increase in contribution margin by $202,000. The net result is the increase in market volume and the decreased market share should still have resulted in FFL increasing its contribution margin by $303,000 over the budget.

2. Change in Mix of Sales

   FFL sold more of the basic and less of the deluxe models. Since the deluxe model has a much higher contribution margin per unit ($210 vs. $80), the change in mix of sales had a negative impact on profits (i.e. decrease of $234,000). This negative impact, however, is not enough to offset the positive impact of the sales quantity increase (i.e. $234,000 decrease vs. $303,000 increase).

3. Price Changes

   Even though the price of the basic model increased by 8.3%, the sales volume also increased. The price increase alone would have a favourable impact of $180,000 on revenue. The problem was with the deluxe model. The price was decreased by 12.5%, resulting in a revenue decrease of $480,000. Also, the volume decreased despite the drop in selling price. The net effect of selling more basic (at lower unit CM) and selling less deluxe (at a higher unit CM) was a decrease in contribution margin of $330,600.

4. Increased Selling and Administration Costs

   Although the variable selling and administration costs were right on standard, the fixed costs increased by 5.3%.

   It appears FFL might have misjudged the market’s preference for basic vs. deluxe models of woodstoves when it prepared the budget. FFL should study the market environment more carefully to ensure the marketing effort is correctly directed and to plan production better.
Production Related Factors:

1. Variable Cost Increases

The variance analysis indicates that FFL experienced substantial savings in direct material costs during fiscal 2004/05. This may have resulted from volume discounts that were not considered in setting the standards and arose as a result of the higher production volumes. However, this cost saving was partially offset by inefficient usage of materials. Usage of direct labour and variable overhead were also somewhat inefficient. However, these inefficiencies were not enough to offset the direct materials cost savings. The main contributors to the increase in costs were the direct labour and variable overhead rates. One might venture to guess that the budget was incorrectly prepared (i.e. did not reflect expected labour rate increases) or FFL experienced problems with the labour union during the year resulting in a new labour contract with negotiated rates much higher than anticipated.

Overall, variable costs to produce the deluxe model decreased by $7 per unit, but this was not enough to offset the large decrease in selling price. On the other hand, variable production costs for the basic model increased by $18.50 per unit, indicating some inefficiency in its production process. These inefficiencies more than offset the cost savings from the deluxe model's production process.

2. Fixed Cost Increases

Fixed manufacturing costs increased by 4%. This increase may have been necessary given the increased volume and change in production mix. Perhaps increased investment in machinery, supervisory staff or other fixed costs may have been required to accommodate the increased sales volume. It must be determined whether these higher costs are expected to continue in the future.
19. Direct vs. Absorption Costing

Learning Objectives

After completing this chapter, you will:

- Understand and be able to explain the relative insights, advantages and disadvantages of variable (direct) and absorption costing.
- Be able to compute and reconcile variable and absorption costing statements.

Variable and Absorption Costing:

Variable costing treats fixed manufacturing costs as period costs, whereas, absorption costing treats fixed manufacturing costs as product costs. The consequence is that under absorption costing, the reported cost of inventory will include both variable and fixed manufacturing costs, whereas, in variable costing the reported cost of inventory will only include variable manufacturing costs. Since absorption costing is required by both ASPE and IFRS, absorption costing is always used for external reporting and tax purposes. However, a significant number of organizations use a form of variable costing for internal decision making.

The following is a summary of the treatment of various costs under variable and absorption costing:

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Internal Decision Making</th>
<th>External Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Absorption Costing</td>
<td>Variable Costing</td>
</tr>
<tr>
<td>Direct materials</td>
<td>Product cost</td>
<td>Product cost</td>
</tr>
<tr>
<td>Direct labour</td>
<td>Product cost</td>
<td>Product cost</td>
</tr>
<tr>
<td>Variable manufacturing overhead</td>
<td>Product cost</td>
<td>Product cost</td>
</tr>
<tr>
<td>Fixed manufacturing overhead</td>
<td>Product cost</td>
<td>Product cost</td>
</tr>
<tr>
<td>Variable non-manufacturing</td>
<td>Product cost</td>
<td>Product cost</td>
</tr>
<tr>
<td>Fixed non-manufacturing</td>
<td>Product cost</td>
<td>Period cost</td>
</tr>
</tbody>
</table>
Example:

Maggie Company produces a single product with the following per unit characteristics:

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Per Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$25.00</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>$6.25</td>
</tr>
<tr>
<td>Direct labour</td>
<td>$7.50</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>$2.45</td>
</tr>
<tr>
<td>Variable selling</td>
<td>$1.95</td>
</tr>
<tr>
<td></td>
<td><strong>18.15</strong></td>
</tr>
<tr>
<td>Contribution margin</td>
<td><strong>6.85</strong></td>
</tr>
</tbody>
</table>

Fixed costs

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing overhead</td>
<td>$3,500,000</td>
</tr>
<tr>
<td>Selling and administrative</td>
<td>$2,500,000</td>
</tr>
<tr>
<td></td>
<td><strong>$6,000,000</strong></td>
</tr>
</tbody>
</table>

During the most recent period Maggie Company produced and sold 1,000,000 items. The following are the income statements that would be reported under variable and absorption costing:

### Maggie Company

#### Variable Costing Income Statement

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (1,000,000 x $25)</td>
<td><strong>$25,000,000</strong></td>
</tr>
<tr>
<td>Variable costs (1,000,000 x $18.15)</td>
<td><strong>18,150,000</strong></td>
</tr>
<tr>
<td>Contribution margin</td>
<td><strong>6,850,000</strong></td>
</tr>
<tr>
<td>Fixed costs</td>
<td><strong>6,000,000</strong></td>
</tr>
<tr>
<td>Operating income</td>
<td><strong>$850,000</strong></td>
</tr>
</tbody>
</table>
Note that the orientation of the absorption costing income statement is functional, manufacturing vs. non-manufacturing costs.

Proponents of the variable costing income statement argue that the income statement highlights the direct relationship between volume and income, which is the major item controllable in the short-term. Maggie Company made and sold 1,000,000 units with a contribution margin of $6.85, yielding a contribution margin of $6,850,000.

The primary argument supporting absorption costing is the matching argument in financial accounting. Matching says costs should be matched to the period in which the benefit of those costs is provided. Matching requires the portion of fixed manufacturing attributable to finished goods inventory should be matched to the period in which the inventory is sold and is, therefore, part of product cost.

The problem is that neither approach provides a full insight into the costs the organization’s needs for long-term product planning. All the costs along the value chain needed to produce a product are relevant in decisions relating to the product’s long-term financial viability given what customers are willing to pay for the product. This includes both variable costs and fixed costs and manufacturing costs and non-manufacturing costs.

The remaining discussion in this chapters focuses on inventory costing and financial reporting considerations under variable and absorption costing.
Financial Reporting Differences between Variable and Absorption Costing

To illustrate the financial reporting differences that arise under variable and absorption costing, return to the example of Maggie Company above and assume Maggie Company has decided to allocate $3.50 ($3,500,000 / 1,000,000) of fixed manufacturing cost to each unit of production. Therefore, the total manufacturing cost per unit under absorption costing will be the variable manufacturing costs of $16.20 plus $3.50 or $19.70. The inventory cost reported under variable costing will be $16.20 per unit.

The following exhibit illustrates the cost flow assumptions under variable and absorption costing for inventory:

![Variable versus Absorption Costing Fixed Manufacturing Cost Flows](image)

As shown in this exhibit, under absorption costing work-in-process absorbs fixed manufacturing costs. Therefore, fixed manufacturing costs are suspended in inventory until the inventory is sold and fixed manufacturing costs are transferred to cost of goods sold. In variable costing, fixed manufacturing costs are treated as period costs and charged directly to cost of goods sold. Income differences between variable and absorption arise when fixed manufacturing costs are absorbed or released from inventory as shown in the following examples.

Example:

Assume in the first year of operations, Maggie Company produces 1,000,000 units of its product and sells 950,000 units. All costs are incurred as planned. The following are the income statements that would result under variable and absorption costing.
Maggie Company
Variable Costing Income Statement

Sales (950,000 x $25) $23,750,000

Variable costs
  Variable cost of goods manufactured – 1,000,000 x $16.20 16,200,000
  Less ending inventory (50,000 x $16.20) 810,000
  15,390,000
  Variable selling (950,000 x $1.95) 1,825,500

Contribution margin 6,507,500

Fixed costs 6,000,000

Operating income $507,500

Maggie Company
Absorption Costing Income Statement

Sales (950,000 x $25) $23,750,000

Cost of goods sold
  Cost of goods manufactured
    Variable: 1,000,000 x $16.20 16,200,000
    Fixed 3,500,000
    19,700,000
  Less ending inventory: 50,000 x 19,700,000 / 1,000,000 985,000

Gross margin 5,035,000

Selling and administrative expenses
  Variable – 950,000 x $1.95 1,852,500
  Fixed 2,500,000

Operating income $682,500

Note that the income reported under absorption costing is $175,000 ($682,500 - $507,500) higher than the income reported under variable costing. This difference is due entirely to the difference of $175,000 ($3,325,000 – $3,500,000) between the fixed manufacturing costs recognized between absorption costing and variable costing.

Where did the $175,000 go? It was absorbed into inventory under absorption costing and is part of the ending inventory cost under absorption costing. The ending inventory cost reported by absorption costing and variable costing will be $985,000 (50,000 * $19.70) and $810,000.
(50,000 * $16.20). The ending inventory under absorption costing is, therefore, $175,000 higher ($985,000 - $810,000) than the ending inventory reported under variable costing.

Note that the reported income difference between absorption costing in this example equals 50,000 * (19.70 – 16.20) = 50,000 * ($3.50). We can generalize this result as follows.

Absorption costing income - variable costing income =

inventory change * fixed manufacturing cost allocated per unit =

50,000 * $3.50 = $175,000.

Now assume in the following year, Maggie Company again manufactures 1,000,000 units and sells 1,050,000, that is, inventory is completely depleted. Again, assume all costs were incurred as planned. The incomes reported under the two approaches are shown in the following exhibits:

Maggie Company
Variable Costing Income Statement

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (1,050,000 x $25)</td>
<td>$26,250,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
</tr>
<tr>
<td>Opening inventory</td>
<td>810,000</td>
</tr>
<tr>
<td>Variable cost of goods manufactured – 1,000,000 x $16.20</td>
<td>16,200,000</td>
</tr>
<tr>
<td></td>
<td>17,010,000</td>
</tr>
<tr>
<td>Variable selling (1,050,000 x $1.95)</td>
<td>2,047,500</td>
</tr>
<tr>
<td></td>
<td>19,057,500</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>7,192,500</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>6,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$1,192,500</td>
</tr>
</tbody>
</table>
Maggie Company
Absorption Costing Income Statement

Sales (1,050,000 x $25) $26,250,000

Cost of goods sold
  Opening inventory 985,000
  Cost of goods manufactured
    Variable: 1,000,000 x $16.20 16,200,000
    Fixed 3,500,000
  19,700,000

Gross margin 5,565,000

Selling and administrative expenses
  Variable – 1,050,000 x $1.95 2,047,500
  Fixed 2,500,000

Operating income $1,017,500

The income reported by variable costing is now $175,000 higher than the income reported by absorption costing. Why? Because the fixed manufacturing cost absorbed in the previous period by absorption costing has now been released from inventory to cost of goods sold under absorption costing. Of course we could have used the formula we developed above:

Absorption costing income - variable costing income =

inventory change * fixed manufacturing cost allocated per unit =

-50,000 * $3.50 = -$175,000.

It might occur to you that things would get a more complicated if the fixed manufacturing overhead rate per unit changes from one period to another. While the accounting becomes more complicated the principle remains the same, reported income differences between direct and absorption costing will reflect the fixed manufacturing costs released and absorbed by finished goods inventory. For example, if Maggie Company is using FIFO costing, the income difference formula becomes:

Absorption costing income - variable costing income =

(change in inventory units from opening inventory * fixed manufacturing cost allocated per unit to opening inventory) + (change in inventory units from current production * fixed manufacturing cost allocated per unit to current production)
Finally, the most general way of expressing the income differences between absorption costing and variable costing is:

Absorption costing operating income - variable costing operating income = fixed manufacturing costs in ending inventory - fixed manufacturing costs in opening inventory

**Standard Absorption Costing**

The above examples assumed the company was using an actual costing system. Return to the Maggie Company data above and assume a standard costing system is used and the company has decided to use practical capacity, which is 1,250,000 units per year, to compute the fixed manufacturing overhead rate. The resulting rate would be $2.80 ($3,500,000 / 1,250,000). Maggie Company decided to allocate unallocated fixed manufacturing overhead to cost of goods sold and sold 1,000,000 units in the first year of operations. The following absorption and variable costing statements would result:

**Maggie Company**

**Variable Costing Income Statement**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (1,000,000 x $25)</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>Variable costs (1,000,000 x $18.15)</td>
<td>18,150,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>6,850,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>6,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$850,000</td>
</tr>
</tbody>
</table>

**Maggie Company**

**Absorption Costing Income Statement**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (1,000,000 x $25)</td>
<td>$25,000,000</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td></td>
</tr>
<tr>
<td>Variable - 1,000,000 x ($6.25^{DM} + 7.50^{DL} + 2.45^{VOH})</td>
<td>16,200,000</td>
</tr>
<tr>
<td>Fixed – 1,000,000 x $2.80</td>
<td>2,800,000</td>
</tr>
<tr>
<td>FOH volume variance – 250,000 x $2.80</td>
<td>700,000</td>
</tr>
<tr>
<td>19,700,000</td>
<td></td>
</tr>
<tr>
<td>Gross Margin</td>
<td>5,300,000</td>
</tr>
<tr>
<td>Selling and administrative expenses</td>
<td></td>
</tr>
<tr>
<td>Variable (1,000,000 x $1.95)</td>
<td>1,950,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>2,500,000</td>
</tr>
<tr>
<td>4,450,000</td>
<td></td>
</tr>
<tr>
<td>Operating income</td>
<td>$850,000</td>
</tr>
</tbody>
</table>
However, if 1,000,000 units were produced and 950,000 were sold, the following absorption and variable costing statements would result:

Maggie Company
Variable Costing Income Statement

Sales (950,000 x $25) $23,750,000
Variable costs
  Variable cost of goods manufactured – 1,000,000 x $16.20 16,200,000
  Less ending inventory (50,000 x $16.20) 810,000
  15,390,000
  Variable selling (950,000 x $1.95) 1,825,500
  17,242,500
Contribution margin 6,507,500
Fixed costs 6,000,000
Operating income $507,500

Maggie Company
Absorption Costing Income Statement

Sales (950,000 x $25) $23,750,000
Cost of goods sold
  Cost of goods manufactured
    Variable: 1,000,000 x $16.20 16,200,000
    Fixed: 1,000,000 x $2.80 2,800,000
    19,000,000
  Less ending inventory: 50,000 x $19 950,000
    18,050,000
  FOH volume variance: 250,000 x $2.80 700,000
    18,750,000
Gross margin 5,000,000
Selling and administrative expenses
  Variable – 950,000 x $1.95 1,852,500
  Fixed 2,500,000
    4,352,500
Operating income $647,500
Note that absorption costing income is $140,000 higher than variable costing income. This
difference is explained by the increase of inventory of 50,000 units, which absorbed $2.80 fixed
manufacturing overhead per unit for a total of $140,000. Note that the effect on income is
directly determined by the rate chosen to allocate fixed manufacturing overhead to production,
which, in turn, is determined by the denominator activity level chosen. Therefore, management
can manipulate income by choosing difference fixed manufacturing overhead rates under
absorption costing and by production level choices.

**Objections to Absorption Costing**

The above example illustrates one of the major objections concerning absorption costing. In
variable costing, the driver of income is sales. In absorption costing the drivers of income are
sales, production and choices made about the fixed manufacturing overhead rate.

As we saw in the example of Maggie Company, in absorption costing income is increased by
increasing inventory or decreased by reducing inventory. This opens the door for income
manipulation through production decisions.

Moreover, as shown in the discussion in the previous section, managers can manipulate income
by changing the fixed manufacturing cost allocation rate. Performance bonus based on reported
income can motivate managers to manipulate income using production and manufacturing
overhead rate choices.

**Absorption and Variable Costing and Cost Volume Profit Analysis**

Return to Maggie Company and assume we are, once again, considering the first year of
operations with no opening inventory. Given the original data provided, we can compute the
breakeven level of sales as:

\[
\frac{\text{Fixed costs}}{\text{CM per unit}} = \frac{3,500,000 + 2,500,000}{6.85} = 875,913 \text{ units}
\]

Following are the incomes that absorption costing and variable costing would report if Maggie
Company sold 875,913 units, manufactured 1,000,000 units, used a fixed manufacturing
overhead rate of $3.50 based on a denominator volume of 1,000,000 units and charged under
allocated fixed manufacturing overhead to cost of goods sold.
Maggie Company
Variable Costing Income Statement

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (875,913 x $25)</td>
<td>$21,897,825</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
</tr>
<tr>
<td>Variable cost of goods manufactured – 1,000,000 x $16.20</td>
<td>16,200,000</td>
</tr>
<tr>
<td>Less ending inventory (124,087 x $16.20)</td>
<td>2,010,209</td>
</tr>
<tr>
<td></td>
<td>14,189,791</td>
</tr>
<tr>
<td>Variable selling (875,913 x $1.95)</td>
<td>1,708,030</td>
</tr>
<tr>
<td></td>
<td>15,897,821</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>6,000,004</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>6,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$4</td>
</tr>
</tbody>
</table>

Maggie Company
Absorption Costing Income Statement

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (875,913 x $25)</td>
<td>$21,897,825</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td></td>
</tr>
<tr>
<td>Cost of goods manufactured</td>
<td></td>
</tr>
<tr>
<td>Variable: 1,000,000 x $16.20</td>
<td>16,200,000</td>
</tr>
<tr>
<td>Fixed: 1,000,000 x $3.50</td>
<td>3,500,000</td>
</tr>
<tr>
<td></td>
<td>19,700,000</td>
</tr>
<tr>
<td>Less ending inventory: 124,087 x $19.70</td>
<td>2,444,514</td>
</tr>
<tr>
<td></td>
<td>17,255,486</td>
</tr>
<tr>
<td>FOH volume variance</td>
<td>-0-</td>
</tr>
<tr>
<td></td>
<td>17,255,486</td>
</tr>
<tr>
<td>Gross margin</td>
<td>4,642,339</td>
</tr>
<tr>
<td>Selling and administrative expenses</td>
<td></td>
</tr>
<tr>
<td>Variable – 875,913 x $1.95</td>
<td>1,708,030</td>
</tr>
<tr>
<td>Fixed</td>
<td>2,500,000</td>
</tr>
<tr>
<td></td>
<td>4,208,030</td>
</tr>
<tr>
<td>Operating income</td>
<td>$434,309</td>
</tr>
</tbody>
</table>
Note that variable costing income reports $0 operating income (there is a slight rounding error since the actual breakeven quantity is 875,912.41); however, absorption costing reports an income of $434,309. Why? Remember, the difference in reported income between absorption costing and direct costing equals fixed manufacturing overhead in ending inventory minus fixed manufacturing overhead in opening inventory. In this case, we have:

\[(1,000,000 – 875,192) * $3.50) – (0 * $3.50) \equiv $434,305\]

Therefore, the breakeven quantity shown under absorption costing and variable costing will differ. It seems counter intuitive that choice regarding production and fixed manufacturing overhead rates should affect breakeven point. However, you can see they do when the focus is on reported external income.

For absorption costing breakeven:

Units sold * contribution margin per unit – fixed manufacturing cost in opening inventory – current fixed manufacturing cost + fixed manufacturing cost in ending inventory – other fixed costs = 0

Noting that:

Fixed manufacturing cost in ending inventory = (units produced – units sold) * manufacturing overhead rate per unit,

Manufacturing overhead rate = current fixed manufacturing costs / denominator activity level

With rearranging, the absorption costing breakeven equation becomes:

Breakeven units = (fixed manufacturing cost in opening inventory + current fixed manufacturing cost) – (units produced * current fixed manufacturing overhead rate per unit) + other fixed costs) / (contribution margin per unit – current fixed manufacturing overhead rate per unit)

If current production equals the denominator activity level (as it does in actual absorption costing) and opening inventory is zero units, the breakeven equation in absorption costing reduces to:

Breakeven unit sales = non-manufacturing fixed costs  
\[\frac{CM \text{ per unit} - \text{FOH per unit}}{\text{CM per unit} - \text{FOH per unit}}\]

= \$2,500,000 / \$(6.85 - 3.50)

= 746,269 units

The following are the resulting absorption costing and variable incomes that would be reported:
Maggie Company
Variable Costing Income Statement

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (746,269 x $25)</td>
<td>$18,656,725</td>
</tr>
<tr>
<td>Variable costs</td>
<td></td>
</tr>
<tr>
<td>Variable cost of goods manufactured – 1,000,000 x $16.20</td>
<td>16,200,000</td>
</tr>
<tr>
<td>Less ending inventory (253,731 x $16.20)</td>
<td>4,110,442</td>
</tr>
<tr>
<td>Variable selling – 746,269 x $1.95</td>
<td>1,455,225</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>5,111,942</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>6,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>($888,058)</td>
</tr>
</tbody>
</table>

Maggie Company
Absorption Costing Income Statement

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (746,269 x $25)</td>
<td>$18,656,725</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td></td>
</tr>
<tr>
<td>Cost of goods manufactured</td>
<td></td>
</tr>
<tr>
<td>Variable: 1,000,000 x $16.20</td>
<td>16,200,000</td>
</tr>
<tr>
<td>Fixed: 1,000,000 x $3.50</td>
<td>3,500,000</td>
</tr>
<tr>
<td>Less ending inventory: 253,731 x $19.70</td>
<td>4,998,501</td>
</tr>
<tr>
<td>FOH volume variance</td>
<td>0</td>
</tr>
<tr>
<td>Gross margin</td>
<td>3,955,226</td>
</tr>
<tr>
<td>Selling and administrative expenses</td>
<td></td>
</tr>
<tr>
<td>Variable – 746,269 x $1.95</td>
<td>1,455,225</td>
</tr>
<tr>
<td>Fixed</td>
<td>2,500,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>3,955,225</td>
</tr>
</tbody>
</table>

Once again, note that the income difference between absorption costing and direct costing equals the change in inventory (1,000,000 – 746,269) * $3.50.
Conclusion:

This chapter has reviewed the nature and form of absorption and variable costing. International accounting regulation require the use of absorption costing for external reporting purposes, while the majority of management accountants argue that variable costing is more appropriate for providing insights for internal decision making.

We have seen how changes in inventory levels create differences in income reported by absorption and variable costing and how management can use accounting and production choices to manipulate income reported under absorption costing, choices that do not affect the income reported by variable costing.
**Problems with Solutions**

Multiple Choice Questions

The following information pertains to items 1 – 4:

The Wye Co. Ltd. expects to produce 11,000 units of product RGW during its first year of operations. The following standard manufacturing costs per unit were established based on this expected production volume:

- **Direct materials**: $13
- **Direct labour**: 12
- **Variable overhead**: 11
- **Fixed overhead**: 6
- **Unit standard cost**: $42

No variable selling and administrative costs were incurred during the year. At the end of the first year of operations, the accountant prepared income statements utilizing actual absorption costing, normal variable (direct) costing, normal absorption costing, standard variable (direct) costing and standard absorption costing. These five income statements, labelled A through E, are produced below (in random order):

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$540,000</td>
<td>$540,000</td>
<td>$540,000</td>
<td>$540,000</td>
<td>$540,000</td>
</tr>
<tr>
<td>Cost of sales</td>
<td>346,500</td>
<td>324,000</td>
<td>400,500</td>
<td>378,000</td>
<td>423,000</td>
</tr>
<tr>
<td>Variances:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>- 5,000</td>
<td>- 5,000</td>
<td>- 5,000</td>
<td>- 5,000</td>
<td>- 5,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>- 20,000</td>
<td>- 20,000</td>
<td>- 20,000</td>
<td>- 20,000</td>
<td>- 20,000</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td>- 10,000</td>
<td>- 10,000</td>
<td>- 10,000</td>
<td>- 10,000</td>
<td>- 10,000</td>
</tr>
<tr>
<td>Other costs</td>
<td>150,000</td>
<td>150,000</td>
<td>80,000</td>
<td>80,000</td>
<td>80,000</td>
</tr>
<tr>
<td></td>
<td>511,500</td>
<td>514,000</td>
<td>505,500</td>
<td>508,000</td>
<td>503,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$28,500</td>
<td>$26,000</td>
<td>$34,500</td>
<td>$32,000</td>
<td>$37,000</td>
</tr>
</tbody>
</table>

1. Which income statement was prepared using actual absorption costing?
   a) A
   b) B
   c) C
   d) D
   e) E
2. Which income statement was prepared using standard variable costing?
   a) A  
   b) B  
   c) C  
   d) D  
   e) E

3. How many units of Product RGW were actually sold during the year?
   a) 8,357  
   b) 9,000  
   c) 9,643  
   d) 10,000  
   e) 11,000

4. How many units of Product RGW were actually produced during the year?
   a) 8,333  
   b) 9,000  
   c) 10,000  
   d) 10,667  
   e) 11,667

5. Last year, fixed manufacturing overhead costs were $30,000, variable production costs were $48,000, fixed selling and administration costs were $20,000 and variable selling administrative expenses were $9,600. There was no beginning inventory. During the year, 3,000 units were produced and 2,400 units were sold at a price of $40 per unit. Under variable costing, what would be the operating income?
   a) A profit of $6,000  
   b) A profit of $4,000  
   c) A loss of $2,000  
   d) A loss of $4,400
6. During the past year, Margot Company's total variable production costs were $10,000 and its total fixed manufacturing overhead costs were $6,800. The company produced 5,000 units during the year and sold 4,600 units. There were no units in the beginning inventory. Which of the following statements is true?
   a) The net income under absorption costing for the year will be $800 higher than net income under variable costing.
   b) The net income under absorption costing for the year will be $544 higher than net income under variable costing.
   c) The net income under absorption costing for the year will be $544 lower than net income under variable costing.
   d) The net income under absorption costing for the year will be $800 lower than net income under variable costing.

7. Under direct costing, product costs consist of:
   a) Variable production costs
   b) Variable selling costs
   c) Variable and fixed production costs
   d) Variable production and selling costs
   e) Variable and fixed production and selling costs

8. Under absorption costing, if management wishes to increase income during a particular period, it would, in the matter of inventory:
   a) Increase inventory
   b) Decrease inventory
   c) Unrelated to inventory
   d) Cannot tell from the information provided
The following information relates to Questions 9 – 12:

Horton Company has just completed its first year of operations. The standard manufacturing cost per unit for its sole product was:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$13</td>
</tr>
<tr>
<td>Direct labour</td>
<td>12</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>11</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$42</strong></td>
</tr>
</tbody>
</table>

The fixed overhead rate was computed by dividing budgeted fixed manufacturing costs of $6,000,000 by practical capacity of 1,000,000 units. Horton Company allocates all under-applied fixed manufacturing overhead to cost of goods sold.

Other fixed costs at Horton Company are $4,000,000 and other variable costs are $4 per unit. During the year, costs are incurred as planned. Production was 950,000 units and sales were 900,000 units at $55 per unit.

9. Horton Company’s operating income under absorption costing would be:
   a) $3,500,000
   b) $3,800,000
   c) $4,100,000
   d) $4,500,000

10. Horton Company’s operating income under variable costing would be:
    a) $3,500,000
    b) $7,100,000
    c) $7,500,000
    d) $4,500,000

11. Horton Company’s breakeven unit sales under absorption costing would be:
    a) 286,667
    b) 444,444
    c) 477,770
    d) 666,667

12. Horton Company’s breakeven unit sales under variable costing would be:
    a) 400,000
    b) 526,316
    c) 666,667
    d) 450,000
The following data pertains to Questions 13 and 14:

Nith Company planned and produced 200,000 units of its single product in 2010, its first year of operation. Variable manufacturing cost was $20 per unit. Variable non-manufacturing cost was $10 per unit sold. Planned and actual fixed manufacturing costs were $600,000. Planned and actual fixed non-manufacturing costs were $400,000. Nith Company sold 120,000 units of product at $40 per unit.

13. Nith Company’s operating income using an actual absorption costing system was:
   a) $440,000
   b) $200,000
   c) $600,000
   d) $840,000

14. Nith Company’s operating income using variable costing system was:
   a) $440,000
   b) $200,000
   c) $600,000
   d) $840,000
Problem 1

Following are the results of operations for the first two years of operations for Schneider Company. Schneider Company computes the fixed manufacturing overhead rate each year by dividing budgeted fixed manufacturing overhead by planned production.

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price per unit</td>
<td>$45.22</td>
<td>$43.44</td>
</tr>
<tr>
<td>Units sold</td>
<td>120,000</td>
<td>110,000</td>
</tr>
</tbody>
</table>

|                      |            |            |
| Variable cost per unit |          |            |
| Manufacturing         | $8.05      | $8.45      |
| Non-manufacturing     | 3.11       | 3.31       |

|                      |            |            |
| Production           |            |            |
| Planned              | 150,000    | 110,000    |
| Actual               | 140,000    | 100,000    |

|                      |            |            |
| Fixed costs          |            |            |
| Manufacturing        | $2,500,000 | $2,600,000 |
| Non-manufacturing    | 1,500,000  | 1,400,000  |

Required:

a) Compute the variable and absorption income for Schneider Company for its first two years of operations.

b) Explain the difference between each year’s variable and absorption costing income

Problem 2

During the most recent year, all incurred costs equalled standard cost and inventory increased by 1,000 units. Income reported under absorption costing was less than income reported under variable costing. Provide an example to show how this could happen.
Problem 3

The Green Company’s sole product is electricity, which it produces from its wind farm. All Green Company’s costs are fixed and amount to $32,000,000 per year for manufacturing costs and $3,000,000 for selling general and administrative costs.

Green Company’s production rate is at the mercy of the elements. Bay City, Green Company’s sole customer, has a fixed contract to purchase 200,000 units of electricity for $200 per unit. When the weather cooperates, Green Company generates more than 200,000 units of electricity and supplies the excess electricity into a power grid. When Green Company generates less than 200,000 units of electricity, it draws power from the power grid to supply Bay City.

In effect, the power grid acts as a buffer inventory for Green Company. Green Company’s accountant has argued that deposits to the grid cannot be treated as sales since there is no sales agreement. Therefore, for accounting purposes, Green Company treats transfers to the power grid as increases in inventory and withdrawals from the power grid as withdrawals from inventory.

During the most recent period Green Company generated 210,000 units of electricity and all costs were incurred as planned.

Required:

a) Compute Green Company’s income during the current year assuming Green Company uses variable costing.

b) What value will Green Company report for the inventory it created if Green Company uses variable costing?

c) Compute Green Company’s income for the current year assuming Green Company uses actual absorption costing.

d) What value will Green Company report for the inventory it created if Green Company uses actual absorption costing?
Problem 4

The Hilton Company manufactures plastic milk crates. At the start of the current year, Hilton Company had no inventory. During the year Hilton Company produced 5,600,000 milk crates. It sold 5,000,000 crates for $2.25 each. Variable manufacturing costs were $.85 per unit and variable general, selling and administrative costs were $.15 per unit. Fixed manufacturing costs were $2,300,000 and fixed general, selling and administrative costs were $1,100,000.

Required:

a) Prepare a variable costing income statement for the current year.

b) Prepare an actual absorption costing income statement for the current year.

c) Reconcile the difference between the variable and absorption costing incomes.

d) What is the breakeven point in unit sales if Hilton Company uses variable costing?

Problem 5

Neale Company just completed its first year of operations and produced the following income statements to summarize operations:

<table>
<thead>
<tr>
<th></th>
<th>Variable Costing</th>
<th>Absorption Costing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$21,250,000</td>
<td>$21,250,000</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td>4,250,000</td>
<td>13,750,000</td>
</tr>
<tr>
<td>Fixed manufacturing costs</td>
<td>10,000,000</td>
<td></td>
</tr>
<tr>
<td>Selling and administrative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>2,125,000</td>
<td>2,125,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>5,000,000</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>($125,000)</td>
<td>$375,000</td>
</tr>
</tbody>
</table>

The planned level of production was 500,000 units and the variable selling, general and administrative expenses were $5 per unit. Neale Company uses a predetermined manufacturing overhead rate, which is equal to budgeted fixed manufacturing cost divided by planned production.

Required:

a) How many units were there in ending inventory?

b) How many units were sold?

c) How many units were made?

d) What would be the breakeven unit sales under variable costing?
Problem 6

Sharon Chiu is the production manager at Hilltop Automotive, a manufacturer of automobile batteries. Sharon’s department is treated as a profit centre and Sharon is evaluated and rewarded a bonus, which is 1% of the profit reported by her unit.

The transfer price for batteries has been set by senior management and is equal to the net realizable value of the batteries Sharon’s department makes and transfers to the sales group.

Sharon has gathered the following data for the upcoming year, which is the first year of operations:

- Planned sales 1,000,000 units
- Selling price per unit $30
- Variable production costs $20
- Fixed production costs $5,000,000
- Fixed manufacturing overhead rate $5 (expected costs/planned sales)
- Fixed non-manufacturing costs $3,000,000

Sharon can operate her department at a rate of 1,000,000 units or 1,200,000 units per year.

Required:

a) Compute Sharon’s bonus if 1,000,000 units or 1,200,000 units are produced.
b) Which production level would the company likely prefer?
c) How would you align Sharon’s interests with those of the company?
Problem 7

The Butron Company uses variable costing for internal management purposes and full-absorption (actual) costing for external reporting purposes. Thus, at the end of each year, financial information must be converted from variable costing to full absorption costing for external reports.

At the end of last year, management anticipated sales would rise 20% this year. Therefore, production was increased from 20,000 units to 24,000 units. However, economic conditions kept sales volume at 20,000 units for both years.

The following data pertain to the two years:

<table>
<thead>
<tr>
<th></th>
<th>Last Year</th>
<th>This Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price per unit</td>
<td>$60</td>
<td>$60</td>
</tr>
<tr>
<td>Sales (units)</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Beginning inventory (units)</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Production (units)</td>
<td>20,000</td>
<td>24,000</td>
</tr>
<tr>
<td>Ending inventory (units)</td>
<td>2,000</td>
<td>6,000</td>
</tr>
</tbody>
</table>

Variable cost per unit for both years was composed of:

- Labour: $15
- Materials: $9
- Variable overhead: $6

\[ \text{Variable cost per unit} = \$30 \]

Estimated and actual fixed costs for each year were:

- Production: $180,000
- Selling and administrative: $200,000

\[ \text{Estimated fixed costs} = \$380,000 \]

Required:

a. Present the income statement based on variable costing for this year.
b. Present the income statement based on full absorption costing for this year.
c. Explain the difference, if any, in the operating profit figures.
Northway Corporation is a manufacturer of a synthetic element. Jim Northway, president of the company, has been eager to get the operating results for the just completed fiscal year. He was surprised when the income statement revealed income before taxes had dropped to $360,000 from $750,000 even though sales volume had increased 100,000 kilograms. This drop in net income had occurred even though Northway had implemented the following changes during the past 12 months to improve the profitability of the company:

- In response to a 10% increase in production costs, the sales price of the company's product was increased by 12%. This action took place on December 1, 2003.
- The management of the selling and administrative departments were given strict instructions to spend no more in fiscal 2004 than in fiscal 2003.

Northway's accounting department prepared and distributed to top management the comparative income statements presented below. The accounting staff also prepared related financial information in the accompanying schedule to assist management in evaluating the company's performance. Northway uses the FIFO inventory method for finished goods.

### Northway Corporation
**Statements of Operating Income**
for the years ended November 30, 2003 and 2004 ($000 omitted)

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$9,000</td>
<td>$11,200</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td>6,750</td>
<td>9,340</td>
</tr>
<tr>
<td>Gross margin</td>
<td>2,250</td>
<td>1,860</td>
</tr>
</tbody>
</table>
| Selling and administ 
|                      | 1,500   | 1,500   |
| Operating Income     | $ 750   | $ 360   |

### Northway Corporation
**Selected Operating and Financial Data**
for 2003 and 2004

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales price</td>
<td>$10/kg</td>
<td>$11.20/kg</td>
</tr>
<tr>
<td>Material cost</td>
<td>$1.50/kg</td>
<td>$1.65/kg</td>
</tr>
<tr>
<td>Direct labour cost</td>
<td>$2.50/kg</td>
<td>$2.75/kg</td>
</tr>
<tr>
<td>Variable overhead cost</td>
<td>$1/kg</td>
<td>$1.10/kg</td>
</tr>
<tr>
<td>Total fixed overhead costs</td>
<td>$3,000,000</td>
<td>$3,300,000</td>
</tr>
</tbody>
</table>
| Selling and administ 
|                      | $1,500,000  | $1,500,000  |
| Sales volume         | 900,000 kg  | 1,000,000 kg|
| Beginning inventory  | 300,000 kg  | 600,000 kg  |
| Units produced       | 1,200,000 kg| 500,000 kg  |
Required:

a. Explain to Jim Northway why Northway Corporation's operating income decreased in the current fiscal year despite the sales price and sales volume increases.

b. A member of the Northway's accounting department has suggested the company adopt variable (direct) costing for internal reporting purposes.

   i. Prepare an operating income statement through income before taxes for the year ended November 30, 2004, for Northway Corporation using the variable (direct) costing method.

   ii. Present a numerical reconciliation of the difference in operating income using the absorption costing method as currently employed by Northway and the variable (direct) costing method as proposed.
Solutions

Multiple Choice Questions

1. e Under actual absorption costing, cost of goods sold is calculated as the actual rate x actual inputs used for both direct and indirect costs. Therefore, no variances would be calculated.

2. b Under standard variable costing, cost of goods sold is calculated as the standard variable cost rate x the standard inputs allowed for actual outputs. Therefore, there may be variable cost variances but no fixed cost variances.

3. b There are various ways to determine the actual sales. Two of the easiest ways are:
   1. From income statement B, which represents standard variable costing, cost of goods sold of $324,000 ÷ standard variable costs of $36 = 9,000 units
   2. From income statement D, which represents standard absorption costing, cost of goods sold of $378,000 ÷ standard costs of $42 = 9,000 units.

4. c Statements C and D must represent absorption costing because each shows a fixed overhead variance and statements A and B, which do not show a fixed overhead variance, must represent variable costing. Therefore, the $150,000 other costs shown in statements A and B must represent the actual fixed overhead and fixed selling and administration expenses. The $80,000 other costs under statement E (actual absorption) represent the actual fixed selling and administration expenses. The $70,000 difference less the $10,000 fixed overhead variance represents the total fixed overhead applied for actual inputs. Therefore, $60,000 / $6 per unit = 10,000 units produced.

An alternative method of calculating units produced is:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating income statement B (i.e. standard variable costing)</td>
<td>514,000</td>
</tr>
<tr>
<td>Operating income statement D (i.e. standard absorption costing)</td>
<td>508,000</td>
</tr>
<tr>
<td>Fixed overhead in ending inventory</td>
<td>6,000</td>
</tr>
<tr>
<td>Divide by $6 standard cost per unit</td>
<td>6</td>
</tr>
<tr>
<td>Number of units in ending inventory</td>
<td>1,000</td>
</tr>
<tr>
<td>Number of units sold</td>
<td>9,000</td>
</tr>
<tr>
<td>Number of units produced</td>
<td>10,000</td>
</tr>
</tbody>
</table>
5. c Variable manufacturing overhead per unit = $48,000 / 3,000 = $16
   Variable selling and administrative expense per unit = $9,600 / 2,400 = $4
   Variable costing income = 2,400 (40 – 16 – 4) – (30,000 + 20,000) = (2,000)

6. b

7. a Direct costing is another term used for variable costing, where all direct
   (variable) manufacturing costs and variable manufacturing overhead costs are
   included as inventoriable costs.

8. a Under absorption costing fixed manufacturing is absorbed into inventory.
   Therefore, as inventory is increased more costs are absorbed into inventory
   and withheld from the income statement.

9. a Volume variance = 50,000 x $6 = $300,000 U
   [900,000 x (55 - 42 - 4)] - 4,000,000 - 300,000 = $3,800,000

10. a CM/Unit = $55 - 13 - 12 - 11 - 4 = 15
    (900,000 x $15) - (6,000,000 + 4,000,000) = $3,500,000

11. d Let X = units sold
    [X(55 - 42 - 4)] - 4,000,000 - volume variance = $0
    Where volume variance = (1,000,000 - X)*6 = 6,000,000 - 6X
    We get: 9X - 4,000,000 - (6,000,000 - 6X) = 0
    9X - 4,000,000 - 6,000,000 + 6X = 0
    15X = 10,000,000
    X = 666,667

12. c ($6,000,000 + 4,000,000) / 15 = 666,667

13. a Volume variance = 0
    [120,000 x ($40 - 20 - 3 - 10)] - 400,000 = $440,000

14. b [120,000 x ($40 - 20 - 10)] - (600,000 + 400,000) = $200,000
Problem 1

a. Absorption costing:

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$5,426,400</td>
<td>$4,778,400</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening inventory</td>
<td>494,334</td>
<td></td>
</tr>
<tr>
<td>Cost of goods manufactured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable: 140,000 x $8.05</td>
<td>1,127,000</td>
<td>845,000</td>
</tr>
<tr>
<td>Fixed: 140,000 x $16.6667</td>
<td>2,333,333</td>
<td>2,363,636</td>
</tr>
<tr>
<td></td>
<td>3,460,334</td>
<td>3,208,636</td>
</tr>
<tr>
<td>Less ending inventory</td>
<td>(494,334)</td>
<td>(320,864)</td>
</tr>
<tr>
<td>Volume variance</td>
<td>166,667</td>
<td>236,364</td>
</tr>
<tr>
<td></td>
<td>3,132,667</td>
<td>3,618,470</td>
</tr>
<tr>
<td>Gross margin</td>
<td>2,293,733</td>
<td>1,159,930</td>
</tr>
<tr>
<td>Non-manufacturing costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable: 120,000 x $3.11</td>
<td>373,200</td>
<td>364,100</td>
</tr>
<tr>
<td>Fixed</td>
<td>1,500,000</td>
<td>1,400,000</td>
</tr>
<tr>
<td></td>
<td>1,873,200</td>
<td>1,764,100</td>
</tr>
<tr>
<td>Operating income</td>
<td>$420,533</td>
<td>($604,170)</td>
</tr>
</tbody>
</table>
Variable costing:

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$5,426,400</td>
</tr>
<tr>
<td>Opening inventory</td>
<td>161,000</td>
</tr>
<tr>
<td>Cost of goods manufactured:</td>
<td></td>
</tr>
<tr>
<td>140,000 x $8.05</td>
<td>1,127,000</td>
</tr>
<tr>
<td>100,000 x $8.45</td>
<td>845,000</td>
</tr>
<tr>
<td>Less ending inventory:</td>
<td></td>
</tr>
<tr>
<td>20,000 x 8.05</td>
<td>161,000</td>
</tr>
<tr>
<td>10,000 x 8.45</td>
<td>84,500</td>
</tr>
<tr>
<td>Non-manufacturing:</td>
<td></td>
</tr>
<tr>
<td>120,000 x 3.11</td>
<td>373,200</td>
</tr>
<tr>
<td>110,000 x 3.31</td>
<td>364,100</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>4,087,200</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>4,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$87,200</td>
</tr>
</tbody>
</table>

b. Absorption costing income

<table>
<thead>
<tr>
<th>Description</th>
<th>Absorption costing income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed costs in ending inventory – 2009</td>
<td></td>
</tr>
<tr>
<td>20,000 x $16.66667</td>
<td>(333,333)</td>
</tr>
<tr>
<td>Fixed costs in ending inventory – 2010</td>
<td></td>
</tr>
<tr>
<td>10,000 x $23.63636</td>
<td>(236,363)</td>
</tr>
<tr>
<td>Variable costing income</td>
<td>$87,200</td>
</tr>
</tbody>
</table>
Problem 2

Assume the opening inventory consisted of 5,000 units that had been assigned a fixed manufacturing overhead rate of $3 per unit. The total amount of fixed manufacturing overhead in inventory was, therefore, $15,000.

Since inventory increased by 1,000 units the ending inventory was 6,000 units. Assume that during the year, management changed the fixed manufacturing overhead rate to $2.25 per unit. Therefore, the total amount of fixed manufacturing overhead in ending inventory was $13,500.

Recall that:

Absorption costing income – variable costing income = fixed manufacturing costs in ending inventory – fixed manufacturing costs in beginning inventory = \((6,000 \times 2.25) - (5,000 \times 3) = 13,500 - 15,000 = -1,500\)

Problem 3

<table>
<thead>
<tr>
<th>Green Company</th>
<th>Variable Costing Income Statement</th>
<th>Green Company</th>
<th>Absorption Costing Income Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$40,000,000</td>
<td>Sales</td>
<td>$40,000,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td>0</td>
<td>Less: cost of goods sold</td>
<td>$0</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$40,000,000</td>
<td>Variable manufacturing</td>
<td></td>
</tr>
<tr>
<td>Fixed costs</td>
<td>Fixed manufacturing</td>
<td>Fixed non-manufacturing</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Fixed manufacturing</td>
<td>$32,000,000</td>
<td>Gross margin</td>
<td>$9,523,810</td>
</tr>
<tr>
<td>Fixed non-manufacturing</td>
<td>$3,000,000</td>
<td>Less: non-manufacturing costs</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$5,000,000</td>
<td>Fixed non-manufacturing</td>
<td>$3,000,000</td>
</tr>
<tr>
<td></td>
<td>Operating income</td>
<td>Operating income</td>
<td>$6,523,810</td>
</tr>
</tbody>
</table>

Variable costing income is \$5,000,000

Ending inventory will be recorded as \$0, since all costs are fixed

Absorption costing income is \$6,523,810

Ending inventory = 10,000 \times (32,000,000 / 210,000) = \$1,523,810
Problem 4

a. Absorption costing:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (5,000,000 x $2.25)</td>
<td>$11,250,000</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td></td>
</tr>
<tr>
<td>Cost of goods manufactured:</td>
<td></td>
</tr>
<tr>
<td>Variable – 5,600,000 x $0.85</td>
<td>4,760,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>2,300,000</td>
</tr>
<tr>
<td>Total</td>
<td>7,060,000</td>
</tr>
<tr>
<td>Less: ending inventory</td>
<td></td>
</tr>
<tr>
<td>$7,060,000 / 5,600,000 x 600,000</td>
<td>(756,429)</td>
</tr>
<tr>
<td>Gross margin</td>
<td>6,303,571</td>
</tr>
<tr>
<td>Non-manufacturing costs</td>
<td></td>
</tr>
<tr>
<td>Variable: 5,000,000 x .15</td>
<td>750,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>1,100,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,850,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$3,096,429</td>
</tr>
</tbody>
</table>

b. Variable costing:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$11,250,000</td>
</tr>
<tr>
<td>Variable costs (5,000,000 x 1)</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>6,250,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>3,400,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>$2,850,000</td>
</tr>
</tbody>
</table>

c. Absorption costing income                           | $3,096,429      |
| Fixed costs in ending inventory – 600,000 x .41071    | (246,429)       |
| Variable costing Income                               | $2,850,000      |

d. $3,400,000 / 1.25 = 2,720,000 units
Problem 5

a) Since the planned level of production was 500,000 and the fixed manufacturing overhead was $10,000,000, the manufacturing overhead rate was $20 (10,000,000 / 500,000). Since there was no opening inventory and absorption costing income was $500,000 higher than variable costing income, the units in ending inventory was 25,000 (500,000 / 20).

b) Since total variable selling, general and administrative costs was $2,125,000 and the rate per unit was $5, unit sales was 425,000 (2,125,000 / 5).

c) Since sales were 425,000, ending inventory was 25,000, and there was no opening inventory, production was 450,000.

d) Since the total contribution margin under variable costing is $14,875,000 (21,250,000 – 4,250,000 – 2,125,000) and 425,000 units were sold, the contribution margin per unit is $35 (14,875,000 / 425,000). Therefore, breakeven units under variable costing would be 428,572 ((10,000,000 + 5,000,000) / 35) units.

Problem 6

a) If 1,000,000 units are produced, income will be 1,000,000 * (30-20) – 5,000,000 – 3,000,000 = 2,000,000 and Sharon’s bonus will be $20,000 (2,000,000 * 1%).

b) If 1,200,000 units are produced, income will be 1,000,000 (200,000 * 5) higher and Sharon’s bonus will be $10,000 (1,000,000 * 1%) higher or $30,000.

c) Since this is a production department, Sharon’s reward is based on her ability to control flexible budget variances.
Problem 7

a. Sales (20,000 x $60) $1,200,000
   Variable costs (20,000 x $30) 600,000
   Contribution margin 600,000
   Fixed costs 380,000
   Operating income $220,000

b. Sales (20,000 x $60) $1,200,000
   Cost of goods sold
      Opening inventory: 2,000 x (30 + 9*) $ 78,000
      Cost of goods manufactured
         Variable costs – 24,000 x $30 720,000
         Fixed costs 180,000
      Ending inventory
         6,000 x (30 + 7.50**) (225,000) 753,000
      Gross margin 447,000
      Selling and administrative expenses 200,000
      Operating income $247,000

c. Difference in income
   Fixed costs in opening inventory: 2,000 x $9 ($18,000)
   Fixed costs in ending inventory: 6,000 x $7.50 45,000
   $27,000

* $180,000 / 20,000 units produced last year
** $180,000 / 24,000 units produced this year
Problem 8

a. Although sales volume increased by 100,000 kg causing an increase in contribution margin, because inventories went down significantly since last year, much of the fixed costs that had accumulated in the opening inventories were released to cost of goods sold during the year.

b. i. Sales $11,200,000

<table>
<thead>
<tr>
<th>Variable costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening inventory: 600,000 x $5</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Cost of goods manufactured:</td>
<td></td>
</tr>
<tr>
<td>500,000 x $5.50</td>
<td>$2,750,000</td>
</tr>
<tr>
<td>Less ending inventory:</td>
<td></td>
</tr>
<tr>
<td>100,000 x $5.50</td>
<td>(550,000)</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>6,000,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fixed costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>3,300,000</td>
</tr>
<tr>
<td>Selling and administrative</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>4,800,000</td>
</tr>
<tr>
<td></td>
<td>$ 1,200,000</td>
</tr>
</tbody>
</table>

ii. Fixed costs in opening inventory:

| Fixed costs in opening inventory:                                   |             |
| 600,000 x $2.50*                                                   | (1,500,000) |
| Fixed costs in ending inventory:                                   |             |
| 100,000 x $6.60**                                                  | 660,000     |
|                                                                    | $840,000    |

Equals the difference in income between variable and absorption costing of:

$1,200,000 - $360,000

* $3,000,000 / 1,200,000 kg produced in 2003
** $3,300,000 / 500,000 kg produced in 2004
20. Transfer Pricing

Learning Objectives

After completing this chapter, you will:

1. Understand the nature and role of profit centres in organizations and how transfer prices support the evaluation of profit centre performance.
2. Understand and be able to compute and explain the four general approaches to transfer pricing and the behaviour that each promotes.

Responsibility Centres – An Introduction

Responsibility centres are administrative units within larger organizations. The following are examples of responsibility units and the objective for which the responsibility unit manager might be held accountable:

<table>
<thead>
<tr>
<th>Responsibility Centre</th>
<th>Objective(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production line</td>
<td>Control costs, achieve target quality and meet production schedule</td>
</tr>
<tr>
<td>Product line</td>
<td>Meet sales, growth and profitability targets</td>
</tr>
<tr>
<td>Warehouse</td>
<td>Control inventory costs, meet shipping schedules</td>
</tr>
<tr>
<td>Appliance department in a department store</td>
<td>Meet sales target</td>
</tr>
<tr>
<td>One property in a motel chain</td>
<td>Meet sales and profitability targets, score on mystery shopper visits</td>
</tr>
<tr>
<td>A business within a large conglomerate</td>
<td>Meet return on investment target</td>
</tr>
</tbody>
</table>

Responsibility accounting systems record and assess performance on the objectives assigned to each responsibility centre. The manager of each responsibility unit is held accountable for the objectives assigned to a unit. A responsibility centre’s manager incentive compensation is often based, in part, on performance relative to the centre’s assigned targets.

The overriding purpose of creating responsibility centres and assigning accountability for responsibility centre performance to managers is to promote achievement of the organization’s objectives. The sole criterion relevant for evaluating the success of the responsibility centre organization form is how well it promotes improvement in overall organization performance.

We will discuss the objectives and scope of responsibility centre design in Chapter 21. In this chapter, we focus on profit centres which are an important type of responsibility centre.
Before we discuss the different approaches to transfer pricing, we need to discuss the nature of profit centres, which identify the role of transfer prices.

**Profit Centres**

The focus of this chapter is transfer pricing, which involves valuing the transfer of a good or service between two responsibility centres. Transfer pricing is only required when the receiving unit is evaluated based on a measure of profit. There are two types of responsibility centres whose performance evaluations are profit based, profit centres and investment centres. Since the transfer pricing issues are the same for both responsibility centre types, we will focus on profit centres in this chapter for expositional convenience.

A profit centre is an organization unit whose manager is held accountable for the profit the unit contributes to the larger organization. The intention is that as profit centre managers pursue the profit objectives assigned to their respective profit centres, they will improve the overall profitability of the organization. Therefore, the primary role of the profit centre approach is to promote an entrepreneurial spirit in managers that improves the organization’s overall performance.

It is important to remember that a profit centre is a fiction created to motivate improved organization performance. Therefore, the only basis for evaluating the profit centre model is whether it succeeds in doing that. Therefore, in all of what follows, the key is to be aware of the two perspectives on transfer pricing that can conflict:

- The perspective of the organization, which is how the transfer price and the resulting profit centre profit can motivate improvement in overall organization performance.
- The perspective of the individual profit centre managers, which is how the transfer price can improve the profit centre’s reported profits and the rewards managers receive from increasing reported profit.

**Potential Interpersonal Conflicts in Transfer Pricing**

To summarize the discussion in the previous section, the transfer pricing method used will result in a transfer price that, in turn, will cause profit centre managers to behave in ways to make their own centre’s profit as large as possible, which, in some cases, can lead to behaviour that results in the organization’s total profit being reduced.

Transfers to a profit centre can be made from a cost centre (which is evaluated based on its ability to control costs) or from another profit centre. If the centre supplying the transfer is a cost centre, the transfer price is of no consequence to that unit. However, if the centre supplying the transfer is a profit centre, the transfer price will define the supplier’s revenue and, hence, will be a factor in determining the supplier’s profit. The transfer price will always be relevant for the receiver since the transfer price will be treated as part of the receiving centre’s cost. Therefore, as the transfer price goes up (down) the seller will be willing to provide more (less) and the
buyer will be willing to buy less (more). It is possible the transfer price may cause the quantity to be transferred to be different than what is best for the overall organization.

Transfer prices can be formula based or negotiated. If transfer prices are set by formula, it is important to understand the behaviour that each approach will motivate. If transfer prices are set by negotiation, it is important to understand the motivations the negotiators will have as they negotiate a transfer price.

**Approaches to Setting the Transfer Price**

There are broad classes of transfer pricing:

1. Approaches based on market price
   - market price
   - adjustments of market price

2. Approaches based on cost
   - variable cost
   - variable cost plus opportunity cost
   - full cost
   - full cost plus mark-up

3. Negotiation

4. Other
   - market price less some adjustment
   - profit splitting
   - dual rate transfer pricing

**Market Price Approaches**

Management accountants are unequivocal in agreeing that when a market price exists, it should be used as the transfer price. This applies irrespective of whether the supplying division is a cost centre or a profit centre.

The idea is that a market price provides an objective valuation of the good or service being transferred and, therefore, provides appropriate incentives to the buying and selling parties. If the supplying division is a profit centre, the market price reflects the opportunity cost of not selling outside. If the supplying division is a cost centre, transferring the intermediate product at less than its market value overstates the value added by the profit centre’s activities, which, in turn, can lead to inappropriate production decisions.

For the buying division, the market price reflects the value of the resource it consumes in its production activities. Any price below market price will result in opportunity losses for the organization as the resource is not used in its most productive manner.
For example, assume Department A produces a product that can be sold to yield a net realizable value of $10 but is transferred to Department B for $8, which is the full cost of producing the intermediate product. Department B adds costs totalling $15 to the intermediate product and sells the final product for $24. Department B reports a profit of $1 for every unit, however, the organization loses $1 for every unit processed further, since the incremental costs exceed the incremental value added.

When a market price exists, the true opportunity cost from not selling outside is the net realizable value of the good or service being transferred since customer related costs, such as selling and distribution, are avoided. Therefore, the stated market price is adjusted for any costs that are avoided by dealing internally.

A significant issue that arises in practice is what constitutes a true market price. For example, in Maggie Company, Division A produces a product Division B sells. There is a market price for the product that is transferred. An outside company seeking to expand sales offers Division B a comparable product at a sharply reduced price. If Division B accepts this offer, it will improve its reported profits significantly. From a purely financial view if the outside price is less than the variable cost of producing internally, the organization will be better off by accepting the outside offer. However, if the offer is accepted, it will likely create havoc in Division A. Production lines will have to be shut down and employees laid off. For this reason, market based transfer prices are often set at expected long-term market prices rather than short-term opportunistic prices outside suppliers might offer.

Cost Based Approaches to Transfer Pricing

Surveys of transfer pricing practice suggest cost based approaches continue to be the most widely used in transfer pricing. This likely reflects two reasons:

1. Costs are readily available in many organizations, and
2. Market prices are not readily available for many intermediate goods transferred between profit centres.

There are many variations on cost based transfer prices. The most likely explanation for these variations is the economic reasoning underlying transfer pricing.

One of the most basic issues in cost based transfer pricing is whether cost should be the actual cost or the standard cost. Although management accountants are divided on this issue, most argue that the transfer price should be based on standard cost for two reasons:

1. To provide the supplying division the incentive to control costs rather than pass along unfavourable variances.
2. To provide a transfer price that reflects long-term conditions rather than cyclical conditions that can affect the costs of variable factors of production.
Variable Cost Based Transfer Prices

Assume that buying Division B can use all the intermediate product the selling Division A can supply. Division A has excess capacity. The discussion of relevant cost in Chapter 10 should lead you to conclude the relevant cost of Division A supplying Division B and, therefore, the transfer price, should be variable cost. The transfer price provides the clearest signal to Division B of the value of the product being transferred as managers in Division B make their production decisions.

If Division A incurs an opportunity cost of supply, the intermediate product, for example, has to curtail production of other products that are profitable, the relevant cost is variable cost plus opportunity cost. In this example, the variable cost should be adjusted to reflect the opportunity cost involved in making the transfer.

The problem with this, of course, is if the transfer is made at either of these variable cost alternatives, Division A earns no incremental profit on the transaction and, therefore, has no motivation to supply any product (or, for that matter, does it have any motivation, not to supply the product). In effect, this is analogous to the short-term or depressed market price setting discussed above.

While, in theory, the variable cost based approaches provide the correct short-term insights, many managers argue that facilities and production planning are too complex to be based on short-term conditions and, therefore, for organization planning and stability purposes, cost based transfer prices should reflect long-term considerations.

Full Cost Based Transfer Prices

Full cost based transfer prices, which are common in practice, may reflect a practical approach organizations use to provide stability in organization planning and operations. In these approaches, the transfer price is full cost or full cost plus a mark-up.

When the transfer price is full cost the buying division is provided with an estimate of the long-term cost of producing the intermediate product and can factor that cost into its production decisions. The issue, of course, is the cost no longer reflects the relevant short-term cost but the long-term relevant cost and, therefore, short-term profitability is potentially sacrificed for long-term planning and stability.

The problem with full cost transfer prices is they result in little or no profit attributed to the supplying division. If all planned costs are realized, the only organization unit that will report a profit is the last organization in the value chain since for all upstream units, the revenue they receive will equal their costs.

The interesting thing about full cost based transfer prices is they align nicely with cost based approaches to performance evaluation. If the cost based transfer price is set at standard cost, then the “profit” reported by each division will be standard cost minus actual cost, which, of course, is each unit’s flexible budget variance.
Observers argue that this is perfectly consistent with responsibilities. Since the supplying division does not contract externally for the intermediate product, it should not be evaluated based on the revenue it creates, but rather, what it controls, which is cost.

This may be the reason why full cost based transfer pricing systems are popular in practice.

A variation of a full cost based transfer price is full cost plus a mark-up. The purpose of the mark-up is to provide a profit potential for the supply division. However, the mark-up creates an inappropriate economic signal to the buying division, since the transfer price no longer reflects costs.

**Negotiated Transfer Prices**

Negotiated transfer prices reflect the essential nature of profit centres since, in this approach, the profit centre manager has a direct influence on the transfer price. Negotiated transfer prices are often used when the intermediate good is a finished good and it is difficult to determine the market price, or when the transfer involves an intermediate product that is seldom transferred.

There are two problems with using negotiated transfer prices:

1. Negotiations may be long and protracted and may consume an inordinate amount of time if transfers are frequent.

2. Negotiations can easily lead to a setting where, from the point of view of the organization, less desirable situations will occur.

To illustrate the first point, consider the operations of an automobile dealership organized on a profit centre basis. The used car department takes a customer’s trade-in and needs to dispose of that vehicle. The managers of the used and new car departments negotiate the transfer price, which is difficult to determine, since it involves a number of different factors, including the mechanical condition of the vehicle. Negotiations are frequent because of the number of transactions involved. Therefore, in many dealerships, the process of automatically transferring a used car to the new car department and negotiating a transfer price has been suspended in favour of allowing the used car manager to send the vehicle to an auction, unless the used car manager offers an acceptable price.

The second point is more subtle. Many observers point out that negotiated transfer prices may reflect the relative bargaining skills of the negotiators rather than the underlying economic value of the good or service being transferred. While this is true, the result is completely consistent with the assignment of accountability underlying responsibility centres. The real issue is the negotiators move away from a transfer price that reflect the good’s economic value. In turn, this will cause the production decisions undertaken by the supplier and the buyer to move away from the choices that would be best from the perspective of the overall organization.
For these two reasons, but particularly the first, negotiated transfer prices are seldom found in practice and are usually confined to situations where there are infrequent transfers of an intermediate product that has no obvious market value.

Other Transfer Prices

Administered Transfer Prices

Administered transfer prices are transfer prices set by senior management. For example, the general manager of an automobile dealership may set the transfer price for shop labour, provided by the service department in the dealership to other departments, at the posted shop rate less 20%.

On the one hand, this approach appears to violate the principle of profit centres since the transfer price is imposed and usually, since the internal rate is less than the outside rate, favours the buying departments. On the other hand, this approach may simply reflect the practical observation the demand provided by the internal departments is likely to be steadier and more predictable and, therefore, is less costly because it is more easily planned and scheduled.

Profit Splitting

In the profit splitting approach to transfer pricing, the total return earned by the various departments is split among the departments using a formula. There are many profit splitting approaches used in practice including those based on each department getting an equal share or getting a share based on its size (such as cost or value added). However, one of the most interesting approaches is the stand alone approach.

To illustrate, consider three departments that contribute to a project that creates an incremental profit of $700,000. The opportunity costs of the three departments contributing to the project are: $100,000, $50,000 and $200,000. The stand alone approach would result in allocating the incremental profits to the three departments as: $200,000 (100,000 / 350,000), $100,000 (50,000 / 350,000) and $400,000 (200,000 / 350,000). The transfer prices to achieve these allocations would be set accordingly.

Dual Rate Approach

In the dual rate approach, the transfer price received by the selling division is the net realizable value of the product, while the price paid by the buying division is the incremental cost to date of the product. This approach provides for costs and revenues in a transfer pricing system that reflect economic theory, since the buyer pays incremental cost for the intermediate product and the seller receives the incremental revenue, thereby, aligning the interests of both parties with the overall interests of the organization.
A General Transfer Pricing Model

The above discussion deals with setting transfer prices between sub-units of the same organization as a general overall policy. There are times, however, that the transfer in question is relatively substantial relative to the selling and purchasing divisions that requires managerial attention.

Generally, a transfer should occur between two divisions if it results in incremental income to the company.

The minimum transfer price is the price that would make the selling division as well off as it was before the transfer and is equal to:

\[
\text{Variable cost} + \text{opportunity cost of lost sales (contribution margin lost)} \pm \text{any other differential costs of making the transfer}
\]

The maximum transfer price is the price that would make the purchasing division as well off as it was before and is equal to:

\[
\text{External price paid} \pm \text{any other differential costs of making the transfer}
\]

If the maximum transfer price exceeds the minimum transfer price, then there will be a benefit to the company and the two divisions of making a transfer.

Example: Division A makes a component whose cost structure is:

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>Amount (in $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable costs – manufacturing</td>
<td>$15</td>
</tr>
<tr>
<td>Variable costs – selling</td>
<td>2</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$27</strong></td>
</tr>
</tbody>
</table>

Division A's annual capacity is 150,000 units and current external sales are 120,000 units at a selling price of $45 each.

Division Z uses a similar component as the one manufactured by Division A and currently purchases 50,000 units from an external supplier at a cost of $42 per unit.

The issue is whether or not Division A should source the component from Division Z.
From the company's perspective, the incremental benefit of doing a transfer is:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings by not purchasing from the external supplier: 50,000 x $42</td>
<td>$2,100,000</td>
</tr>
<tr>
<td>Cost of producing 50,000 units internally*: 50,000 x $15</td>
<td>(750,000)</td>
</tr>
<tr>
<td>Opportunity cost of lost external sales** - lost contribution margin:</td>
<td>(560,000)</td>
</tr>
<tr>
<td>20,000 x $45 - 15 - 2</td>
<td></td>
</tr>
<tr>
<td>Net benefit</td>
<td>$ 790,000</td>
</tr>
</tbody>
</table>

* The usual assumption in such transfers is that all units required are transferred internally. The purchasing division is not likely to accept a partial shipment and then source the remaining requirements externally, they will generally want to deal with one supplier for a given component.

** The selling division (A) currently has excess capacity of 150,000 - 120,000 = 30,000 units. In order to meet Division Z's requirements, they will need to turn away 50,000 - 30,000 = 20,000 units of regular sales.

Clearly, it is in the best interests of the company to have a transfer take place. The next step is for the managers of each division to negotiate a suitable transfer price.

The minimum transfer price from the Division A manager's perspective is the lowest price that could be charged for each component that would leave the division indifferent:

Minimum TP = variable cost + opportunity cost
= $15 + ($560,000 / 50,000)
= $15 + 11.20
= $26.20

The maximum transfer price is the most the Division Z manager would pay for each component and is equal to the price they are currently paying, $42 per unit.

Given the minimum TP < maximum TP, a range of transfer prices exist that will make each division better off. Assume the agreed upon transfer price is $39 per unit.

The incremental benefit to Division A is:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution margin on internal sales: 50,000 x (39 - 15)</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>Opportunity cost of lost external sales** - lost contribution margin:</td>
<td>(560,000)</td>
</tr>
<tr>
<td>20,000 x $45 - 15 - 2</td>
<td></td>
</tr>
<tr>
<td>Net benefit</td>
<td>$640,000</td>
</tr>
</tbody>
</table>

The incremental benefit to Division Z is 50,000 units x ($42 - 39) = $150,000

The total benefit of $640,000 + 150,000 = $790,000 and is equal to the overall benefit calculated from the company's perspective above.
International Transfer Pricing

The discussion in this chapter has focussed on transfer prices needed to support transfers that take place within organizations. Management accountants call this class of transfer prices domestic transfer prices. International transfer prices arise when goods and services are transferred between different tax jurisdictions. Whereas the primary issues in domestic transfer prices are to motivate responsibility centre managers to make decisions that are in the organization’s best interests, in international transfer pricing, the motivation is to minimize global tax payments, while respecting the laws in each tax jurisdiction.

The issue that arises is quite basic. If a multi-national organization makes a product in one country and sells the product in another country, the transfer price should be set so that as much income as possible will be recognized in the country with the lower tax rates. Tax authorities are clearly aware of this motivation, so each country has enacted laws relating to the appropriate transfer price that should be used.

Most tax authorities follow the international transfer pricing regulations laid down by the Organization for Economic Development and Cooperation (OECD). In Canada, there are two groups of international transfer pricing methods each with alternatives:

1. The transactional methods:
   - comparable uncontrolled price
   - resale price method
   - cost plus method

2. The transactional profit methods:
   - profit split method
   - transactional net margin method

The issues in multi-national transfer pricing are beyond the scope of this review. However, since there are potentially huge effects on taxes payable by multi-nationals and tax revenues for tax authorities, this is a significant area for tax planning.

Conclusion:

Transfer prices are needed when intermediate products (goods or services) are transferred between organization units that are evaluated using the responsibility centre approach. Transfer prices provide the basis for the financial evaluation of the department’s performance. It is important to stress that a responsibility centre’s financial evaluation may be only one of the elements of performance used to evaluate a responsibility centre. The need for and, a discussion of, other performance metrics is a topic addressed in Chapter 21.
Problems with Solutions

Multiple Choice Questions

1. Mar Company has two decentralized divisions, X and Y. Division X has been purchasing certain component parts from Division Y at $75 per unit. Because Division Y plans to raise the price to $100 per unit, Division X desires to purchase these parts from external suppliers for $75 per unit. The following information is available:

- Y's variable costs per unit: $70
- Y's annual fixed costs: $15,000
- Y's annual production of these parts for X: 1,000 units

If Division X buys from an external supplier, the facilities Division Y uses to manufacture these parts will be idle. Assuming Division Y's fixed costs cannot be avoided, what is the result if Mar requires Division X to buy from Division Y at a transfer price of $100 per unit?

a) It is sub-optimal for the company as a whole because X should buy from outside suppliers at $75 per unit.

b) It is more profitable for the company as a whole than allowing X to buy from outside suppliers at $75 per unit.

c) It provides higher overall company operating income than a transfer price of $75 per unit.

d) It provides lower overall company operating income than a transfer price of $75 per unit.
Questions 2 and 3 refer to the following:

A company has two divisions, the Hogan Division and the Jasper Division. The Hogan Division makes and sells K7 motors, which can either be sold to outside customers or to the Jasper Division. Next month, the following results are expected to occur at Hogan:

- **Selling price per K7 motor to outside customers**: $115
- **Unit variable production cost**: $75
- **Monthly capacity of K7 motors**: 3,500 units
- **Sales of K7 motors to outside customers**: 2,100 units

Jasper would like to buy 1,200 of these motors from Hogan next month. Hogan can purchase these motors from an outside supplier at $110 each.

2. If Hogan sells 1,200 of the motors to Jasper next month at a price of $110 per motor, the monthly effect on profits of the company as a whole will be:
   a) $42,000 decrease
   b) $42,000 increase
   c) $48,000 increase
   d) $48,000 decrease
   e) None of the above

3. Assume sales of K7 motors to outside customers is expected to be 2,840 units next month while all other conditions remain the same. If Hogan sells 1,200 motors to Jasper next month at a price of $110 per motor, the monthly effect on profits of the company as a whole will be:
   a) $42,000 decrease
   b) $42,000 increase
   c) $21,600 decrease
   d) $20,400 increase
   e) None of the above
Questions 4 – 11 refer to the following:

Quinn Company is divided into two profit centres, manufacturing and selling. One of the products the manufacturing division transfers to the selling division is Product XT332. In the manufacturing division, the standard variable manufacturing cost of producing XT332 and the standard full manufacturing cost of producing XT332 are $43 and $47.50, respectively. The fixed manufacturing overhead rate per unit is computed by dividing expected fixed manufacturing costs by the denominator activity level of 500,000 units. During the most recent period, the actual variable manufacturing cost was $44.15 per unit and the fixed manufacturing overhead spending variance was $150,000 favourable.

The selling division incurs variable and fixed manufacturing costs of $2.35 and $1.95, respectively to complete the product for sale. Selling costs are $.50 per unit. The selling division faces the following demand schedule for this product:

<table>
<thead>
<tr>
<th>Price</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>$54.00</td>
<td>600,000</td>
</tr>
<tr>
<td>56.00</td>
<td>590,000</td>
</tr>
<tr>
<td>58.00</td>
<td>575,000</td>
</tr>
<tr>
<td>60.00</td>
<td>555,000</td>
</tr>
<tr>
<td>62.00</td>
<td>520,000</td>
</tr>
<tr>
<td>63.00</td>
<td>480,000</td>
</tr>
<tr>
<td>63.50</td>
<td>420,000</td>
</tr>
<tr>
<td>63.75</td>
<td>320,000</td>
</tr>
<tr>
<td>64.00</td>
<td>300,000</td>
</tr>
</tbody>
</table>

4. If the transfer price is standard full manufacturing cost, how many units of XT332 will the selling division demand?
   a) 600,000
   b) 575,000
   c) 520,000
   d) 480,000

5. Assume the manufacturing division produces and sells 500,000 units of XT332 to the selling division, what profit would the manufacturing division report for work on this product if the transfer price is standard full manufacturing cost:
   a) ($425,000)
   b) ($150,000)
   c) $150,000
   d) $575,000
6. If the transfer price is standard variable manufacturing cost, how many units of XT332 will the selling division demand?
   a) 600,000  
b) 575,000  
c) 520,000  
d) 480,000

The following information is additional to the information for Quinn Company and applies to Questions 7 – 10:

The manufacturing division has been approached by an outside customer. The customer wants the manufacturing division to produce a product that will provide a contribution margin of $15 per unit. The customer will purchase whatever quantity the manufacturing division can supply and is prepared to sign a long-term contract to purchase at this price. For every unit supplied to this external customer, the manufacturing division will have to give up making three units of XT332.

7. If the managers of the profit centres are free to negotiate the transfer price, what is the minimum price the manager of the manufacturing division should accept for each unit of XT332?
   a) $44.00  
b) $47.50  
c) $48.00  
d) $59.00

8. From the point of view of Quinn Company, what is the optimal number of units of XT332 that should be transferred to the selling division under these conditions?
   a) 600,000  
b) 575,000  
c) 520,000  
d) 480,000

9. What is the opportunity loss to Quinn Company if the CEO insists on using standard full cost as the transfer price?
   a) ($135,000)  
b) ($75,000)  
c) 0  
d) $125,000
10. In addition to the above information, assume the manufacturing division is in a tax jurisdiction with a marginal tax rate of 40% and the selling division is in a tax jurisdiction with a marginal tax rate of 30%. Ignoring all other considerations, the optimal transfer price from the perspective of Quinn Division would be:

a) Standard variable cost
b) Standard full cost
c) Standard variable cost plus opportunity cost
d) Cannot be determined from the information provided
Problem 1

Diversified Liquid Products (DLP) is a multi-divisional manufacturer of various liquid products. The divisions are autonomous segments with each division responsible for its own sales, cost of operations and equipment acquisition. Divisional performance is evaluated annually based on ROI. Each division serves a different market. Because the markets and products of the divisions are so different, there have never been any transfers between divisions.

The consumer division manufactures products purchased by individuals for household use. The division plans to introduce a new household cleaning product called Sludge. Roberta Katz, the consumer division manager, has discussed the supply of the glass container for Sludge with Nathan Danielson of the industrial division. They both believe a glass container currently made by the industrial division for packaging its product Lubri-Solve could be modified for use with Sludge. Consequently, Katz asked Danielson for a price for the glass containers. The following conversation took place regarding the price to be charged for the glass containers:

Danielson: “Roberta, we can make the necessary modifications to the glass container easily. The specifications used in packaging Sludge are slightly different, so the raw materials should cost about 10% more than those used for the glass container for Lubri-Solve. However, the labour time should be the same because the glass container fabrication process is the same. I would price the glass container at our regular rate: full cost plus a 30% mark-up, which, according to my calculations, would be $20.53 per glass container.”

Katz: “That’s higher than I expected, Nathan. I was thinking a good price would be your variable manufacturing cost. After all, your fixed costs will be incurred regardless of this job. In addition, I received a quotation from one of the consumer division’s regular suppliers to provide us with the glass container at $19 each.”

Danielson: “Roberta, I am at capacity. By making the glass container for you, I have to cut my production of Lubri-Solve. The labour time freed by not having to mix chemicals and package Lubri-Solve can be shifted to the production of Scrubo, our other product. I’d like to sell the glass containers to you at variable cost, but I have excess demand for both products. I don’t mind changing my product mix to Scrubo as long as I can continue to make the same ROI for my division. The following are my standard costs for the two products and a schedule of my manufacturing overhead”. (See Exhibits 1 and 2)
### Exhibit 1 – Industrial Division Standard Costs and Prices

<table>
<thead>
<tr>
<th>Material/Activity</th>
<th>Lubri-Solve</th>
<th>Scrubo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>$7.35</td>
<td>$6.50</td>
</tr>
<tr>
<td>Glass container</td>
<td>6.40</td>
<td>—</td>
</tr>
<tr>
<td>Paper box (purchased)</td>
<td>—</td>
<td>6.00</td>
</tr>
<tr>
<td>Chemical mixing (.5 hrs. @ $7.50/hr.)</td>
<td>3.75</td>
<td>3.75</td>
</tr>
<tr>
<td>Glass container (.5 hrs. @ $7.50/hr.)</td>
<td>3.75</td>
<td>—</td>
</tr>
<tr>
<td>Packaging (.5 hrs. @ $7.50/hr.)</td>
<td>3.75</td>
<td>3.75</td>
</tr>
<tr>
<td>Manufacturing overhead ($10/DLH)</td>
<td>15.00</td>
<td>10.00</td>
</tr>
<tr>
<td><strong>Total standard cost</strong></td>
<td><strong>$40.00</strong></td>
<td><strong>$30.00</strong></td>
</tr>
<tr>
<td>Selling price (including 30% mark-up)</td>
<td><strong>$52.00</strong></td>
<td><strong>$39.00</strong></td>
</tr>
</tbody>
</table>

### Exhibit 2 – Industrial Division Manufacturing Overhead Budget

<table>
<thead>
<tr>
<th>Overhead Item</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplies</td>
<td>Variable</td>
<td>$370,000</td>
</tr>
<tr>
<td>Indirect labour</td>
<td>Variable</td>
<td>375,000</td>
</tr>
<tr>
<td>Supervision</td>
<td>Fixed</td>
<td>150,000</td>
</tr>
<tr>
<td>Power</td>
<td>Variable</td>
<td>180,000</td>
</tr>
<tr>
<td>Heat and light</td>
<td>Fixed</td>
<td>120,000</td>
</tr>
<tr>
<td>Property tax and insurance</td>
<td>Fixed</td>
<td>130,000</td>
</tr>
<tr>
<td>Depreciation</td>
<td>Fixed</td>
<td>1,100,000</td>
</tr>
<tr>
<td>Employee benefits</td>
<td>Variable</td>
<td>575,000</td>
</tr>
<tr>
<td><strong>Total overhead</strong></td>
<td></td>
<td><strong>$3,000,000</strong></td>
</tr>
<tr>
<td>Capacity in direct labour hours (DLH)</td>
<td></td>
<td>300,000</td>
</tr>
<tr>
<td>Overhead rate per direct labour hour</td>
<td></td>
<td><strong>$10</strong></td>
</tr>
</tbody>
</table>

Katz: “I see your point, Nathan, but I don’t want to price myself out of the market. In addition to pricing, I am also concerned about delivery. We’ll need the glass containers within two weeks of placing our order or we risk losing some important potential customers. Our outside supplier claims they can meet our timing needs.”

Danielson: “Oh-oh. That lead-time is short considering the production rescheduling we need to do. I can’t promise you a lead-time shorter than four weeks at the moment.”
Katz: "There are a number of issues that need to be addressed here, Nathan. As we have no previous experience in transferring goods between our divisions, I think we should speak with the controller at corporate headquarters before we can agree on a transfer price.”

Required:

Calculate the transfer price that satisfies Danielson’s ROI requirements.
Problem 2

West Industries is a highly decentralized corporation with independent operating divisions. Each division is evaluated and rewarded based on its total net income. One division, Visic, manufacture and sell air conditioners. It is projecting a sales forecast of 17,400 for next year.

Another division, Weber, makes and sells compressors. Its projected income statement for next year is:

<table>
<thead>
<tr>
<th>Weber Division</th>
<th>Per Unit</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pro Forma Income Statement</td>
<td></td>
<td>for next year</td>
</tr>
<tr>
<td>Sales revenues</td>
<td>$100</td>
<td>$6,400,000</td>
</tr>
<tr>
<td>Less cost of goods sold:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>12</td>
<td>768,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>8</td>
<td>512,000</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>10</td>
<td>640,000</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td>11</td>
<td>704,000</td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>2,624,000</td>
</tr>
<tr>
<td>Gross profit</td>
<td>59</td>
<td>3,776,000</td>
</tr>
<tr>
<td>Operating expenses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable selling expenses</td>
<td>6</td>
<td>384,000</td>
</tr>
<tr>
<td>Fixed selling expenses</td>
<td>4</td>
<td>256,000</td>
</tr>
<tr>
<td>Fixed administrative expenses</td>
<td>7</td>
<td>448,000</td>
</tr>
<tr>
<td>Total operating expenses</td>
<td>17</td>
<td>1,088,000</td>
</tr>
<tr>
<td>Pre-tax net income</td>
<td>$42</td>
<td>$2,688,000</td>
</tr>
</tbody>
</table>

Weber has the capacity to produce 75,000 compressors annually. Visic, currently purchasing from an outside source at $70, proposes Weber transfer compressors to them at a transfer price of $50. The Visic manager justified the low bid based on cost savings that should be realized if compressors are transferred. Because specifications for this compressor are slightly different from Weber's standard model, $1.50 per compressor of direct materials cost can be saved and no variable selling expenses will be incurred on compressors transferred.

Required:

a. Compute the estimated effect on Weber's net income if the 17,400 compressors are transferred at $50 each.

b. Determine whether it would be in West Industries' best interests for Weber to transfer compressors at $50 each.

c. What is the minimum transfer price you would accept as the Weber manager?
Problem 3

Parker Corporation has two divisions, Ajax and Defco, and both are profit centres. One of the products Ajax manufactures is electrical fitting 1726, which is protected under patent and, thus, is not available from any other source. Its variable costs are $4.25 per unit and its normal sales price is $7.50.

Defco has just been awarded an Air Force contract for the manufacture of a special brake unit. Because Defco was only operating at 50% capacity, it purposefully bid low to increase its chances of winning the contract in what, the manager believed, would be a competitive process, due to the sagging state of the defence contracting and airline manufacturing industries. The brake's bid sheet shows:

| Purchased parts from outside vendors | $22.50  |
| Ajax electrical fitting 1726 | 5.00    |
| Other variable costs | 14.00   |
| Standard variable manufacturing and delivery costs | 41.50   |
| Indirect cost mark-up for fixed factory overhead, administration costs and profit | 8.00    |
| **Brake bid price** | **$49.50** |

Required:

a. Recommend whether or not Ajax should supply fitting 1726 to Defco.
b. Discuss whether a transfer is in Parker's long-term economic interest.
Problem 4

Nolan Electronics is organized into two profit centres, the manufacturing division and the selling division. The manufacturing division produces a programmable chip that can be used in timers and process control equipment. The variable and fixed manufacturing costs per chip are $5 and $8, respectively. The chips can be sold to yield net revenue of $14 per unit. The chip manufacturing facility is operating at capacity. The controller in the manufacturing facility has estimated that because of other production opportunities, the opportunity cost of producing this chip is $9 per unit.

The selling division programs the chips to meet the requirements of individual customers. The variable and fixed costs per chip in the selling division are $1.50 and $.25, respectively. On average, the programmed chips are sold to yield a net revenue of $16 per unit.

During the past year the manufacturing division transferred 750,000 chips to the selling division. All costs were 10% above standard in the manufacturing division and at standard in the selling division.

Required:

a) What is the incremental profit reported by the manufacturing division and the selling division resulting from these chips if:
   i. The transfer price is standard full manufacturing cost.
   ii. The transfer price is market price

b) If the chip price is to be negotiated:
   i. What should be the floor price for the manufacturing division?
   ii. Which should be the ceiling price for the selling division?
Problem 5

Mortie Motors has four profit centres: new car sales; used car sales; service; and leasing. The new car sales department acquires used cars from customers who trade them in on new car purchases. The new car sales department can either sell the used car to the used car sales department or sell the used car in a used car auction which operates twice weekly.

The auction charges the seller a fee equal to 3% of the value of the automobile sold. In addition, Mortie Motors pays transportation related costs of about $100 for each car conveyed to the auction. The buyer at the auction pays 13% HST on all purchases. About 90% of buyers are independent used car dealers.

Mortie, the owner and general manager of Mortie Motors, is tired of the constant squabbling between the managers of the used and new car departments over the price to be paid for transfers from the new car department to the used car department.

Because the used car auction is large, there is a ready supply of posted prices for used cars that passed through the auction. Mortie decided to use the most recent auction price for the vehicles as the transfer price. These prices reflect the average perceived condition of the vehicles passing through the auction. The rule is, the used car manager can take or decline any vehicle offered by the new car department. However, if the vehicle is taken, the transfer price will be the most recent auction price for that type of vehicle.

The manager of the used car department complained saying the new car manager was transferring the vehicles thought to be in superior condition to the auction where they would return an above average price and offering the vehicles, thought to be in inferior condition, to the used car department where their ultimate value was actually less than the auction price used as the transfer price. Therefore, the used car manager was declining many of the vehicles on offer from the new car department and purchasing through the auction.

Mortie is unsure what to do.

Required:

Given that Mortie is committed to a profit centre organization structure, what would you recommend?
Problem 6

Deere Company is organized into two divisions, A and B. Division A produces an intermediate product that it supplies to Division B. There is no market for the intermediate product. Division B sells the final product for $50 per unit.

The following exhibit identifies the standard costs per unit in each department:

<table>
<thead>
<tr>
<th></th>
<th>Division A</th>
<th>Division B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$5</td>
<td>$2</td>
</tr>
<tr>
<td>Direct labour</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Variable manufacturing overhead</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Fixed manufacturing overhead</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Variable selling</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Fixed selling</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>$20</td>
<td>$17</td>
</tr>
</tbody>
</table>

Deere Company uses a dual transfer pricing system. The transfer price per unit received by Division A is the final selling price less all identifiable additional costs in Division B. The price paid per unit by Division B is the identifiable costs up to the point of transfer.

In the most recent period, there were no variances of any kind and 25,000 units were transferred from Division A to Division B and then all sold by Division B.

Required:

a) What profit would Division A report on these sales?
b) What profit would Division B report on these sales?
c) What profit would Deere Company report on these sales?
d) Should Deere Company use variable
Note that problems 7 and 8 are comprehensive mini-cases where transfer pricing is a central issue in each case. Each case also includes elements discussed in the next chapter. Although it is not necessary, you may find it easier if you attempt each case after you have read Chapter 21.

Problem 7

Canadian Motors International (CMI) is an international company organized into three divisions, each of which is treated as an investment centre. Divisional performance evaluation and managerial bonuses are based on achieving a 12% divisional return on investment (ROI). Divisional ROI is calculated as pre-tax divisional income divided by divisional investment. See Exhibit 1 showing the structure of CMI.

Paul Sing, president of CMI is concerned about both divisional and overall corporate performance. The following discussion took place between Paul Sing and Erin Hunter, the new controller.

Paul Sing, president: "I wonder if the growth we enjoyed in the early eighties was really worth it. Now that we're an international organization, I'm not sure what's going on in each of the divisions."

Erin Hunter, controller: "But you've laid out some ground rules for the divisional managers to work within. I heard you say this morning they are supposed to act as independent business units and maximize divisional return on investments."

Paul Sing, president: "I've also instructed the divisional managers to buy from and sell to each other, whenever possible, and the price for these internal transactions has to be set at 1.25 times full production cost. Every time I turn around, one of them is complaining about what the other division is doing."

The engine division (ED) manufactures standard carburettor engines and fuel-injected engines. The manufacturing process involves product design, machining of parts, assembly and quality assurance. ED has developed a strong reputation based on product quality and the guarantee of complete customer satisfaction. Lately, CMI management expressed some concerns regarding the overall profitability of ED given CMI's overall desired rate of return of 12% before taxes (the corporate tax rate in Canada is 40%). All carburettor engines produced by ED are sold to the snowmobile division (SD) of CMI.

Information concerning the manufacture of the engines is provided in Exhibit 2. The manager of ED has been complaining that his division's ROI is decreasing as carburettor engine sales to SD increase. He has argued with Paul Sing that he should be allowed to increase the price of carburettor engines to $500, which is the market price for a similar engine. Alternatively, the ED manager has threatened to stop producing carburettor engines. Sales prospects for the fuel-injected engine are virtually limitless at the current price of $600 per engine. The only restriction facing ED is an upper limit of 200,000 machine hours per year.
The snowmobile division (SD) manufactures snowmobiles valued for their durability and performance. Information on the profitability of SD is shown in Exhibit 3. SD buys all its carburettor engines from ED.

Paul Sing has been pleased with the past performance of SD as sales and profits have continued to increase. He decided to ask the SD manager how a price increase in carburettor engines would affect sales. The reply was that snowmobile sales are price sensitive and the proposed increase in the price of engines from ED would require SD to increase the domestic price of the snowmobile to $3,400. This would cause the domestic sales volume to fall to 3,500 units per year. The SD manager also complained that ED's service has steadily decreased over the past year, causing delays in the production of snowmobiles and, if delivery times do not improve, sales could be lost.

The international division (ID) of CMI is located in Sweden where the corporate tax rate is 30%. ID's only business activity is to sell snowmobiles imported from SD. ID pays a 20% import duty based on the transfer price. Customs officials in Sweden carefully monitor the invoices of imported manufactured goods to ensure the goods are priced at "fair values". The government of Sweden considers any price between full production cost and 150% of full production cost to be within its definition of fair value. Information on ID is provided in Exhibit 4.

While ID is only two years old, it has gained a significant market share in Sweden by following a penetration pricing strategy. All indications are that sales will continue to grow. In response to a recent inquiry by Paul Sing, ID's manager indicated the proposed increase in the cost of a snowmobile from SD would lead him to increase the ID sales price by $300 per unit causing volumes to decline to 1,700 per year.

At the conclusion of their meeting, Paul Sing requested Erin Hunter to analyze the company's current situation, including the ED manager’s two proposals and recommend improvements. Specifically, he would like her to determine the impact of each proposal on the pre-tax income and return on investment for each division and the company as a whole, along with the behavioural implications of these proposals. Paul Sing would also like a discussion of the relevant considerations in setting CMI's domestic and international transfer pricing policies. Other issues, such as organization structure, performance evaluation, the bonus system and improvement of the company's future profitability are other concerns Paul Sing would like her to address.

Required:

As Erin Hunter, the new controller, prepare a report to Paul Sing, president of Canadian Motors International.
Exhibit 1
Canadian Motors International

Canadian Motors International (CMI)

<table>
<thead>
<tr>
<th>Division</th>
<th>Products</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Division (Canada) ED</td>
<td>Snowmobiles</td>
<td>In Canada</td>
</tr>
<tr>
<td></td>
<td>Engines</td>
<td></td>
</tr>
<tr>
<td>Carburettor Engines</td>
<td>Snowmobiles</td>
<td>In Canada</td>
</tr>
<tr>
<td></td>
<td>Engines</td>
<td></td>
</tr>
<tr>
<td>International Division (Sweden) ID</td>
<td>Snowmobiles</td>
<td>In Sweden</td>
</tr>
<tr>
<td></td>
<td>Engines</td>
<td></td>
</tr>
</tbody>
</table>
Exhibit 2
Engine Division

<table>
<thead>
<tr>
<th>Volume (units)</th>
<th>Carburettor</th>
<th>Fuel-Injected</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit 6,000</td>
<td>Unit 22,000</td>
<td>Unit 28,000</td>
</tr>
<tr>
<td>Revenue</td>
<td>$400 $2,400,000</td>
<td>$600 $13,200,000</td>
<td>$15,600,000</td>
</tr>
</tbody>
</table>

Direct costs:

<table>
<thead>
<tr>
<th></th>
<th>Per Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>$150</td>
<td>$900,000</td>
</tr>
<tr>
<td>Labour</td>
<td>70</td>
<td>420,000</td>
</tr>
<tr>
<td>Production overhead</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>45</td>
<td>270,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>55</td>
<td>330,000</td>
</tr>
<tr>
<td>Variable selling &amp; admin.</td>
<td>10</td>
<td>60,000</td>
</tr>
</tbody>
</table>

Total direct costs $330 $1,980,000 $359 $7,898,000 $9,878,000

Fixed selling and admin. $4,733,000

Total costs $14,611,000

Pre-tax divisional income $989,000

Machine hours 4 24,000 8 176,000 200,000

Divisional investment $11,697,000

Divisional ROI 8.5%
### Exhibit 3
Snowmobile Division

<table>
<thead>
<tr>
<th></th>
<th>Per Unit</th>
<th>Volume</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales: domestic</td>
<td>$3,300</td>
<td>4,000</td>
<td>$13,200,000</td>
</tr>
<tr>
<td>Sales: transfers to ID</td>
<td>$3,610</td>
<td>2,000</td>
<td>7,220,000</td>
</tr>
<tr>
<td><strong>Total sales</strong></td>
<td></td>
<td>6,000</td>
<td>20,420,000</td>
</tr>
<tr>
<td>Direct materials (Note)</td>
<td>$1,300</td>
<td>6,000</td>
<td>7,800,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>1,200</td>
<td>6,000</td>
<td>7,200,000</td>
</tr>
<tr>
<td>Variable production overhead</td>
<td>100</td>
<td>6,000</td>
<td>600,000</td>
</tr>
<tr>
<td>Fixed production overhead</td>
<td>288</td>
<td>5,000</td>
<td>1,728,000</td>
</tr>
<tr>
<td>Selling and administration:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>52</td>
<td>6,000</td>
<td>312,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>361</td>
<td>6,000</td>
<td>2,166,000</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td>$3,301</td>
<td>6,000</td>
<td>19,806,000</td>
</tr>
<tr>
<td>Pre-tax divisional income</td>
<td></td>
<td></td>
<td>$614,000</td>
</tr>
<tr>
<td>Divisional investment</td>
<td></td>
<td></td>
<td>$4,083,000</td>
</tr>
<tr>
<td>Divisional ROI</td>
<td></td>
<td></td>
<td>15.0%</td>
</tr>
</tbody>
</table>

Note: Includes engines at $400 per engine.
Exhibit 4  
International Division  
(in C$)

<table>
<thead>
<tr>
<th></th>
<th>Per Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td></td>
<td>2,000</td>
</tr>
<tr>
<td>Revenue</td>
<td>$4,700</td>
<td>$9,400,000</td>
</tr>
<tr>
<td>Cost of snowmobiles (Note)</td>
<td>4,332</td>
<td>8,664,000</td>
</tr>
<tr>
<td>Gross margin</td>
<td>368</td>
<td>736,000</td>
</tr>
<tr>
<td>Selling and administration:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>47</td>
<td>94,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>86</td>
<td>172,000</td>
</tr>
<tr>
<td></td>
<td>133</td>
<td>266,000</td>
</tr>
<tr>
<td>Pre-tax divisional income</td>
<td>$235</td>
<td>$470,000</td>
</tr>
<tr>
<td>Divisional investment</td>
<td></td>
<td>$2,379,000</td>
</tr>
<tr>
<td>Divisional ROI</td>
<td></td>
<td>19.8%</td>
</tr>
</tbody>
</table>

Note: As acquired from the snowmobile division at 125% of full production cost (rounded to the nearest dollar) plus 20% import duty on goods imported into Sweden.
Problem 8

Seagull Controls Limited manufactures small control units used in process control equipment. It has two operating divisions: the component division and the device division. The component division was set up originally as an autonomous cost centre with the mission of supplying a high quality control component, CTR1, to the device division where it is made part of a precision control unit (PCU). The CTR1 component is designed specifically for the PCU and there is no immediate external market for the component.

In 2002, Seagull expanded and automated its manufacturing facilities. With the expansion, the component division had enough capacity, not only to satisfy the internal requirements of the device division, but also to accept a contract to produce a new control component, CTR2. The contract was for 25,000 units per year for five years.

The component division has been treated as a profit centre since the commencement of production and sales of CTR2. Its performance evaluation is based on divisional net income before taxes, just like the device division. Since the CTR2 contract provided a net margin of 20%, the component division also demanded a transfer price for the CTR1, which would generate a 20% net margin. The device division had no choice but to accept this transfer price as it could not locate another supplier providing the same quality of the CTR1 as the component division.

Exhibits 1 and 2 provide budgeted net margin data for the two divisions for 2004.

Dave Demski, manager of the device division, was concerned about the high transfer price of the CTR1 component as it was negatively affecting the division’s net income before taxes. In late 2003, Dave began investigating possible external sources of the CTR1 component at more reasonable prices. In January 2004, Dave signed a contract with an external supplier for delivery of 10,000 units of the CTR1 component throughout the year at a price of $210 per unit starting in February 2004. This would result in a savings of $900,000 for the device division when compared with the internal transfer price.

Dave believed the component division would not object as it could pursue an opportunity to supply another new component, JAFAR, to Apex Automotive. However, the contract Dave signed for CTR1 contained the following two options for Dave to make changes, if necessary:

1) The contract could be cancelled within 10 days of signing at a penalty of 12% of the full contract price.

2) The order quantity could be decreased within 30 days of signing the contract to 2,000 units, but at a lump sum cost of $100,000 to cover tooling costs in addition to the $210 per unit price.

When Carl Chevis, manager of the component division, heard of the contract, he was extremely upset. Carl, who has been with the company for a number of years, believed the mission of the component division is to supply the high quality CTR1 component internally. Any other
business, such as the sale of the new CTR2 component, is supplementary. He felt Dave's actions would hurt the component division's net income before taxes for 2004. Carl requested a meeting with Lucie Lambert, president of Seagull Controls Limited, to discuss the matter.

During the meeting, both Dave and Carl presented their cases to Lucie Lambert. Carl indicated that if the device division were to purchase the CTR1 components externally, it would cause considerable financial difficulties for the component division. Carl admitted he was considering pursuing a potential contract with Apex Automotive to supply the JAFAR component. Apex is ordering several samples of 500 units of JAFAR from various potential suppliers in 2004 for $700 per unit. If Apex prefers the quality of the component division's sample, Apex will order 8,000 units of JAFAR per year for 2005 and 2006 at $700 per unit.

If Apex places this two year order, the efficiency of the component division's plant must be improved. Currently, a large portion of each shift is spent on complex process warm-up and shutdown procedures. Increased efficiency can be achieved with continuous manufacturing.

The plant can be converted to continuous operation by expanding plant operations from two eight hour shifts to three eight hour shifts and a capital investment of $2,000,000. This investment would be placed in the Class 8 pool of assets with a 20% CCA rate for tax purposes, but would be depreciated on a straight-line basis over two years. The investment would have no salvage value any time after completing the expansion. The conversion to continuous operation requires complex adjustments and would take a year to implement. After implementation is complete, the plant's capacity will have doubled.

Net margin information for the JAFAR order assuming plant expansion is provided in Exhibit 3. Carl indicated to Lucie that with his high tech equipment, he will be able to produce a high quality JAFAR component and he believes there is a 75% chance of receiving the two year contract with Apex Automotive beginning in 2005.

Lucie was confused about the conflict between Dave and Carl and wondered how things went wrong so fast. At the last retreat with the Board of Directors, the Board clarified Seagull's mission statement: the company is committed to growing as quickly as possible into Canada's leading integrated manufacturer of small process control devices. It will do this by ensuring it has the most innovative technology and the most flexible responses to customer delivery needs. Both managers expressed positively to the Board that the performance evaluation system and the divisional programs give them the tools and motivation they need to increase sales of the PCU by 10% per year.

Lucie asked Mario Mancini, the company controller, to analyze the situation and recommend the company's best course of action to resolve the conflicts between Dave and Carl and to enhance corporate growth.

In his preliminary analysis, Mario decided to include the following in his report:

1. An analysis of the various sourcing options for the CTR1 component in 2004.
2. A net present value analysis of the opportunity to produce JAFAR for Apex Automotive.
3. A review of Seagull Controls Limited's management control system, including sourcing, performance evaluation and transfer pricing policies.
4. Recommendations to promote corporate growth.

Required:

As Mario Mancini, the company controller, prepare a report to Lucie Lambert, President of Seagull Controls Limited. Assume the company's tax rate is 45% and its after-tax cost of capital is 12%.
Exhibit 1
Seagull Controls Limited
Component Division
Budgeted Production and Sales Data for CTR1 and CTR2 Components
for the year ending December 31, 2004

<table>
<thead>
<tr>
<th></th>
<th>CTR1</th>
<th>CTR2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production and sales (units)</td>
<td>14,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Internal transfer price</td>
<td>$300</td>
<td></td>
</tr>
<tr>
<td>External selling price</td>
<td></td>
<td>$175</td>
</tr>
<tr>
<td>Cost per unit:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>54</td>
<td>22</td>
</tr>
<tr>
<td>Direct labour₁</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Factory overhead₂</td>
<td>116</td>
<td>58</td>
</tr>
<tr>
<td>Selling₃</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>General and administrative₄</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>240</td>
<td>140</td>
</tr>
<tr>
<td>Net income before tax</td>
<td>$60</td>
<td>$35</td>
</tr>
<tr>
<td>Net margin</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Notes:
1. The rate is $25 per direct labour hour for both types of components.
2. Factory overhead is applied on an actual machine hour basis. The variable overhead rate is $28 per machine hour and the fixed overhead rate is $30 per machine hour, based on the practical capacity of 60,000 machine hours.
3. There are no selling expenses for internal transfers of the CTR1 component and selling expenses for the CTR2 component are 40% variable and 60% fixed.
4. The general and administrative expenses are fixed and are allocated to the two types of components on the basis of units transferred and sold.
### Exhibit 2

Seagull Controls Limited  
Device Division  
Budgeted Production and Sales Data for Precision Control Unit (PCU)  
for the year ending December 31, 2004

#### Precision Control Unit

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production and sales (units)</td>
<td>14,000</td>
</tr>
<tr>
<td>Selling price</td>
<td>$820</td>
</tr>
<tr>
<td>Cost per unit:</td>
<td></td>
</tr>
<tr>
<td>CTR1 component</td>
<td>300</td>
</tr>
<tr>
<td>Other direct materials</td>
<td>84</td>
</tr>
<tr>
<td>Direct labour</td>
<td>72</td>
</tr>
<tr>
<td>Factory overhead</td>
<td>140</td>
</tr>
<tr>
<td>Selling</td>
<td>20</td>
</tr>
<tr>
<td>General and administrative expenses</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td>738</td>
</tr>
<tr>
<td>Net income before tax</td>
<td>$ 82</td>
</tr>
<tr>
<td>Net margin</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Notes:**

1. Budgeted sales volume for 2004 reflects a 10% increase over the 2003 sales volume.
2. The rate is $24 per direct labour hour.
3. Factory overhead is applied on an actual machine hour basis. The variable overhead rate is $16 per machine hour and the fixed overhead rate is $12 per machine hour, based on the expected activity. Practical capacity of the plant is 100,000 machine hours.
4. The selling expenses for the precision control unit (PCU) are 30% variable and 70% fixed.
5. The general and administrative expenses for the PCU are fixed.
Exhibit 3

Seagull Controls Limited
Component Division
Cost and Sales Data for 2005 and 2006 JAFAR Component

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$700</td>
</tr>
<tr>
<td>Cost per unit:</td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>200</td>
</tr>
<tr>
<td>Direct labour</td>
<td>100</td>
</tr>
<tr>
<td>Factory overhead</td>
<td>265</td>
</tr>
<tr>
<td>Selling (variable)</td>
<td>10</td>
</tr>
<tr>
<td>General and administrative</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>605</td>
</tr>
<tr>
<td>Net income before tax</td>
<td>$ 95</td>
</tr>
<tr>
<td>Net margin</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

Note:

1 The direct labour and variable overhead rates are the same as those of the CTR1 and CTR2 components. The fixed factory overhead rate, including depreciation, for the component division would be reduced to $25 per machine hour based on the expanded practical capacity of 120,000 machine hours. Total fixed general and administrative expenses would be unaffected by the plant expansion but would continue to be allocated to the components at $30 per unit transferred or sold.
Solutions

Multiple Choice Questions

1. b Purchasing the part from an external supplier for any price higher than $70 will cause the company to lose money since (1) the variable cost of making the part is $70, and (2) the facilities would remain idle.

2. b Savings by not purchasing from external supplier
   \[1,200 \times (\$110 - 75)\]
   $42,000

3. d Savings by not purchasing from external supplier
   \[1,200 \times (\$110 - 75)\]
   $42,000
   Opportunity cost of lost sales
   \[540 \times \$40 \text{ CM/unit}\]
   \[268 \times 40 \text{ CM/unit} \times 540\]
   $20,400

4. d The selling division's contribution margin per unit will be equal to the selling price less the transfer price of $47.50 (the manufacturing division's full manufacturing cost) less its own variable costs of $2.35 and $.50. As per the table below, they will maximize their total contribution margin at a sales piece of $63 and volume of 480,000 units.

<table>
<thead>
<tr>
<th>Price</th>
<th>Demand</th>
<th>CM/Unit</th>
<th>Total CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.00</td>
<td>600,000</td>
<td>3.65</td>
<td>2,190,000</td>
</tr>
<tr>
<td>56.00</td>
<td>590,000</td>
<td>5.65</td>
<td>3,333,500</td>
</tr>
<tr>
<td>58.00</td>
<td>575,000</td>
<td>7.65</td>
<td>4,398,750</td>
</tr>
<tr>
<td>60.00</td>
<td>555,000</td>
<td>9.65</td>
<td>5,355,750</td>
</tr>
<tr>
<td>62.00</td>
<td>520,000</td>
<td>11.65</td>
<td>6,058,000</td>
</tr>
<tr>
<td>63.00</td>
<td>480,000</td>
<td>12.65</td>
<td>6,072,000</td>
</tr>
<tr>
<td>63.50</td>
<td>420,000</td>
<td>13.15</td>
<td>5,523,000</td>
</tr>
<tr>
<td>63.75</td>
<td>350,000</td>
<td>13.40</td>
<td>4,690,000</td>
</tr>
<tr>
<td>64.00</td>
<td>300,000</td>
<td>13.65</td>
<td>4,095,000</td>
</tr>
</tbody>
</table>

5. a Contribution margin = 500,000 x (47.50 transfer price - 44.15 actual variable costs)
   Fixed overhead at standard: 500,000 x ($47.50 - 43)
   Fixed overhead spending variance
   \[= 500,000 \times \$1.675,000\]
   \[= (2,250,000)\]
   \[= 150,000\]
   \[= ($425,000)\]
6. The selling division's contribution margin per unit will be equal to the selling price less the transfer price of $43 (the manufacturing division's standard variable manufacturing cost) less its own variable costs of $2.35 and $.50. As per the table below, they will maximize their total contribution margin at a sales piece of $62 and volume of 520,000 units.

<table>
<thead>
<tr>
<th>Price</th>
<th>Demand</th>
<th>CM/Unit</th>
<th>Total CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.00</td>
<td>600,000</td>
<td>8.15</td>
<td>4,890,000</td>
</tr>
<tr>
<td>56.00</td>
<td>590,000</td>
<td>10.15</td>
<td>5,988,500</td>
</tr>
<tr>
<td>58.00</td>
<td>575,000</td>
<td>12.15</td>
<td>6,986,250</td>
</tr>
<tr>
<td>60.00</td>
<td>555,000</td>
<td>14.15</td>
<td>7,853,250</td>
</tr>
<tr>
<td>62.00</td>
<td>520,000</td>
<td>16.15</td>
<td>8,398,000</td>
</tr>
<tr>
<td>63.00</td>
<td>480,000</td>
<td>17.15</td>
<td>8,232,000</td>
</tr>
<tr>
<td>63.50</td>
<td>420,000</td>
<td>17.65</td>
<td>7,413,000</td>
</tr>
<tr>
<td>63.75</td>
<td>350,000</td>
<td>17.90</td>
<td>6,265,000</td>
</tr>
<tr>
<td>64.00</td>
<td>300,000</td>
<td>18.15</td>
<td>5,445,000</td>
</tr>
</tbody>
</table>

7. The minimum or floor price the manager of the selling division should use is the out of pocket cost of $43 plus the opportunity cost of $5 per unit sacrificed to supply the new product, a total of $48.

8. With the optimal transfer price of $48 per unit, the net realizable value of transferred product is the final selling price less the selling cost of $.50 less the variable costs in the selling division of $2.35. Since this is a long-term price, the fixed costs in the selling division would be deducted as well to compute the long-term net realizable value.

<table>
<thead>
<tr>
<th>Price</th>
<th>Demand</th>
<th>NRV/Unit</th>
<th>Total NRV</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.00</td>
<td>600,000</td>
<td>1.20</td>
<td>720,000</td>
</tr>
<tr>
<td>56.00</td>
<td>590,000</td>
<td>3.20</td>
<td>1,888,000</td>
</tr>
<tr>
<td>58.00</td>
<td>575,000</td>
<td>5.20</td>
<td>2,990,000</td>
</tr>
<tr>
<td>60.00</td>
<td>555,000</td>
<td>7.20</td>
<td>3,996,000</td>
</tr>
<tr>
<td>62.00</td>
<td>520,000</td>
<td>9.20</td>
<td>4,784,000</td>
</tr>
<tr>
<td>63.00</td>
<td>480,000</td>
<td>10.20</td>
<td>4,896,000</td>
</tr>
<tr>
<td>63.50</td>
<td>420,000</td>
<td>10.70</td>
<td>4,494,000</td>
</tr>
<tr>
<td>63.75</td>
<td>350,000</td>
<td>10.95</td>
<td>3,832,500</td>
</tr>
<tr>
<td>64.00</td>
<td>300,000</td>
<td>11.20</td>
<td>3,360,000</td>
</tr>
</tbody>
</table>
9. c Since the same amount of 480,000 would be demanded using the standard fall manufacturing costs, the opportunity cost of using that transfer price would be zero.

10. a Since the manufacturing division is in the higher tax jurisdiction Quinn Company would want to use the lowest possible transfer price in order to locate as much of the profits in the selling division. Therefore, standard variable cost would be used as the transfer price.
Problem 1

Transfer price analysis:

Variable costs $13.29
Opportunity costs 5.50
Transfer price $18.79

Variable costs:

- Direct material ($6.40 x 110%) $7.04
- Direct labour (.5 hrs @ $7.50/hr.) 3.75
- Variable overhead (.5 hrs @ $5/hr.) 2.50
- Total variable cost per unit $13.29

Overhead analysis:

<table>
<thead>
<tr>
<th>Item</th>
<th>Variable Amount</th>
<th>Fixed Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Per DLH</td>
</tr>
<tr>
<td>Supplies</td>
<td>$370,000</td>
<td>$1.23</td>
</tr>
<tr>
<td>Indirect labour</td>
<td>375,000</td>
<td>1.25</td>
</tr>
<tr>
<td>Supervision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>180,000</td>
<td>.60</td>
</tr>
<tr>
<td>Heat and light</td>
<td>120,000</td>
<td>.40</td>
</tr>
<tr>
<td>Property tax and insurance</td>
<td>130,000</td>
<td>.43</td>
</tr>
<tr>
<td>Depreciation</td>
<td>1,100,000</td>
<td>3.67</td>
</tr>
<tr>
<td>Employee benefits</td>
<td>575,000</td>
<td>1.92</td>
</tr>
<tr>
<td>Totals</td>
<td>$1,500,000</td>
<td>$5.00</td>
</tr>
</tbody>
</table>
Opportunity cost analysis:

<table>
<thead>
<tr>
<th></th>
<th>Lubri-Solve</th>
<th>Scubo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$52.00</td>
<td>$39.00</td>
</tr>
<tr>
<td>Variable cost:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>$13.75</td>
<td>$12.50</td>
</tr>
<tr>
<td>Labour:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 DLH x $7.50/DLH</td>
<td>11.25</td>
<td></td>
</tr>
<tr>
<td>1.0 DLH x $7.50/DLH</td>
<td>7.50</td>
<td></td>
</tr>
<tr>
<td>Variable overhead:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 DLH x $5/DLH</td>
<td>7.50</td>
<td></td>
</tr>
<tr>
<td>1.0 DLH x $5/DLH</td>
<td>5.00</td>
<td></td>
</tr>
<tr>
<td>Total variable costs</td>
<td>$32.50</td>
<td>$25.00</td>
</tr>
<tr>
<td>Contribution margin per unit</td>
<td>$19.50</td>
<td>$14.00</td>
</tr>
<tr>
<td>Opportunity cost of shifting production = $5.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Problem 2

a. Contribution margin on compressors transferred out:
\[
17,400 \times (\$50 - 10.50 \text{ DM} - 8 \text{ DL} - 10 \text{ VOH})
\]
\[
= 17,400 \times 21.50 \quad \text{\$374,100}
\]

Contribution margin lost on external sales:
\[
6,400^* \times (\$100 - 12 \text{ DM} - 8 \text{ DL} - 10 \text{ VOH} - 6 \text{ Var Sel})
\]
\[
6,400 \times 64 
\]

Incremental income
\[
(\text{\$35,500})
\]

* Weber's capacity

Less: expected sales ($6,400,000 / 100)

Excess capacity

Units required by Visic

External sales lost

b. From the company's perspective:

Savings by not purchasing externally
\[
17,400 \times 70 
\]
\[
\text{\$1,218,000}
\]

Cost of making compressors
\[
17,400 \times (10.50 \text{ DM} + 8 \text{ DL} + 10 \text{ VOH})
\]
\[
= 17,400 \times 28.50 \quad \text{\(495,900\)}
\]

Contribution margin lost on external sales
\[
(409,600)
\]

Incremental income
\[
\text{\$312,500}
\]

c. Variable cost
\[
\text{\$28.50}
\]

Opportunity cost of lost sales:
\[
\frac{409,600}{17,400} \quad \text{23.54}
\]

Minimum transfer price
\[
\text{\$52.04}
\]
Problem 3

a. If Ajax is operating at capacity, then the minimum transfer price will be equal to the normal sales price of $7.50. If the Ajax division has enough capacity to supply the Defco division, then the minimum transfer price will be equal to the variable cost of $4.25.

On the other hand, the Defco division’s maximum transfer price is $5 + the $8 cost mark-up = $13.

b. If the Defco contract is a one-time contract and does not result in Ajax having to turn away regular customers, then the transfer is in Parker’s long-term economic interest.

If the Defco contract is a recurring contract, then the transfer is in Parker’s long-term economic interest since the lost CM on Ajax customers will be offset on a recurring basis by Defco’s contract.

However, if we are dealing with a one-time contract and Ajax has to turn away regular customers, then the transfer is in the long-term economic interests of Parker only if it is reasonably assured that Ajax will continue operating at capacity after the contract.
Problem 4

a)  

<table>
<thead>
<tr>
<th></th>
<th>Manufacturing</th>
<th>Selling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$9,750,000</td>
<td>$12,000,000</td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transferred in</td>
<td>$0</td>
<td>$9,750,000</td>
</tr>
<tr>
<td>Variable</td>
<td>4,125,000</td>
<td>1,125,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>6,600,000</td>
<td>187,500</td>
</tr>
<tr>
<td>Profit</td>
<td>($975,000)</td>
<td>$937,500</td>
</tr>
</tbody>
</table>

ii) Revenue  

<table>
<thead>
<tr>
<th></th>
<th>Manufacturing</th>
<th>Selling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$10,500,000</td>
<td>$12,000,000</td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transferred in</td>
<td>$0</td>
<td>$10,500,000</td>
</tr>
<tr>
<td>Variable</td>
<td>4,125,000</td>
<td>1,125,000</td>
</tr>
<tr>
<td>Fixed</td>
<td>6,600,000</td>
<td>187,500</td>
</tr>
<tr>
<td>Profit</td>
<td>($225,000)</td>
<td>$187,500</td>
</tr>
</tbody>
</table>

b)  

i) The floor price will be $14, which is the maximum of opportunity cost plus short-term out-of-pocket cost (which is $13) and the net realizable value (which is $14).

ii) The ceiling price will be the net realizable value of the chips as they enter the selling division, which is $14.50 ($16 - $1.50).
Problem 5

The issue Mortie has created is called the adverse selection problem and this problem often arises in transfer pricing situations when the profit centre managers are restricted in their behaviour.

The manager of the new car division is behaving rationally. (S)he is selling the used cars in a way thought to best increase the profit of the new car department. The problem with the transfer pricing system is the used car manager is at a disadvantage because (s)he is offered vehicles by the new car department manager that are thought to be worth less than the auction (market) price.

Moreover, as the managers transact in the auction market, they are incurring unnecessary transactions costs (the provincial portion of the HST) and the vehicle transportation costs.

Since it is the new car manager that is responsible for acquiring the used vehicle, it would be useful to reverse how transfers are handled. The used car manager should have first call on whether to take the vehicle at the auction price. If the used car manager declines the vehicle as the auction price the new car manager can either bargain for a lower price or transfer the vehicle to the auction.

The key is to avoid the costs of transacting with parties outside the organization in order to avoid transactions costs.

Problem 6

a) The net realizable value of each unit as it leaves Division A is $33 ($50-$17). The cost per unit in Division A is $20. Therefore, the profit per unit is $13 and the total profit that would be reported is $325,000 (25,000 * 13).

b) Division B will report the same profit.

c) Deere Company profit will be $325,000 (50-20-17)*25,000.

d) If the system is intended to support the best short-term allocation of resources, then variable costs, not full costs, should be used in computing the transfer price. However, if the system is intended to support the best long-term allocation of resources, then full cost should be used.
Problem 7

1. Analysis of the proposal to increase the transfer price of carburettors to $500

Impact on sales and production volumes:
- ID sales drop from 2,000 units to 1,700 units
- SD domestic sales from 4,000 units to 3,500 units
- Total sales drop from 6,000 units to 5,200 units

ED Capacity: 200,000 MH
- Requirement for 5,200 carburettor engines: 5,200 x 4 = 20,800
- Available for fuel-injected engines: 179,200

Engine division:

Contribution margin:
- Carburettors: [5,200 x ($500 - 275)] = $1,170,000
- Fuel-injection: [22,400 x ($600 - 287)] = 7,011,200
- Total: $8,181,200

Fixed costs:
- Production: (1,914,000)
- Selling and administration: (4,733,000)
- Pre-tax divisional income: $1,534,200

Divisional ROI ($1,534,200 ÷ $11,697,000) = 13.1%

Snowmobile division:

Transfer price to international division:
- SD variable production costs – per Exhibit 3: $2,600
- Increase in cost of motors: 100
- Fixed production costs per unit – $1,728,000 ÷ 5,200 units: 332
- Fully absorbed cost: 3,032
  + x 1.25
- Transfer price to ID: $3,790
Total revenues:

- Domestic – 3,500 units @ $3,400  $11,900,000
- International – 1,700 @ $3,790  6,443,000
  
  18,343,000

Variable costs – ($2,700 + 52 \text{variable selling}) \times 5,200 \text{ units}  (14,310,400)

Total contribution margin  4,032,600

Less fixed costs:
- Production  (1,728,000)
- Selling and administration  (2,166,000)

Pre-tax divisional income  $ 138,600

Divisional ROI ($138,600 \div 4,083,000)  3.4%

International division:

Revenues – 1,700 @ $5,000  $8,500,000

Variable costs [($3,790 \times 1.2) + 47] \times 1,700  7,811,500

Contribution margin  688,500

Fixed costs  (172,000)

Pre-tax divisional income  $ 516,500

Divisional ROI ($516,500 \div 2,379,000)  21.7%

Summary:

<table>
<thead>
<tr>
<th></th>
<th>Engine Division</th>
<th>Snowmobile Division</th>
<th>International Division</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-tax Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed</td>
<td>$1,534,200</td>
<td>$138,600</td>
<td>$516,500</td>
<td>$2,189,300</td>
</tr>
<tr>
<td>Current</td>
<td>989,000</td>
<td>614,000</td>
<td>470,000</td>
<td>2,073,000</td>
</tr>
<tr>
<td>Change</td>
<td>$545,200</td>
<td>$(475,400)</td>
<td>$46,500</td>
<td>$116,300</td>
</tr>
</tbody>
</table>

ROI:

<table>
<thead>
<tr>
<th></th>
<th>Engine Division</th>
<th>Snowmobile Division</th>
<th>International Division</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed</td>
<td>13.1%</td>
<td>3.4%</td>
<td>21.7%</td>
<td>12.1%</td>
</tr>
<tr>
<td>Current</td>
<td>8.5%</td>
<td>15.0%</td>
<td>19.8%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Change</td>
<td>4.6%</td>
<td>(11.6%)</td>
<td>1.9%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

The only manager unhappy with the new transfer price is the snowmobile division manager. However, the overall company's results are better, therefore, the change should be made.
2. Analysis of the proposal to stop production of carburettor engines

Maximum transfer price (from SD division's point of view) $500.00

Minimum transfer price (from ED division's point of view):
- Variable cost of producing a carburettor engine $275.00
- Fixed costs (assumed avoidable) of carburettor engine production: $330,000 ÷ 5,200 engines 63.46
- Fuel-injected engine CM lost when one carburettor engine is transferred:
  - CM on fuel-injected engine $600 - 287 = 313 \div 2 (two carburettor engines are manufactured in lieu of one fuel-injected engine) 156.50
  - $494.96

Therefore, it is profitable for the company as a whole to transfer carburettor engines. If the transfer price is $494.96, the engine division is as well off as it would be if it were to sell only fuel-injected engines.

Impact on company net income if carburettor engines are purchased externally:

- Increased CM on sale of fuel-injected engines: $813,800
- VC savings of not manufacturing carburettor engines: 1,430,000
- Cost of purchasing carburettor engines externally: (2,600,000)
- Fixed cost savings 330,000
- Incremental company income $(26,200)

(This incremental income can also be calculated as the profit differential times the number of units transferred: $[500 - 494.96] \times 5,200$ units $= 26,208$)

Note that this incremental company income is also the incremental engine division income since transfers are assumed to be at $500, thereby, having no impact on the snowmobile and international divisions.

Note that if the demand for engines from the snowmobile division drops below 4,817* engines, the company and the engine division would be better off purchasing carburettor engines externally:

* $500 - 275 - 156.5 = 68.50 = \text{maximum per unit fixed costs of carburettor production}$
  - $330,000 \div 68.50 = 4,817 \text{ engines}$
3. Transfer Pricing Policies

The following should be considered when considering transfers between ED and SD:

- Promotion of goal congruence: the transfer pricing policy should aim to achieve top management's goals (i.e. achieving the 12% ROI).

- Promotion of a sustained high level of managerial effort.

- Promotion of a high level of subunit autonomy – divisional managers should be given freedom to set transfer prices and to buy/sell engines/snowmobiles internally or externally. If the SD manager is given this autonomy and is faced with the decision to purchase internally a poor quality carburettor engine for $500 or an external high quality engine at the same price, he will do so. This will provide an incentive for the ED manager to provide a better quality product.

International transfer pricing – for external reporting purposes, the transfer prices to be considered are (1) full cost and (2) 150% of full cost:

<table>
<thead>
<tr>
<th></th>
<th>Full Cost</th>
<th>150% of Full Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax cost in Canada</td>
<td>$3,032.00</td>
<td>$4,548.00</td>
</tr>
<tr>
<td>Custom duties in Sweden</td>
<td>(606.40)</td>
<td>(909.60)</td>
</tr>
<tr>
<td>Tax savings in Sweden</td>
<td>1,091.52</td>
<td>1,637.28</td>
</tr>
<tr>
<td></td>
<td>$485.12</td>
<td>$121.28</td>
</tr>
</tbody>
</table>

Therefore, transfers should be made at full cost. This does not, however, preclude the use of a different transfer price for purposes of performance evaluation. This should be at the market price of $3,400. This will reduce the SD division net income to $(524,400), a reduction of $663,000 [1,700 units x ($3,790 - 3,400)].
4. Organizational Structure

The key to making any organization structure work is to match performance evaluation to factors controllable by the division and to ensure the transfer pricing and performance evaluation systems motivate the divisions to act in a manner that strives to achieve company goals.

Clearly, the ED and SD divisions are true investment centres.

The ID division, however, is nothing more than a sales outlet for SD products in another country. On the assumption that ID does not sell our competition's products, the ID should be treated as a revenue centre or simply as part of the SD division.

5. Other issues

- Performance evaluation and bonuses are based on a single measure. This motivates divisional managers to focus on improving divisional ROI, but not necessarily the company's ROI. Other factors, such as service to customers, market share improvement and product quality, should also be considered.

- Using the same target ROI for all divisions may not be appropriate. Business risks involved in the different industries could be quite different, resulting in some divisions having an advantage over other divisions.

- The use of ROI may be inducing the managers of highly profitable divisions to reject projects that have projected ROIs in excess of 12% but less that the division's ROI.
  - projects that have long-term benefits may be rejected because of short-term negative effects on divisional ROI.
  - the ROI target could also lead managers to take actions that cause short-term increases in divisional ROI, but are in conflict with the long-term interests of the company (i.e. reducing discretionary expenses such as R&M).
  - other ROI related problems: inflation, depreciation method.

- It appears the performance evaluation of divisional managers is not distinguished from performance evaluation of divisions. Often, the most talented manager is put in charge of the weakest division in an attempt to improve the weak division's operations.
Problem 8

A. Sourcing of CTR1 components in 2004

Capacity calculations:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical capacity (machine hours)</td>
<td>60,000</td>
</tr>
<tr>
<td>Required for CTR2 (maximum) – 25,000 x 1 hour</td>
<td>-25,000</td>
</tr>
<tr>
<td>Required for CTR1: 14,000 x 2 hours</td>
<td>-28,000</td>
</tr>
<tr>
<td>Required for JAFAR: 500 x 5 hours</td>
<td>-2,500</td>
</tr>
<tr>
<td>Excess capacity</td>
<td>4,500</td>
</tr>
</tbody>
</table>

Option 1: purchase 10,000 units from external suppliers: 10,000 x $210 $2,100,000

Option 2: cancel contract and pay penalty
(calculated from the company's point of view):

Variable production costs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$54</td>
</tr>
<tr>
<td>Direct labour</td>
<td>40</td>
</tr>
<tr>
<td>Variable overhead: 2 hours x $28</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$150</td>
</tr>
<tr>
<td></td>
<td>x 10,000</td>
</tr>
<tr>
<td></td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Penalty: $2,100,000 x 12%</td>
<td>252,000</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1,752,000</td>
</tr>
</tbody>
</table>

Option 3: buy 2,000 units of CTR1 externally:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal production costs: 8,000 x $150</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>External purchase costs: 2,000 x $210</td>
<td>420,000</td>
</tr>
<tr>
<td>Tooling cost to external supplier</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>$1,720,000</td>
</tr>
</tbody>
</table>
Discussion:

- Option 3 is the least costly

- Need to consider the quality and reliability of delivery of external components – considering the difference between Option 2 and 3 is only $32,000, Option 3 may not be worthwhile

- Recommend they choose Option 2
B. Apex Automotive Opportunity

NPV analysis:

Capital cost \(\$2,000,000\)

Tax shield: \(\left(\frac{2,000,000 \times 0.2 \times 0.45}{0.12 + 0.2}\right) \times \left(\frac{1.06}{1.12}\right)\)

\[ \text{532,366} \]

Increased fixed overhead:

New FOH: \(120,000 \times \$25\) \(\$3,000,000\)

Old FOH: \(60,000 \times \$30\) \(\$1,800,000\)

Increase \(\$1,200,000\)

Less: increase in depreciation \(\left(\frac{2,000,000}{2}\right)\) \(-\$1,000,000\)

\[ \text{200,000} \times (1-t) \text{\ 0.55} \]

\[ \text{N = 2, I = 12, PMT = 110,000, PV = (185,906)} \]

Annual cash inflows:

Selling price \(\$700\)

Direct materials \(-\$200\)

Direct labour \(-\$100\)

Variable overhead: 5 hours* \(\times \$28\) \(-\$140\)

Variable selling \(-\$10\)

\[ \text{250} \times \text{Units} \text{\ 8000} \times (1-t) \text{\ 0.55} \]

\[ \text{N = 2, I = 12, PMT = 1,100,000 \quad 1,859,056} \]

Net Present Value if we get APEX order \(\$205,516\)

* combined OH rate = \$28 + 25 = \$53

Hours = \$265 \div 53 = 5
NPV if we do not receive APEX order:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital cost</td>
<td>-2,000,000</td>
</tr>
<tr>
<td>Tax shield</td>
<td>532,366</td>
</tr>
<tr>
<td>Increase in fixed overhead</td>
<td>-185,906</td>
</tr>
<tr>
<td></td>
<td>-1,653,540</td>
</tr>
</tbody>
</table>

Expected NPV: (205,516 x 75%) + (-1,653,540 x 25%) = -2,562,488

Note: The 500 unit order is not included since it has no bearing on the decision
Discussion:

- Order is not guaranteed

- Not clear if we proceed with expansion before order is received (i.e. what is the lead time for expansion)

- With a 10% annual increase if PCU's, we have enough capacity as:

  \[
  \begin{align*}
  \text{CTR2: } & 25,000 \times 1\text{MH} & 25,000 \\
  \text{CTR1: } & 14,000 \times 1.1 \times 1.1 \times 2\text{MH} & 33,880 \\
  & & 58,880
  \end{align*}
  \]

- Not advisable to pursue APEX order unless uncertainty is dealt with

C. Review of Management Control System

- Component division (CD) was set up to supply the CTR1 component to the device division (DD)
  - this was reinforced at the recent Board of Directors retreat
  - mission statement would support treating CD as a cost centre and basing its performance on controlling costs, while maintaining high quality

- Conflict began when CD began producing the CTR2 and evaluating on the basis of divisional NIBT (i.e. as a profit centre)
  - this caused both managers to make suboptimal decisions
  - CD manager was motivated to set a transfer price that provided a reasonable gross margin
  - the high TP lead the DD manager to sign a contract with an external supplier, which was not in the best interests of the company overall (goal incongruence)

- Minimum transfer price = variable production costs = $150
  Maximum transfer price = outside supplier price = $210

  Net loss to the company: \(10,000 \times (210 - 150) = 600,000\)
• Options to solve conflict:

1  Treat CD as a cost centre
   - responsible for controlling costs and quality
   - division managers' performance should be at least partially based on
     overall company profits and achieving company goals; this will give the
     manager an incentive to consider opportunities for using idle capacities

2  Continue to treat CD as a profit centre but impose a sourcing policy
   - sourcing policy would require both divisions to supply/source the CTR1
     component internally
   - need a transfer pricing policy:
     Variable cost – will maximize DD income and minimize CD
     Income, but would ensure the CD's income is unaffected by
     internal transfers
     Full cost – charge an appropriate amount of FOH
     Negotiated – somewhere between minimum and maximum
     Market – usually the best (must have a stable market price)

3  Centralize the organization's structure
   - either by top management or combine both divisions

Recommend # 2 with market price as a transfer price.
21. Performance Evaluation

Learning Objectives

After completing this chapter, you will:

1. Be able to describe the benefits and costs of decentralization.

2. Understand and be able to describe the nature, role and use of responsibility centres in organizations.

3. Understand and be able to identify the appropriate use of each of the four major types of responsibility centres.

4. Understand and be able to develop performance measures for each of the four major types of responsibility centres.

Decentralization

In centralized organizations, often called command and control organizations, all major decisions are made at the top of the organization hierarchy. Subordinates are told what to do and these directions are enforced by rules that specify the penalties for non-compliance. As organizations grew, senior executives realized the information gathering, information processing and decision making tasks required to make all decisions centrally was becoming impossible.

In decentralized organizations, decision making is delegated down the organization hierarchy with the realization that through specialization in task and information, the lower level managers will be in a better position than their superiors to take the appropriate course of action.

The objective and consequence of decentralization creates a fundamental problem in control. That is, the controller (the superior) by virtue of the subordinate’s specialization was not in a position to adequately judge the controlee’s (the subordinate) performance. Therefore, the approach in the centralized system of telling people what to do was replaced with the instruction to do what is best to promote the organization’s interests.

Therefore, decentralization is invariably accompanied by a system of accountability for local results thought to promote the organization’s best interests. The key, of course, is whether the overall objectives in complex organization that involves effective interaction among various organization units can be factored into a set of individual objectives that each unit can pursue.

The most common accountability approach is responsibility accounting. In responsibility accounting, the organization is partitioned into sub-units called responsibility centres. Senior executives evaluate the performance of each responsibility centre using performance metrics that reflect the accountability relationship of the centre with senior management.
The Pros and Cons of Decentralization

The following table identifies the pros and cons most often identified with decentralization:

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Leads to a faster recognition of changes in the organization’s external environment and a faster response to those changes</td>
<td>• Creates opportunity costs when decentralized decisions are not in the organization’s best interests through:</td>
</tr>
<tr>
<td>• Provides an opportunity to have decision makers develop better information by locating them closer to customers</td>
<td>o Sub-optimization from sacrificing corporate level results to improve unit level results</td>
</tr>
<tr>
<td>• Provides the opportunity to have decision makers develop specialized skills</td>
<td>o Inappropriate risk taking</td>
</tr>
<tr>
<td>• Provides the opportunity to partition decision making responsibilities resulting in better decision making focus</td>
<td>• Can increase support costs:</td>
</tr>
<tr>
<td>• Provides for a tighter system of accountability by narrowing the scope of decision making responsibilities</td>
<td>o Increased need for control will increase control related data processing costs</td>
</tr>
<tr>
<td>• Provides for increased motivation by giving employees decision making responsibilities</td>
<td>o Redundant support departments are created</td>
</tr>
<tr>
<td></td>
<td>o Loss of economies of scale in providing centralized support services</td>
</tr>
</tbody>
</table>

Put another way, the following factors increase the potential value of decentralization:

• Organization size and complexity – as organizations grow it becomes increasingly difficult for managers at the top of the organization to acquire and evaluate all the information needed to make decisions.

• Enhanced organization performance from quickly adapting to a rapidly changing environment – as the pace of change in the environment of the organization increases, creating a need for the organization to respond quickly, the less able the organization is to wait for information to be passed up the organization hierarchy, be evaluated and a decision passed down through the hierarchy.

• Enhanced organization performance from developing specialized decision making skills – as organizations rely on increasingly sophisticated skills to perform effectively it becomes less likely that a small group of managers at the top of the organization will have the requisite decision making skills, thereby, requiring delegation of these decisions to task specialists.
The following factors can create significant organization costs:

- The need for highly coordinated organization units – the effect of decomposing the organization into responsibility centres and assigning the responsibility centres specific goals creates the potential the responsibility centres will act in their own self interest rather than in the interest of the overall organization. The greater the need for organization units to interact effectively to achieve organization goals, the greater the cost of decentralization.

- Significant organization risk created by delegated decisions – as decisions are delegated, the possibility a decision will be made that is not consistent with the objectives of the overall organization increase. If the decision can create catastrophic organization risk, the authority to make the decision will be retained by senior management.

- Significant control costs attendant with required control systems needed to ensure decentralized decision making is consistent with organization objectives: if decision making is delegated, the need for control systems increases with the potential risk that the decision can create for the overall organization and, in turn, requiring control systems that provide boundaries for the decisions. The costs of these control systems can be significant if they require constant monitoring.

Therefore, there are two broad substantive issues when considering decentralization:

1. Do the gains from creating specialists in task and information and the benefits from increasing response time to local conditions outweigh the potential opportunity costs of local decisions that are not in the organization’s best interests?

2. Can managers be effectively motivated to pursue their assigned objectives given the understanding they have a better understanding of the potential of their individual units than does the controller at the top of the organization?

Examples Illustrating the Costs of Decentralized Decision Making

Following are two examples of the possible costs of decentralized decision making.

Opportunity Costs Created by Pursuing Local Objectives:

Assume the manager of a responsibility centre is evaluated based on a performance metric reflecting the consequences of the responsibility centre’s activities. The manager can devote her time either to improving the responsibility centre’s performance metric or engaging in various behaviours, such as coordinating or cooperating with other responsibility centres to improve overall organization performance. Assume the responsibility centre manager has three choices relating to coordinating/cooperating, which are low, medium and high effort. The performance metric for the manager’s responsibility centre and the overall organization are as follows for each choice. Note that the organization is better off when the responsibility centre manager provides a high level of coordination/cooperative behaviour.
Finally, assume the centre manager is evaluated based on a weighed combination of the unit performance metric and the organization performance metric. That is, the centre manager’s evaluation or reward is determined as follows:

\[ \text{Reward} = a \times \text{unit performance metric} + (1 - a) \times \text{organization performance metric} \]

Where \(a\) is greater than or equal to zero and less than or equal to one.

In this setting, you can think of the manager’s investment in coordination/cooperation as having a cost and the manager will compare the cost of coordinating with its return. Note that if the units are highly interactive, that is, the overall return to the organization is high as coordination increases, the greater will be the value of coordination to the organization. However, as the cost to the manager of coordinating increases, the less likely the manager will engage in coordination.

The following is a graph showing the payoff to the manager from the three cooperation behaviour levels for different values of \(a\):

<table>
<thead>
<tr>
<th>Coordination/Cooperating Level</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit performance metric</td>
<td>50</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Organization performance metric</td>
<td>90</td>
<td>120</td>
<td>130</td>
</tr>
</tbody>
</table>
If $a$ is set equal to 1, the manager is evaluated solely based on the responsibility centre performance metric. If $a$ is set equal to zero, the manager is evaluated solely based on organization performance. For values of $a$ between .75 and one, the manager will provide a low level of cooperation. For values of $a$ between .75 and .67, the manager will provide a medium level of cooperation. For values of $a$ between zero and .67, the manager will provide a high level of cooperation.

The point of this illustration is that how managers are evaluated and rewarded will affect their decision making behaviour and can lead to local decisions that are not in the best interests of the overall organization.

Managerial Effort Incentives:

The above example raises the question: “Why not evaluate the organization based on organization level performance – why use responsibility centres at all?”

The first response is that returns in the above table may reflect the task and information specialization provided by decentralization. That is, the corporate level returns would be much lower if the managers were not specializing.
The second response is the widely held belief that basing individual rewards on group performance will lead to lower levels of motivation. This is called the free rider problem. The idea is the less responsive is the performance measure to the level of individual effort, as in the case of group vs. individual rewards, the less will be the effort put into work.

The Philosophy of Responsibility Centres

Responsibility centres are the conventional means to delegate decision making responsibility in organizations. The objectives assigned to the responsibility centre are monitored by a system of responsibility centre accounting, which focuses on the responsibility centre’s key deliverables.

The controllability principle is an important concept often used in setting performance objectives for responsibility centres. The controllability principle argues that managers should only be held accountable for things they can control.

The other side of the controllability principle is the performance measure used for a responsibility centre should include all the relevant factors the responsibility centre affects that in turn affect organization level performance. This is important in that the responsibility centre manager will not sacrifice performance on an important non-measured activity in favour of a measured one. For example, the manager of a purchasing department evaluated based solely on the ability to meet cost targets may purchase inferior quality goods that cause excessive manufacturing costs and quality related losses.

With these ideas in mind, we can turn to consider the major types of responsibility centres.

Types of Responsibility Centres

There are four major types of responsibility centres that we will now discuss.

1. Revenue centres
2. Cost centres
3. Profit centres
4. Investment centres

Revenue centres:

The manager of a revenue centre is assumed to have control only over the revenues generated by the centre. In particular, the manager is deemed to be unable to control the centre’s costs and investment level and, therefore, has no profit or return on investment responsibility.

In addition to revenue responsibility there may be non-financial performance requirements such as customer satisfaction or meeting surprise audits relating to how the centre is being run.
The manager of a revenue centre might be evaluated on one or several of the following:

1. The actual revenue level
2. The revenue level relative to plan
3. The growth in revenue or market share
4. Revenue relative to comparable organization units

In each of the above, organizations often substitute contribution margin for revenue in order to focus managerial attention on the most profitable products.

Some common examples of revenue centres are:
- The manager of the appliance department in a large department store
- The manager of a bar in a large hotel

There are relatively few units that qualify as pure revenue centres since most sales operations incur costs related to making those sales. If a sales operation is evaluated as a revenue centre, but the manager controls salary and wage costs, the centre manager will have no motivation to control sales and might engage in excessive staffing or unprofitable sales generating activities. This is an example of ensuring all facets under the responsibility centre manager’s control are evaluated.

Cost centre:

The manager of a cost centre is assumed to have control over the level of costs incurred. There are two broad types of cost centres, discretionary and volume driven. In both cases, the performance of the cost centre manager is evaluated in terms of how well the manager controlled costs relative to a budget.

Budgets arise in discretionary cost centres through periodic appropriations by senior management. For example, a department in government is provided with budget that has been authorized by a central budget authority. Level one control is achieved by comparing the amount spent with the amount authorized. Level two control will also include measures that assess the efficiency and effectiveness of the expenditures. For example, a government department unit charged with finding employment for the unemployed would be provided a certain operating budget. Level one control would involve comparing actual expenditure with the amount authorized and level two control would evaluate measures such as cost per hour of counselling and cost per job found.

In volume driven cost centres, such as a production line, budgets are developed that reflect the volume of activity undertaken and actual costs are compared with budget. This is the role of flexible budgets which we discussed in a previous chapter.

Once again, it is important to ensure the performance measure considers all facets of performance that affect the organization. For example, if costs can be reduced by impairing quality or failing to meet production schedules, the manager of the cost centre will be motivated
to do this at the expense of the long-term interests of the organization. It is important that all relevant factors be included in the evaluation of the cost centre manager’s performance.

Profit centres:

Profit centres were discussed extensively in Chapter 20.

Investment centres:

Investment centres are profit centres where the manager is deemed to be able to control both the level of profit and the level of investment. Therefore, the profit reported must be scaled or adjusted for the level of investment, otherwise, the manager will have no incentive to control the investment level.

There are two common means of adjusting the profit measure to reflect the level of investment, return on investment and residual income.

Return on investment is computed by dividing the responsibility centre’s reported profit by the level of investment in the responsibility centre.

Return on investment was popularized by the Dupont Corporation as a measure of performance evaluation. If investment is measured by shareholders’ equity we have:

\[ \text{ROI} = \frac{\text{net income}}{\text{shareholders' equity}} \]

This can be expanded as follows:

\[ \text{ROI} = \left( \frac{\text{net income}}{\text{sales}} \right) \times \left( \frac{\text{sales}}{\text{assets}} \right) \times \left( \frac{\text{assets}}{\text{shareholders' equity}} \right) \]

The ratio of net income to sales, called net profit margin, is the proportion of each sales dollar left after all expenses and taxes returned to shareholders. It is, therefore, a measure of operating efficiency. The ratio of sales to assets, called asset turnover, is a measure of ability to generate sales from a given level of assets, in effect, a productivity measure. The ratio of assets to shareholders’ equity is a measure of financial leverage.

Therefore, return on investment is the product of efficiency, productivity and leverage. Since most investment centre managers do not control the capital structure investment in the return on investment, calculation is defined as the centre’s assets and the following measure is used as the return on investment:

\[ \text{ROI} = \left( \frac{\text{net income}}{\text{sales}} \right) \times \left( \frac{\text{sales}}{\text{assets}} \right) \]

Recall from Chapter 20 the issues surrounding transfer pricing make it difficult to measure profits in a profit centre. The same issue will apply to an investment center with additional problems relating to deciding how to allocate jointly used assets to individual investment centres and how to value those asses (for example, net realizable value, book value, net book value).
Beyond measurement issues, there is a fundamental motivational problem in using return on investment to evaluate investment centre performance. Consider an organization that requires an after-tax return of 10% on investment and a project that promises an expected return of 12%. The manager of an investment centre is rewarded based on the return on investment in the investment centre. The average rate is 14% before the above investment. The manager will be motivated to reject the investment (which provides an expected return in excess of the required return) since it will lower the centre’s average return on investment.

In response to this problem, some organizations use residual income, which is computed as follows:

\[
\text{Residual income} = \text{operating income} - (\text{required rate of return} \times \text{investment})
\]

With this approach, the investment centre manager is motivated to accept, if funds permit, any investment that is expected to return an amount in excess of the required rate of return. This avoids the problem noted above relating to the return on investment criterion.

The problem with residual income, however, is if an investment today will provide returns only in the future then, like all short-term performance measures, like profit, long-term results may be foregone in favour of improving short-term performance.

Measuring the Asset Base in Return in Investment and Residual Income Calculations:

An important consideration in computing return on investment or residual income is how to measure the asset base. The following are the major alternatives that have been proposed:

1. Historical cost
2. Net book value
3. Net realizable value

Although all three are used in practice, net realizable value is seldom used and net book value is more frequently used than historical cost.

The advantage of using net realizable value (the market value of the asset less the cost of selling the asset) is this amount reflects the value of the organization’s ongoing investment in the asset. The problem with using net realizable value is market values are difficult or costly to obtain. However, with the advent of IFRS, which permits market valuations for assets, this alternative may become more widely used.

The advantage claimed for using net book value is the asset values used to compute return on investment are consistent with the values reported on the balance sheet and the income in the numerator of the calculation reflects the depreciation reported on the income statement.
The major problem with using net book value is if the asset generates a constant annuity, return on investment will increase as the asset is depreciated, which suggests instability in the return on investment measure caused by this measurement basis.

In the following example, the organization acquires a machine for $50,000. The machine generates an initial cash flow of $15,000 per year for five years, at which time it is sold for a net realizable value of zero. The following are the return on investment calculations for the five years using gross book value and net book value assuming straight-line depreciation:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow</th>
<th>Depreciation</th>
<th>Income</th>
<th>Gross book value</th>
<th>Net book value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15,000</td>
<td>10,000</td>
<td>5,000</td>
<td>50,000</td>
<td>40,000</td>
</tr>
<tr>
<td>2</td>
<td>15,000</td>
<td>10,000</td>
<td>5,000</td>
<td>40,000</td>
<td>30,000</td>
</tr>
<tr>
<td>3</td>
<td>15,000</td>
<td>10,000</td>
<td>5,000</td>
<td>30,000</td>
<td>20,000</td>
</tr>
<tr>
<td>4</td>
<td>15,000</td>
<td>10,000</td>
<td>5,000</td>
<td>20,000</td>
<td>10,000</td>
</tr>
<tr>
<td>5</td>
<td>15,000</td>
<td>10,000</td>
<td>5,000</td>
<td>10,000</td>
<td>0</td>
</tr>
</tbody>
</table>

ROI based on:
- Gross book value: 10.0% 10.0% 10.0% 10.0% 10.0%
- Net book value: 12.5% 16.7% 25.0% 50.0% ∞

A related problem using net realizable value in computing return on investment is managers evaluated by this performance measure will be motivated not to replace highly depreciated assets even though evaluated, using net present value replacement, might be beneficial for the organization.

The problem of increasing return on investment reported when using net book value can be resolved by using the so called economic depreciation. This process begins by computing the internal rate of return on the investment, which, in this case, is 15.24%. In each period, income is computed by multiplying the internal rate of return by the opening level of investment in that period. The difference between the cash flow and the income is treated as depreciation. The following exhibit shows the result. To illustrate the opening value of the investment in Year 1 is $50,000. Income in Year 1 of $7,619 is computed by multiplying $50,000 by the internal rate of return of 15.24%. Depreciation of $7,381 in Year 1 is computed by subtracting the computed income from the incremental cash flow ($15,000 - $7,619). As shown in the following exhibit, this approach provides a constant return on investment figure:
The major problem with this approach is it generates increasing amounts of depreciation over the project life, which most people find counter intuitive. Also, the approach is unwieldy in practice since actual cash flows will most likely differ from projected cash flows.

Within each of the gross book value and net book value alternatives, there are two options for the value to be used:
- Value at year-end
- Average of the year start and year-end values

Most management accountants agree the most reasonable result is provided by averaging the opening and ending investment levels.

Conclusion:

This chapter has discussed the issue using responsibility centres are a means of control in organizations that have decentralized decision making responsibility.

This chapter has discussed some of the benefits and costs of using the responsibility centre approach to organization control and the types of responsibility centres commonly used. As we have seen, the issues in designing and evaluating responsibility involves a complex mixture of behavioural considerations that result from decentralization and the use of responsibility centres.

Above all, the only relevant criterion to use to evaluate a proposed responsibility centre design is whether the design improves the potential for overall organization performance.
Problems with Solutions

Multiple Choice Questions

1. Which of the following is not a claimed benefit of decentralization?
   a) Faster response
   b) Increased coordination
   c) Developing middle managers’ decision making skills
   d) Provides increased motivation.

2. Which of the following pairs of conditions is thought to increase the potential value of decentralization?
   a) Increasing organization size and increased need for inter-unit coordination.
   b) Increased control costs and increasing organization complexity.
   c) Need for prompt response and increased organization risk.
   d) Need to develop specialized skills and low control costs.

3. Which of the following provides the greatest potential for a free rider problem?
   a) The group task requires a high level of coordination among group members.
   b) The individual tasks within the group are similar.
   c) The group has a strong culture.
   d) The work needs to be completed quickly.

4. The controllability principle is most appropriately invoked in which of the following conditions in a manufacturing department that is evaluated as a cost centre?
   a) An unexpected high cost of a commodity that is a key raw material.
   b) A strike by workers.
   c) Efficiency losses due to unexpected production increases.
   d) Machine time loss due to damage caused by a lightning strike.

5. Which of the following is a legitimate responsibility centre?
   a) A legal department
   b) A personnel department
   c) A sales department
   d) All of the above.
6. A production department evaluated based on its performance relative to standard costs has incurred excessive production line set up costs due to constant and unexpected requests by the sales department, which is evaluated based on revenue, for rush orders. These costs:

a) Should be absorbed by the production department since being flexible is part of the department’s responsibility.
b) Should not be absorbed by the production department and treated as an uncontrollable cost.
c) Should be charged back to the sales department.
d) Should be prorated between the production department and the sales department.

7. If the return on investment is 3.5% and the profit margin is 8.75%, total asset turnover is:

a) .31
b) .40
c) 2.5
d) Cannot tell from the data provided

8. If revenues are $4,500,000, the profit margin is 11%, total asset turnover is 3 and the required return on investment is 15%, then residual income is:

a) $270,000
b) $478,500
c) $495,000
d) Cannot tell from the data provided

9. Which of the following is true about evaluating an organization unit using residual income?

a) Projects with a net present value that is positive will always be accepted
b) The manager will be motivated to dispose of non-productive assets
c) The manager will be motivated to pursue non-financial objectives
d) The manager will always be more likely to accept projects if performance was evaluated using return on investment.
Problem 1

The giftware division of Danny Company sells decorative plates. The giftware division has total fixed costs of $2,500,000 and average assets of $10,000,000. The average contribution margin per unit is $8.

Required:

a) If the manager of the division is evaluated based on the division’s return on investment what is minimum level of sales the division must achieve to provide a return on investment of 15%?

b) Assume the manager of the division is evaluated using residual income and the cost of capital is assessed as 20%. What is the minimum level of sales the division must achieve to meet achieve a non-negative residual income?

Problem 2

Star Petroleum is a gasoline retailer. Star pays the refiner $.85 per litre of regular gasoline, which it sells for an average price of $1.05 per litre. Star’s other costs are fixed and amount to $450,000 per year. The gross book value of property 100201 is $1,250,000, consisting of the land and the building valued at their historical cost of $250,000 and $1,000,000, respectively. The net book value of the building is $200,000.

Last year, property 100201 sold 3,000,000 litres of gasoline.

A property developer has offered Star Petroleum $5,000,000 for the property.

Required:

a) Compute the return on investment using:
   i. Gross book value
   ii. Net book value
   iii. Market value

b) If Star Petroleum has a pre-tax required rate of return on investment of 15%, compute residual income using:
   i. Gross book value
   ii. Net book value
   iii. Market value
Problem 3

Restful Inns operates a chain of motels. Each property is identical in order to convey a standard image to customers. Each property is evaluated as an investment centre in order to ensure the Board that all properties are being managed and evaluated effectively. The general manager at each motel is evaluated based on the motel’s return on assets.

The chief operating officer is concerned about property number 234-AB, which is consistently a weak performer compared to the average of all motels in the chain. The following exhibit compares this unit’s performance with that of the average of all motels in the chain. The local market size number is the total revenue of all comparable motels in the geographic area of each motel in the chain. The average ROI number is the average ROI reported by all competitor motels in each motel’s geographic area.

<table>
<thead>
<tr>
<th></th>
<th>Revenue</th>
<th>Net Income</th>
<th>Assets</th>
<th>ROI</th>
<th>Market Size</th>
<th>Average ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motel 234-AB</td>
<td>$1,600,000</td>
<td>$125,000</td>
<td>$2,500,000</td>
<td>5.0%</td>
<td>$35,000,000</td>
<td>3.5%</td>
</tr>
<tr>
<td>Chain-wide average</td>
<td>3,700,000</td>
<td>265,000</td>
<td>2,600,000</td>
<td>10.2%</td>
<td>95,000,000</td>
<td>9.0%</td>
</tr>
</tbody>
</table>

Required:

a) Evaluate the performance of the manager of the motel in question.

b) What might Restful Inns do in this situation?

Problem 4

Pat Toste is the manager of an organization segment that is evaluated using the return on investment criterion. Pat is considering investing in a new machine that will cost $500,000, with a life of five years, will have no salvage value and will decrease manufacturing costs by $150,000 in each of the five years of operation. The company faces a 32% tax rate. Assume, for convenience, the machine will be depreciated on a straight-line basis over the five year life for both tax and accounting purposes.

Required:

a) Is this a financially attractive investment from the company’s perspective if the required after-tax return on investment is 9%?

b) If Pat is evaluated based on return on assets and the current ROI in Pat’s division is 8%, will Pat make this investment? Assume the asset is measured by its net book value at year-end.
Problem 5

Osti Industries produces tool and die machinery for manufacturers. The company expanded vertically in 2004 by acquiring one of its suppliers of alloy steel plates, Robertson Steel Company. In order to manage the two separate businesses, the operations of Robertson are reported separately as an investment centre.

Osti monitors its divisions on the basis of both unit contribution and return on average investment (ROI), with investment defined as average operating assets employed. Management bonuses are determined on ROI. All investments in operating assets are expected to earn a minimum return of 11% before income taxes.

Robertson's cost of goods sold is considered to be entirely variable, while the division's administrative expenses are not dependent on volume. Selling expenses are a mixed cost with 40% attributed to sales volume. Robertson's ROI has ranged from 11.8% to 14.7% since 2004. During the fiscal year ended November 30, 2009, Robertson contemplated a capital acquisition with an estimated ROI of 11.5%; however, division management decided against the investment because it believed the investment would decrease Robertson's overall ROI.

The 2009 operating statement for Robertson follows. The division's operating assets employed were $15,750,000 at November 30, 2009, a 5% increase over the 2008 year-end balance.

**Robertson Steel Division**

**Operating Statement**

*for the year ended November 30, 2009*  
*($000 omitted)*

<table>
<thead>
<tr>
<th>Sales revenue</th>
<th>$25,000</th>
</tr>
</thead>
</table>

Less expenses:

<table>
<thead>
<tr>
<th>Cost of goods sold</th>
<th>$16,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative expenses</td>
<td>3,955</td>
</tr>
<tr>
<td>Selling expenses</td>
<td>2,700</td>
</tr>
</tbody>
</table>

| Income from operations before income taxes | 23,155 | $ 1,845 |

Required:

a. Calculate the unit contribution for Robertson steel division if 1,484,000 units were produced and sold during the year ended November 30, 2009.

b. Calculate the following performance measures for 2009 for the Robertson steel division:
   1. Pre-tax return on average investment in operating assets employed (ROI).
   2. Residual income (RI) calculated on the basis of average operating assets employed.
c. Explain why Robertson management would have been more likely to accept the contemplated capital acquisition if RI rather than ROI had been used as a performance measurement.
Solutions

Multiple Choice Questions

1. b  a, c and d are claimed benefits.

2. d  a – as the need for inter-unit coordination increases the potential value of decentralization falls
     b – as control costs increase, the value of decentralization falls
     c – as organization risk increases, the value of decentralization falls

3. b  a – the more highly coordinated the tasks, the less likely the individual can shirk
     c – a group with a strong culture would not tolerate shirking
     c – not relevant

4. c  a – the manager would be expected to acquire critical long-term supplies through a contract in order to fix the price
     b – this is a normal business risk and would be treated as foreseeable and requiring a contingency plan
     d – this is a normal business risk and would be treated as foreseeable and requiring a contingency plan

5. d  Support departments are legitimately treated as responsibility centres

6. d  Since the cost is inflicted by the demands of the sales department, it should bear some of the costs. Since this is a possibility, there should be contingency planning in the production department. The most likely alternative treatment would be c.

7. b  Return on investment= profit margin * total asset turnover. Therefore, total asset turnover is 3.5% / 8.75% = .40

8. a  Net income = $4,500,000 * 11% = $495,000. Total assets = $4,500,000 / 3 = 1,500,000
     Therefore, residual income = 495,000 – (1,500,000 * .15) = $270,000

9. b  a – it is quite possible that in the short-term accepting a project will reduce the residual income in some years.
     c – like all performance measures based on a profit derivative, residual income must be supplemented by non-financial performance measures in order to provide the requisite variety to assess the performance of most responsibility centres.
     d – this depends on the situation and, therefore, is not always true
Problem 1

Let $x$ be the required units of sale:

(a) \[ \frac{8x - 2,500,000}{10,000,000} = 15\% \]
\[ 8x - 2,500,000 = 1,500,000 \]
\[ 8x = 4,000,000 \]
\[ x = 500,000 \text{ units} \]

(b) \[ 8x - 2,500,000 = 10,000,000 \times (20\% ) \]
\[ 8x - 2,500,000 = 2,000,000 \]
\[ 8x = 4,500,000 \]
\[ \text{therefore, } x = 562,500 \]

Problem 2

Net income = \( (1.05 - .85) \times 3,000,000 - 450,000 = \$150,000 \)

a) i. \( \frac{150,000}{1,250,000} = 12\% \)
ii. \( \frac{150,000}{450,000} = 33.3\% \)
iii. \( \frac{150,000}{5,000,000} = 3\% \)

b) i. \( \frac{150,000}{(1,250,000 \times 15\%)} = -$37,500 \)
ii. \( \frac{150,000}{(450,000 \times 15\%)} = $82,500 \)
iii. \( \frac{150,000}{(5,000,000 \times 15\%)} = ($600,000) \)

Problem 3

a) Although the motel is evaluated as an investment centre, the properties are physically identical so the manager of each unit has no control over the investment base. The profit margin at unit 234-AB is 7.81\% \( (125,000 \div 1,600,000) \), which is higher than the chain average of 7.16\% \( (265,000 \div 3,700,000) \). Therefore, this manager is controlling costs more effectively than the average manager.

The manager has achieved a 4.57\% \( (1,600,000 \div 35,000,000) \) share in the local market vs. a chain wide average of 3.89\% \( (3,700,000 \div 95,000,000) \).

Therefore, based on what the manager can control, she is doing better than the average in the chain.

b) This unit is located in a small market and the size of the local market may not justify a motel this size. Alternatively, management might decide this market is simply not profitable and exit the market.
Problem 4

Therefore, the incremental cash flow will be -$500,000 at time zero and $134,000 for each of the five years.

a) Initial investment

<table>
<thead>
<tr>
<th>Present value of annual cash flows:</th>
</tr>
</thead>
<tbody>
<tr>
<td>After-tax savings: $150,000 x .68</td>
</tr>
<tr>
<td>Tax shield on depreciation: $100,000 x .32</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

N = 5, I = 9, PMT = $134,000

Net present value

| $ 21,213 |

b) The incremental income from this investment will be ($150,000 - (500,000 / 5)) or $50,000 each year. The tax on this will be $16,000 (50,000 * .32). The net income reported at the end of Year 1 will be $34,000 ($50,000 * (1-.32)). Therefore, the incremental return on assets in Year 1 if this investment is made will be 8.5% [34,000 / (500,000-100,000)]. Since this increases the average return on investments in Pat’s division, Pat will find this investment opportunity attractive.

Problem 5

a. Sales revenue per unit: $25,000 / 1,484 $16.85
   Cost of goods sold: $16,500 / 1,484 (11.12)
   Variable selling: $2,700 x 40% / 1,484 (.73)
   Contribution margin per unit $ 5.00

b. 1 Average assets = [(15,750,000 / 1.05) + 15,750,000] / 2
   = (15,000,000 + 15,750,000) / 2
   = $15,375,000

   ROI = $1,845 / 15,375 = 12%

   2 RI = $1,845,000 – (15,375,000 x 11%)
   = $1,845,000 – 1,691,250
   = $153,750

c. Accepting the new investment would have increased RI.
22. Strategic Cost Management Techniques

Note that these topics are not covered in class in the accelerated program, nor will they be tested in the accelerated program exams. They are, however, required topics in the CMA Canada Competency Map and could be tested on the Entrance Examination. We recommend this chapter be read as part of your preparation for the Entrance Examination.

Learning Objectives

After completing this chapter, you will understand and be able to explain the decision making relevance of the following strategic cost management concepts:

- Process mapping
- Total quality management
- Cost of quality
- Activity based management
- Target costing
- Theory of constraints
- Kaizen costing
- Life cycle costing

Process Mapping

Process mapping (also known as process charting or flow charting) provides a visual representation of a process by documenting the activities (often referred to as events or steps) used to make a product (good or service). The goal of process mapping is to improve both the effectiveness and efficiency of a process.

Process mapping is attributed to Frank Gilbreth, who developed the original ideas in the 1920s. Gilbreth had observed bricklayers working for his construction company going about their tasks each in their own ways. Gilbreth decided to document the best practices to improve the efficiency of work. The original model proposed by Gilbreth focused on a visual approach that was limited to simply drawing the process. Later, adaptations included adding times, quality and cost data to each of the documented activities.

Because of its focus on standardizing work and improving efficiency, process mapping has been widely used in the six sigma management system, which focuses on standardizing processes to improve quality.

The following is an example of a generic process map provided at [www.rff.com](http://www.rff.com). In an actual implementation, each process step would be identified specifically rather than using the generic...
“process step”. For example, the box opposite the customer might be “take and transmit customer order to sales”:

The importance of process mapping to management accountants will be developed below in the discussion of activity based management.

If you are interested in process mapping, interesting examples can be seen at www.youtube.com

**Total Quality Management**

The evolution of the original process mapping approach began with the concept of total quality management (TQM), a term developed by W. Edwards Deming, one of the so called quality gurus who had a major impact on business thinking in the 1940s. TQM continued Gilbreth’s efficiency perspective, but added the notion of standardization to support product quality as well as cost reduction. Like process mapping, the focus in TQM is to identify the best process and then to ensure conformance to that process. By focusing on customers, TQM set the foundation for activity based management, which we will discuss below.

TQM is more a management philosophy than a process. TQM involves the use of many different tools to support and promote the reduction of cost and defective production. While the number of TQM tools exceeds 100, the most commonly used are: graphs, run charts, Pareto charts, force field analysis, Ishikawa diagrams, brainstorming, tree diagrams, process charts,
scatter diagrams and the development and use of a systematic process of planning, executing, measuring and revising when necessary (called the plan, do, check, act, cycle).

Following are a few examples.

Below is a run chart looking at the fill rates of a milk packaging machine. The machine is set for a fill rate of 1000 millilitres. The machine manufacturer advises if the fill rate is above 1,002 millilitres or below 998 millilitres, the machine is not operating within tolerance.

The following is a Pareto chart illustrating the results of a survey of why students did poorly in a course:
The following is an Ishikawa (fishbone) chart prepared by the consultancy of Booz-Allen & Hamilton showing the causes of late boarding for an airline:

![Ishikawa Chart](image-url)
A common element of most of the TQM tools is the need for process observation, documentation and measurement, hence, the important role for management accountants in the TQM approach. If you search the phrase total quality management tools on the web, you will find a number of interesting tools organizations have developed to promote quality improvement.

**Cost of Quality**

The cost of quality (COQ) is the cost associated with failing to produce a defect-free product. For this reason, some authors refer to this concept as “the cost of poor quality”. The term COQ is widely attributed to Joseph Juran’s Quality Control Handbook.

There are four components of the cost of quality:

1. **Prevention costs** are costs of activities designed to prevent defects. These activities include: working with suppliers to improve incoming quality of raw materials, training production line employees and improving process reliability.

2. **Appraisal costs** are the costs of inspection used to identify defects. These costs include testing incoming raw materials, testing and validating worker and equipment conformance to specification and inspecting completed or partially completed production.

3. **Internal failure costs** are costs needed to repair or replace defective production while the product is still in the producer’s hands. These costs include scrap, rework and downgrading (that is, the opportunity cost incurred when the product is sold as a second).

4. **External failure costs** are costs required to repair or replace defective production after the product has been delivered to the customer. Examples include: the cost of a customer complaint department, warranty claims and product recalls. In addition, there are intangible or opportunity costs associated with external failure. These include the loss of company image associated with an external product failure. A stunning example of intangible external failure costs is the 2002 demise of Arthur Andersen caused by defects in its performance relating to its audit of Enron. Another less well known example is the decline on Perrier’s sales and profitability caused by Perrier’s failure in 1994 to disclose accurately the source of benzene found in its bottled water.

The cost of quality (COQ) is the sum of these four costs. In order to scale for organization size, COQ is often expressed as a percentage of organization revenue. Moreover, COQ is often shown as a trend as evidence of improvement or deterioration in quality related activities.

Philip Crosby popularized the idea of COQ in his 1979 book Quality is Free. Crosby promoted the idea that a dollar invested upstream in prevention costs saved more than a dollar downstream in inspection, internal failure and external failure costs.
The following is an example of a COQ report (Measuring the Cost of Quality in a Hotel Restaurant Operation; Collin Ramden, Jocelina Santos and Hyun Kyung Chatfield, International Journal of Contemporary Hospitality Management, Vol. 19 No. 4, 2007, pp. 286-295)

<table>
<thead>
<tr>
<th>Costs of quality</th>
<th>2005</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$150,000</td>
<td>$120,000</td>
</tr>
<tr>
<td>Cost</td>
<td>Percentage of revenues</td>
<td>Cost</td>
</tr>
<tr>
<td>(1)</td>
<td>(2) = (1)</td>
<td>(3)</td>
</tr>
<tr>
<td>Design menu</td>
<td>$1,680</td>
<td>$840</td>
</tr>
<tr>
<td>Equipment maintenance</td>
<td>1,050</td>
<td>360</td>
</tr>
<tr>
<td>Training</td>
<td>2,640</td>
<td>900</td>
</tr>
<tr>
<td>Vendor evaluation</td>
<td>630</td>
<td>300</td>
</tr>
<tr>
<td>Total prevention costs</td>
<td>6,000</td>
<td>2,400</td>
</tr>
<tr>
<td>Prevention costs:</td>
<td>4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Inspection of production</td>
<td>975</td>
<td>1,080</td>
</tr>
<tr>
<td>Product-testing equipment</td>
<td>840</td>
<td>1,380</td>
</tr>
<tr>
<td>Incoming products inspection</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td>Product-testing (labor and material)</td>
<td>945</td>
<td>2,040</td>
</tr>
<tr>
<td>Total appraisal costs</td>
<td>3,000</td>
<td>4,800</td>
</tr>
<tr>
<td>Appraisal costs:</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Scrap</td>
<td>1,950</td>
<td>2,610</td>
</tr>
<tr>
<td>Rework</td>
<td>1,275</td>
<td>1,800</td>
</tr>
<tr>
<td>Breakdown maintenance</td>
<td>525</td>
<td>960</td>
</tr>
<tr>
<td>Total internal failure costs</td>
<td>3,750</td>
<td>5,400</td>
</tr>
<tr>
<td>Internal failure costs:</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Returned meals (room service)</td>
<td>1,650</td>
<td>840</td>
</tr>
<tr>
<td>Customer support</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Discount due to defects</td>
<td>1,050</td>
<td>2,160</td>
</tr>
<tr>
<td>Lost of sales</td>
<td>2,250</td>
<td>3,000</td>
</tr>
<tr>
<td>Total external failure cost</td>
<td>5,250</td>
<td>6,600</td>
</tr>
<tr>
<td>Total costs of quality</td>
<td>$18,000</td>
<td>$19,200</td>
</tr>
<tr>
<td></td>
<td>12.0</td>
<td>16.0</td>
</tr>
</tbody>
</table>

Activity Based Management

Highly influenced by American quality experts such as Joseph Juran and Edwards Deming, who in turn were influenced by Gilbreth’s ideas, Japanese manufacturers, particularly Toyota, developed a process of continuous improvement they called kaizen. In the early 1990s, American management writers, particularly Michael Hammer, further evolved the improvement idea with an approach they called business process re-engineering.

While kaizen focused on continuous improvement of an existing process, business process re-engineering returned to Gilbreth’s original idea of eliminating unnecessary steps to improve efficiency. In addition, however, Hammer’s perspective combined Gilbreth’s process mapping idea with Michael Porter’s notion of a value chain in order to focus the activities of the process
on customer requirements. Therefore, the important additional perspective offered by business process re-engineering was that the process was evaluated from the perspective of the customer rather than simply engineering efficiency, which was Gilbreth’s perspective. As a result, business process re-engineering or simply re-engineering, identifies activities that can be eliminated or improved without affecting the value of the final product. This perspective led to the important concepts of value-added and non-value-added activities.

Activity based management begins with drawing a process map that identifies all the activities used to produce a product. Then, each activity is labelled as value-added or non-value-added. A value-added activity adds something to the product that creates value for the customer. For example, putting a steering wheel in an automobile is value-added. A non-value-added activity does not. Good examples of non-value added activities are moving, storing, inspecting and repairing. Therefore, the additional perspective of the customer orientation was to identify non-value-added activities that were candidates for elimination because they created costs but added no value for the customer. The idea of focusing on eliminating non-value-added activities and improving the efficiency of value-added activities is now commonly known as activity based management or ABM.

The management accounting contribution to ABM is measurement. The initial contribution of management accountants was the development of the activity based costing (ABC) system discussed in Chapter 6. Later came the recognition that other facets of each activity, such as quality and time that were important to the customer were additional measurements that could, and should, be associated with each activity. The identification of the cost, quality and time taken to perform each activity became the key management accounting contributions to ABM.

Target Costing

Target costing, sometimes called price led costing, is a planning tool. The purpose of target costing is to develop a product and the process to produce the product so the product will meet customer requirements at a price the customer will be willing to pay and will return a specified profit to the organization.

The target costing team consists of representatives from all the functional areas thought to have contributions in the product development process. These include representatives from marketing, plant engineering, product engineering and design, purchasing and potential customers. The key in target costing is to manage this diverse team in which members bring functional rather than product perspectives. Therefore, the key in managing this team is a leader with a strong business, financial and strategic focus to the team. This is an ideal role for management accountants.

The motivation for target costing is the observation that by the time production starts, that is, the product design and product process have been chosen and implemented, the activities comprising 80% of the product cost have been committed leaving only activities that account for 20% of the product cost open for cost reduction activities (see Figure 3400-1). Therefore, the idea in target costing is to look for opportunities to reduce product costs during the design stage.
Target costing begins with a proposed product (good or service) design (see Figure 3400-2). A representative market panel identifies the most likely price the market would be willing to pay for a product with these proposed characteristics. This price is called the target selling price. It is important to note that, unlike cost plus pricing, the target selling price is determined by potential customers and not the organization.

Next, a tentative product and process design are undertaken and costed. The resulting cost is called the product’s “as-if” cost. A required return on investment is deducted from the target selling price to determine the target cost. Again it is important to note that the target costs and the as-if costs are estimates.

If the as-if cost is less than the target cost, the product development is undertaken. If not, a series of product and process redesigns are undertaken (which can result in both target cost and as-if cost changes) until the product cost is greater than the as-if cost.

The following is an example of how target costing was used to conduct a value analysis on a proposed product component:

One of Boeing’s customers requested heated floors. Before target costing, The Boeing Company was inclined to provide almost whatever the customer wanted without regard to cost. The company now prices airplane options separately. When this particular customer learned the price for heated floors was more than $1 million, it reconsidered its request.

The theory of constraints was proposed by E. Goldratt and J. Cox in 1984. The first step in the theory of constraints is to ensure that, given the resource requirements of the different products, the organization is producing the most profitable product mix. The second step involves mapping the process and identifying the key bottleneck (constraint) that is preventing higher levels of throughput (output). The third step is to remove the bottleneck (if it is financially desirable) by either increasing the productivity of the bottleneck resource or adding more of the resource. Once a bottleneck has been removed, the overall process can be recalibrated to identify the best product mix and a new bottleneck will arise. The cycle is then repeated with the new bottleneck. The process will end when there is a bottleneck that cannot be removed, for example, the maximum level of sales has been achieved since the market will not absorb any more.

The key metric in the theory of constraints is computing the opportunity cost of the bottleneck resource, which involves knowing how to predict the revenues and costs resulting from eliminating a production bottleneck, an important knowledge contribution the management accountant can make to production management.
Kaizen Costing

Kaizen is a program of continuous process review that looks for opportunities to reduce costs through improvements in existing activities. Kaizen costing is the process of setting and monitoring kaizen cost reduction targets.

Kaizen costing targets are usually expressed as a cost reduction rate based on current costs. For example, if the current cost for an activity is $1,000 and the kaizen costing rate is 3%, the target cost in the following year will be $970.

Kaizen costing activities are sometimes generated by a sudden reduction in product price caused by increased competition as the organization tries to regain profitability.

Life Cycle Costing

Life cycle costing (also called cradle to grave costing) involves the estimation and management of a product’s costs through its lifecycle. The lifecycle is generally seen as having the following four stages:

1. Product development and introduction – this period is characterized by large expenditures on research and product development. There will also be major costs relating to testing the product and introducing the product to the market place.

2. Early growth – this period is characterized by continued marketing costs intended to promote product recognition and some product development costs if the product is found to need modifications.

3. Late growth and maturity – this period is characterized by intense competition. Marketing and customer service costs will be high. Prices will be falling causing shrinking margins and pressure to reduce manufacturing costs.

4. Product decline and abandonment – this period is characterized by a gradual reduction in product demand until the product, at least in its current form, is no longer viable. At this point, product abandonment costs will be incurred at the product is withdrawn from the market.

For this discussion it is useful to organize product related costs into the following six groups:

1. Product related research and development costs
2. Product design costs
3. Manufacturing costs
4. Selling and distribution costs
5. Marketing costs
6. Customer service costs
The following is a summary of the cost levels that might be experienced in each stage of the product life cycle for a common manufactured consumer product:

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>Product Development and Introduction</th>
<th>Early Growth</th>
<th>Late Growth</th>
<th>Decline and Abandonment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product related research and development costs</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Product design costs</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Manufacturing costs</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Selling and distribution costs</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Marketing costs</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Customer service costs</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

The lifecycle costing tool is designed to support two significant management decisions:

1. Product planners must consider potentially significant product non-manufacturing costs during the product planning stage in order to determine whether the market price will provide for the recovery of all costs and provide a reasonable return to invested capital.

2. Product lifecycle costing prepares the organization for significant product related costs. While most organizations routinely consider manufacturing and customer related costs, product development costs and product abandonment costs (such as closing a factory or reconditioning a brown field site) can be significant and need to be reflected in organization budgets.

Conclusion:

This chapter has reviewed a number of tools used by management accountants to support organization decision making. The purpose of this review is to provide only a brief introduction and overview. More details on some of these tools will be developed in the Strategic Leadership Program.

All these tools stress a significant management accounting role in organizations, that is, to develop and interpret important information to inform strategic decisions.
Multiple Choice Questions

Question 1

The primary purpose of process mapping is:

a) To improve the effectiveness and efficiency of a process  
b) To promote consistency in doing work  
c) Identify best practices  
d) All of the above

Question 2

Which of the following is not a common total quality management tool?

a) Pareto charts  
b) Run charts  
c) Brainstorming  
d) Variance analysis

Question 3

Which of the following would be considered a component in the cost of quality?

a) Training workers  
b) Product testing  
c) Inspecting incoming raw materials  
d) All of the above

Question 4

Which of the following is not true about the cost of quality?

a) The ideal cost of quality is zero  
b) Cost of quality should be expressed as a fraction of sales  
c) Spending a dollar on prevention cost will reduce total quality cost  
d) Cost of quality can be applied in both manufacturing and service organizations.
Question 5

Which of the following statements is true about where primary attention should be focused in activity based management?

a) Improve the efficiency of all operations  
b) Improve the quality of all operations  
c) Eliminate non-value added activities  
d) None of the above

Question 6

Which of the following is not true about the theory of constraints?

a) Each resource should be put to its most profitable use  
b) Relieve all the constraints in a system simultaneously to ensure optimality  
c) Ensure each constraint is being used efficiently  
d) Keep relieving constraints until the cost of relieving the last constraint exceeds the benefit

Question 7

Kaizen costing argues that:

a) Operations should be improved using small continuous adjustments  
b) Quality should be improved at all costs  
c) Always look to eliminate non-value added steps  
d) Ensure during planning that the best product and process design are chosen

Question 8

Lifecycle costing is intended to:

a) Ensure that at each stage of the product lifecycle, the product price is adjusted to cover the costs in that stage of the product lifecycle  
b) Ensure the company creates a sinking fund to cover any product abandonment costs  
c) Both of the above  
d) Neither of the above
Multiple Choice Question Solutions

Question 1   d
Question 2   d
Question 3   d
Question 4   a
Question 5   c
Question 6   b
Question 7   a
Question 8   d