Chapter 2
Cost Concepts and Behavior
Learning Objectives

L.O. 1  Explain the basic concept of “cost.”
L.O. 2  Explain how costs are presented in financial statements.
L.O. 3  Explain the process of cost allocation.
L.O. 4  Understand how material, labor, and overhead costs are added to a product at each stage of the production process.
L.O. 5  Define basic cost behaviors, including fixed, variable, semivariable, and step costs.
L.O. 6  Identify the components of a product’s costs.
L.O. 7  Understand the distinction between financial and contribution margin income statements.
What is a Cost?

L.O. 1 Explain the basic concept of “cost.”

• Cost is a sacrifice of resources.
Cost versus Expenses

- **Cost**
  - Outlay Cost
    - Past, present, or future cash outflow
  - Opportunity Costs
    - Forgone benefit from the best alternative course of action

- **Expense**
  - Cost charged against revenue in an accounting period
Presentation of Costs in Financial Statements

L.O. 2 Explain how costs are presented in financial statements.

Income Statements

Service company

Revenues
- Cost of services sold
= Gross margin
- Marketing and administrative costs
= Operating profit

Cost of billable hours

The excess of operating revenue over costs necessary to generate those revenues
Presentation of Costs in Financial Statements

Income Statements

Merchandising company

- Revenues
  - Cost of goods sold
  = Gross margin
  - Marketing and administrative costs
  = Operating profit

Expense assigned to products sold during a period

The excess of operating revenue over costs necessary to generate those revenues
Presentation of Costs in Financial Statements

Income Statements

Manufacturing company

Cost incurred to manufacture the product sold

Sales revenue
  - Cost of goods sold
  = Gross margin

Product costs recorded as “inventory” when cost is incurred

- Marketing and administrative costs

Period costs recorded as an expense in the period the cost is incurred

= Operating profit

Expensed when sold

LO2
Product versus Period Costs

- Two types of manufacturing costs:
  - **Product costs:** Costs related to inventory
  - **Period costs:** Non-manufacturing costs related to the firm
Product versus Period Costs

Product costs:
Costs that are recorded as an asset in inventory when incurred and expensed as Cost of Goods Sold when sold

Period costs:
Costs recognized for financial reporting when incurred
Direct and Indirect Manufacturing Costs

Direct costs: Costs that, for a reasonable cost, can be directly traced to the product.

Direct materials: Materials directly traceable to the product

Direct labor: Work directly traceable to transforming materials into the finished product
Direct and Indirect Manufacturing Costs

Indirect costs:
Costs that cannot reasonably be directly traced to the product.

Manufacturing overhead:
All production costs except direct materials and direct labor.

- Indirect materials
- Indirect labor
- Other indirect costs
Prime Costs and Conversion Costs

Prime costs:
The “primary” costs of the product

Conversion costs:
Costs necessary to “convert” materials into a product

Direct materials
Direct labor
Direct labor
Manufacturing overhead
Non-manufacturing Costs

• Recognized as expenses when the costs are incurred

Marketing:
Costs necessary to sell the products

Administrative:
Costs necessary to operate the business

Advertising
Sales commissions
Shipping costs
Executive salaries
Data processing
Legal costs
L.O. 3 Explain the process of cost allocation.

- It is the process of assigning indirect costs to products, services, business units, etc.
Cost Allocation

1. Define the cost pool:
   The collection of costs to be assigned to cost objects

2. Determine the cost allocation rule:
   The method used to assign costs in the cost pool to cost objects

3. Assign the costs in the cost pool to the cost object:
   Any end to which a cost is assigned – product, product line, department, customer, etc.
Cost Allocation: Example

Rockford Corporation has two divisions, East Coast and West Coast. Both divisions are supported by the IS Group.

<table>
<thead>
<tr>
<th></th>
<th>East Coast</th>
<th>West Coast</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>$80 million</td>
<td>$20 million</td>
<td>$100 million</td>
</tr>
</tbody>
</table>

1. Define the cost pool: IS department’s costs of $1,000,000

2. Determine the cost allocation rule: IS costs are allocated based on divisional revenue. (% of revenue)

3. Assign to the cost object: East Coast: 80% of cost
   West Coast: 20% of cost
Cost Flow Diagram

Corporate IS Group
$1,000,000

East Coast
$800,000

Allocated

West Coast
$200,000
Details of Manufacturing Cost Flows

L.O. 4 Understand how material, labor, and overhead costs are added to a product at each stage of the production process.

• Product costs are recorded in inventory when costs are incurred.
• A manufacturing company has three inventory accounts:
  1. Raw Materials Inventory: Materials purchased to make a product
  2. Work-in-Process Inventory: Products currently in the production process, but not yet completed
  3. Finished Goods Inventory: Completed products that have not yet been sold
Inventory Accounts
– The Balance Sheet

Direct Materials Inventory

- Beg. RM inventory
- Purchases
= Raw materials available for production
- Ending RM inventory
= Raw materials transferred to WIP

Work-in-Process Inventory

- Beg. WIP inventory
+ Direct materials transferred from raw materials
+ Direct labor
+ Manufacturing overhead
= Total manufacturing costs
= Ending WIP inventory
- Costs of goods completed and transferred to finished goods (or cost of goods manufactured)

Finished Goods Inventory

- Beg. FG inventory
+ Cost of goods completed and transferred from WIP
= Goods available for sale
= Ending FG inventory
- Cost of goods sold

To the Income Statement
How Costs Flow Through the Statements

JACKSON GEARS
Income Statement
For the Year Ending December 31, Year 200X

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$20,450,000</td>
</tr>
<tr>
<td>Less: Cost of goods sold</td>
<td>13,100,000</td>
</tr>
<tr>
<td>Gross margin</td>
<td>$ 7,350,000</td>
</tr>
<tr>
<td>Less: Marketing and administrative expenses</td>
<td>3,850,000</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$ 3,500,000</td>
</tr>
</tbody>
</table>
## How Costs Flow Through the Statements

JACKSON GEARS
Cost of Goods Manufactured Statement
For the Year Ending December 31, Year 200X ($000)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount ($000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning work-in-process inventory, January 1</td>
<td>270</td>
</tr>
<tr>
<td>Manufacturing costs during the year:</td>
<td></td>
</tr>
<tr>
<td>Direct materials:</td>
<td></td>
</tr>
<tr>
<td>Beginning inventory, January 1</td>
<td>95</td>
</tr>
<tr>
<td>Add: Purchases</td>
<td>5,627</td>
</tr>
<tr>
<td>Direct materials available</td>
<td>5,722</td>
</tr>
<tr>
<td>Less: Ending inventory, December 31</td>
<td>72</td>
</tr>
<tr>
<td>Direct material put into production</td>
<td>5,650</td>
</tr>
<tr>
<td>Direct labor</td>
<td>1,220</td>
</tr>
<tr>
<td>Manufacturing overhead</td>
<td>6,780</td>
</tr>
<tr>
<td>Total manufacturing costs incurred</td>
<td>13,650</td>
</tr>
<tr>
<td>Total work in process during the year</td>
<td>13,920</td>
</tr>
<tr>
<td>Less: Ending work-in-process inventory, December 31</td>
<td>310</td>
</tr>
<tr>
<td>Cost of goods manufactured</td>
<td>13,610</td>
</tr>
</tbody>
</table>
How Costs Flow Through the Statements

JACKSON GEARS
Cost of Goods Sold Statement
For the Year Ending December 31, Year 200X ($000)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount ($000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning finished goods inventory, January 1</td>
<td>420</td>
</tr>
<tr>
<td>Cost of goods manufactured</td>
<td>13,610</td>
</tr>
<tr>
<td>Finished goods available for sale</td>
<td>14,030</td>
</tr>
<tr>
<td>Less: Ending Finished Goods Inventory, December 31</td>
<td>930</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td>13,100</td>
</tr>
</tbody>
</table>
L.O. 5  Define basic cost behaviors, including fixed, variable, semivariable, and step costs.

Cost behavior:
How costs respond to a change in activity level within the relevant range

Relevant range:
Activity levels within which a given total fixed cost or unit variable cost will be unchanged
Fixed Costs

- Fixed costs remain unchanged as volume changes within the relevant range.
- Fixed costs per unit varies inversely to a change in activity.
- Fixed costs are “fixed” in “total” as activity changes.
Variable Costs

• Costs that change in direct proportion with a change in the volume within the relevant range.
• Variable costs “vary” in “total” as activity changes.
• Variable cost per unit stays constant when activity changes within the relevant range.
Relevant Range

Volume

Fixed Costs

LO5
Semivariable Costs

- Costs that have both fixed and variable components
- Also known as mixed costs
Step Costs

- Costs that increase in total with steps when the volume changes to a particular level
- Step costs are also known as semifixed costs.
Components of Product Costs

L.O. 6 Identify the components of a product’s costs.

Full cost:
The sum of all costs of manufacturing and selling a unit of the product

Full absorption cost:
The sum of all variable and fixed costs of manufacturing a unit of the product

Variable cost:
The sum of all variable costs of manufacturing and selling a unit of the product
Components of Product Costs

Full cost per unit = $40

Full absorption cost per unit = $29

Direct materials = $8

Direct labor = $7

Variable manufacturing overhead = $8

Fixed manufacturing overhead = $6

Variable marketing and administrative costs = $4

Fixed marketing and administrative costs = $7

Variable manufacturing cost = $23

Unit variable cost = $27

Variable marketing and administrative costs = $4

Full cost per unit = $40

LO6
Making Cost Information Useful

L.O. 7 Understand the distinction between financial and contribution margin income statements.

### Full absorption costing:
- Required by GAAP
- Used for:
  - Financial purposes
  - External reporting

<table>
<thead>
<tr>
<th>Sales revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Cost of goods sold</td>
</tr>
<tr>
<td>= Gross margin</td>
</tr>
</tbody>
</table>

### Variable costing:
- Used for:
  - Managerial purposes
  - Internal decision making

<table>
<thead>
<tr>
<th>Sales revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Variable costs</td>
</tr>
<tr>
<td>= Contribution margin</td>
</tr>
</tbody>
</table>
Making Cost Information Useful

Financial income statement

- Full absorption costing

  Sales price
  - Full absorption cost
  = Gross margin

Contribution margin income statement

- Variable costing

  Sales price
  - Variable costs
  = Contribution margin
Income Statement: Full Absorption Costing

Sales revenue

- Cost of goods sold

= Gross margin

- Marketing and administrative costs

= Operating profit

Full absorption

Variable and fixed manufacturing costs

Period costs

Variable and fixed marketing and administrative costs
Income Statement: Variable Costing

Sales revenue

- Variable costs

= Contribution margin

- Fixed costs

= Operating profit

Variable manufacturing costs and variable marketing and administrative costs

Fixed manufacturing costs and fixed marketing and administrative costs
End of Chapter 2
Chapter 3

Fundamentals of Cost-Volume-Profit Analysis
Learning Objectives

L.O. 1  Use cost-volume-profit (CVP) analysis to analyze decisions.
L.O. 2  Understand the effect of cost structure on decisions.
L.O. 3  Use Microsoft Excel to perform CVP analysis.
L.O. 4  Incorporate taxes, multiple products, and alternative cost structures into the CVP analysis.
L.O. 5  Understand the assumptions and limitations of CVP analysis.
Cost-Volume-Profit Analysis

L.O. 1 Use cost-volume-profit (CVP) analysis to analyze decisions.

What is CVP?

• CVP analysis explores the relationship between revenue, cost, and volume and their effect on profits.
Profit Equation

The Income Statement

Total revenues
– Total costs
= Operating profit

The Income Statement written horizontally

Operating profit = Total revenues – Total costs
Profit = TR – TC
Profit Equation

- Total revenue \((TR)\)
  \[ TR = PX \]
  - Average selling price per unit \((P)\)
  - Units of output produced and sold \((X)\)

- Total cost \((TC)\)
  \[ TC = VX + F \]
  - Variable cost per unit \((V)\) × Units of output \((X)\)
  - Fixed costs \((F)\)
Profit Equation

Profit = Total revenue – Total costs
    = TR – TC
    TC = VX + F

Therefore, Profit = PX – (VX + F)

Profit = (Price – Variable costs) × Units of output – Fixed costs
    = X(P – V) – F
Contribution Margin

• This is the difference between price and variable cost.
• It is what is leftover to cover fixed costs and then add to operating profit.

Contribution margin = Price per unit – Variable cost per unit

\[ P - V \]
CVP Example

U-Develop
Income Statement
For the Month Ending March 20XX

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (12,000 prints at $0.60)</td>
<td>$7,200</td>
</tr>
<tr>
<td>Less:</td>
<td></td>
</tr>
<tr>
<td>Variable costs of goods sold (12,000 × $0.30)</td>
<td>$3,600</td>
</tr>
<tr>
<td>Variable selling costs (12,000 × $0.06)</td>
<td>720</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$2,880</td>
</tr>
<tr>
<td>Less: Fixed costs</td>
<td>1,500</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$1,380</td>
</tr>
</tbody>
</table>

• Contribution margin = $2,880 ÷ 12,000 = $0.24
Break-Even Volume in Units

• This is the volume level at which profits equal zero.

\[
\text{Profit 0} = X(P - V) - F
\]

If profit = 0, then \( X = \frac{F}{P - V} \)

Break-even volume (in units) = \( \frac{\text{Fixed costs}}{\text{Unit contribution margin}} \)

= \( \frac{\$1,500}{\$0.24} \)

= 6,250 prints
Contribution margin percentage (contribution margin ratio) is the contribution margin as a percentage of sales revenue.

What is the contribution margin percentage?

\[
\frac{0.24}{0.60} = 0.40 \text{ (or 40\%)}
\]

\[
\frac{1500}{0.40} = 3750
\]
Assume that management wants to have a profit of $1,800.

How many prints must be sold?

\[ \frac{($1,500 + $1,800)}{0.24} = 13,750 \]

What is the target dollar sales?

\[ \frac{($1,500 + $1,800)}{0.40} = $8,250 \]
CVP Summary: Break-Even

Break-even volume (units)  =  \frac{\text{Fixed costs}}{\text{Unit contribution margin}}

Break-even volume (sales dollars)  =  \frac{\text{Fixed costs}}{\text{Contribution margin ratio}}
CVP Summary: Target Volume

Target volume (units) = \( \frac{\text{Fixed costs} + \text{Target profit}}{\text{Unit contribution margin}} \)

Target volume (sales dollars) = \( \frac{\text{Fixed costs} + \text{Target profit}}{\text{Contribution margin ratio}} \)
Graphic Presentation

Total cost
\[ TC = 1,500 + 0.36X \]

Total revenue
\[ TR = 0.60 \times 3,750 \]

6,250 prints
Use of CVP to Analyze the Effect of Different Cost Structures

L.O. 2 Understand the effect of cost structure on decisions.

Cost structure:
The proportion of fixed and variable costs to total costs.

Operating leverage:
The extent to which the cost structure is comprised of fixed costs.
Use of CVP to Analyze the Effect of Different Cost Structures

Operating leverage = \frac{\text{Contribution margin}}{\text{Operating profit}}

- The higher the organization’s operating leverage, the higher the break-even point.
## Comparison of Cost Structures

<table>
<thead>
<tr>
<th></th>
<th>Lo-Lev Company (1,000,000 units)</th>
<th>Hi-Lev Company (1,000,000 units)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount</td>
<td>%</td>
</tr>
<tr>
<td><strong>Sales</strong></td>
<td>$1,000,000</td>
<td>100</td>
</tr>
<tr>
<td>Variable costs</td>
<td>750,000</td>
<td>75</td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
<td>$ 250,000</td>
<td>25</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>50,000</td>
<td>5</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$ 200,000</td>
<td>20</td>
</tr>
<tr>
<td><strong>Break-even point</strong></td>
<td>200,000 units</td>
<td></td>
</tr>
<tr>
<td><strong>Contribution margin per unit</strong></td>
<td>$0.25</td>
<td></td>
</tr>
<tr>
<td><strong>Degree of operating leverage</strong></td>
<td>1.25</td>
<td></td>
</tr>
</tbody>
</table>
### Comparison of Cost Structures

- Suppose Low-Lev and High-Lev both increase sales 10% or $100,000.

<table>
<thead>
<tr>
<th></th>
<th>Lo-Lev</th>
<th>Hi-Lev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales increase</td>
<td>$100,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>0.25</td>
<td>0.75</td>
</tr>
<tr>
<td>Increase in profit</td>
<td>$25,000</td>
<td>$75,000</td>
</tr>
<tr>
<td>Prior net income</td>
<td>$200,000</td>
<td>$200,000</td>
</tr>
<tr>
<td>Net income with sales increase of 10%</td>
<td>$225,000</td>
<td>$275,000</td>
</tr>
</tbody>
</table>
Margin of Safety

• The excess of projected or actual sales volume over break-even volume

• The excess of projected or actual sales revenue over break-even revenue

• Suppose U-Develop sells 8,000 prints.

• At a break-even volume of 6,250, its margin of safety is:

  Sales – Break-even = 8,000 – 6,250 = 1,750 prints
L.O. 3  Use Microsoft Excel to perform CVP analysis.

A spreadsheet program is ideally suited to performing CPV routinely.

1. Choose “Tools: Goal Seek…” from the menu bar.
2. In the “Set cell” edit field, enter the cell address for the target profit calculation.
3. In the “To value” edit field, enter the target profit.
4. In the “By changing cell” edit field, enter the cell address of the volume variable.
5. Click “OK” and the program will find the break-even volume.
Extensions of the CVP Model: Income Taxes

L.O. 4 Incorporate taxes, multiple products, and alternative cost structures into the CVP analysis.

• The owners of U-Develop want to generate after-tax operating profits of $1,800.

• The tax rate is 25%.

• What is the target operating profit?

Target operating profit = TOP ÷ (1 – Tax rate)

TOP = $1,800 ÷ (1 – 0.25) = $2,400
Extensions of the CVP Model: Income Taxes

• How many units must be sold?

\[
\text{Fixed costs} + \left[ \frac{\text{Target profit}}{1 - \text{Tax rate}} \right]
\]
\[
\frac{\text{Unit contribution margin}}{}
\]

\[
\frac{($1,500 + $2,400)}{0.24} = 16,250 \text{ prints}
\]
Extensions of the CVP Model: Income Taxes

Proof:

Sales: 16,250 × $0.60 $9,750
Variable costs: 16,250 × $0.36 5,850
Contribution margin $3,900
Fixed costs 1,500
Net income before taxes $2,400
Income taxes: $2,400 × 25% 600
Net income $1,800
Extensions of the CVP Model: Multiproduct Analysis

• Management expects to sell 9 prints at $.60 each for every enlargement it sells at $1.00.

<table>
<thead>
<tr>
<th></th>
<th>Prints</th>
<th>Enlargements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price</td>
<td>$0.60</td>
<td>$1.00</td>
</tr>
<tr>
<td>Less: Variable cost</td>
<td>.36</td>
<td>.56</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$0.24</td>
<td>$0.44</td>
</tr>
</tbody>
</table>

• Total fixed costs = $1,820
Extensions of the CVP Model: Multiproduct Analysis

• What is the contribution margin of the mix?

\[(9 \times \$0.24) + (1 \times \$0.44) = \$2.16 + \$0.44 = \$2.60\]

• What is the weighted-average contribution margin of the mix?

\[(.90 \times \$0.24) + (.10 \times \$0.44) = \$0.26\]

• What is the breakeven of the mix?
Extensions of the CVP Model: Multiproduct Analysis

\[
\begin{align*}
7000 \times 90\% & = 6,300 \text{ prints} \\
7000 \times 10\% & = 700 \text{ enlargements} \\
\text{Total units} & = 7,000
\end{align*}
\]

$1,820 \text{ fixed costs} \div 0.26 = 7,000 \text{ units}$
Extensions of the CVP Model: Multiproduct Analysis

6,300 prints × $0.60 = $3,780
700 enlargements × $1.00 = $700
Total Dollars = $4,480

.90 × $0.60 for prints + .10 × $1.00 for enlargements = $.64

• What is the weighted-average contribution margin percentage?
• $.26 divided by $.64 = 40.625%
Extensions of the CVP Model:
Multiproduct Analysis

Weighted average revenue:
\((0.90 \times $0.60) + (0.10 \times $1.00) = $0.64\)

Weighted average contribution margin:
\($0.26 \div $0.64 = 40.625\%\)

\($1,820 \div 0.40625 = $4,480\)
Extensions of the CVP Model: Alternative Cost Structures

- Given: Fixed costs of $1,500 are sufficient for monthly volumes less than or equal to 5,000 prints. For every additional 5,000 prints U-Develop must rent a machine for $480 per month.

- Original break-even was 6,250 units.

\[ (0.24 \times 6,250) - (1,500 + 480) = 480 \]
Extensions of the CVP Model: Alternative Cost Structures

• What is the break-even using new fixed cost containing the rental of the additional machine?

Break-even units = \((1,500 + 480) \div 0.24 = 8,250\)
Assumptions and Limitations of CVP Analysis

L.O. 5 Understand the assumptions and limitations of CVP analysis.

• Although the CVP model is a very strong tool, the output is dependent upon the assumptions made by cost analysts.

• These assumptions include which costs are fixed and which are variable.
Assumptions and Limitations of CVP Analysis

• With the aid of software programs, many of the limitations have been eliminated.

• Complicated cost structures are easily incorporated in CVP analysis when software tools are used.
End of Chapter 3
Chapter 4

Fundamentals of Cost Analysis for Decision Making
Learning Objectives

L.O. 1  Use differential analysis to analyze decisions.

L.O. 2  Understand how to apply differential analysis to pricing decisions.

L.O. 3  Understand several approaches for establishing prices based on costs for long-run pricing decisions.

L.O. 4  Understand how to apply differential analysis to production decisions.

L.O. 5  Understand the theory of constraints.
Differential Analysis

L.O. 1 Use differential analysis to analyze decisions.

Differential analysis:
The process of estimating revenues and costs of alternative actions available to decision makers and of comparing these estimates to the status quo.

Short run:
The period of time over which capacity will be unchanged, usually one year.
Differential Costs

With two or more alternatives, costs that differ among or between alternatives

Costs that change in response to an alternative course of action

Differential costs differ between actions.

Alternative A

Alternative B
Sunk Costs

Costs incurred in the past that cannot be changed by present or future decisions

A sunk cost is NOT relevant for making decisions.
Differential Costs versus Total Costs

- Information presented to management can show the detailed costs that are included for making a decision, or it can show just the differences between alternatives, as follows.

<table>
<thead>
<tr>
<th></th>
<th>Status Quo</th>
<th>Alternative</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$750</td>
<td>$900</td>
<td>$150</td>
</tr>
<tr>
<td>Variable costs</td>
<td>(250)</td>
<td>(300)</td>
<td>(50)</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$500</td>
<td>$600</td>
<td>$100</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>(350)</td>
<td>(350)</td>
<td>-0-</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$150</td>
<td>$250</td>
<td>$100</td>
</tr>
</tbody>
</table>
Differential Analysis and Pricing Decisions

L.O. 2 Understand how to apply differential analysis to pricing decisions.

Variable costs must always be covered.

Fixed costs must be covered in the long run.
Short-Run versus Long-Run Pricing Decisions

**Short-run pricing decision:**
Less than one year
Pricing a one-time special order.

**Long-run pricing decision:**
Longer than one year
Pricing a new product.
Short-Run Pricing Decisions: Special Orders

- An order that will not affect other sales and is usually a one-time occurrence

Accept special order?

Status quo: Reject special order

Alternative: Accept special order

Option 1

Value of option 1

Is option 1 > option 2?

Option 2

Value of option 2

LO2 4-9
Short-Run Pricing Decisions: Special Orders

• U-Develop has received a one-time offer for 500 prints at a special price of 40¢ per print ($200).
• The regular price is 50¢ and they have enough idle capacity in the week to take the offer.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales for the week (5,000 prints at 50¢)</td>
<td>$2,500</td>
</tr>
<tr>
<td>Variable costs, including paper, maintenance, and usage payment to machine owner (5,000 copies at 20¢)</td>
<td>$1,000</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$1,500</td>
</tr>
<tr>
<td>Fixed costs (supplies, plus allocated costs of the print shop)</td>
<td>$1,200</td>
</tr>
<tr>
<td>Operating profit for the week</td>
<td>$300</td>
</tr>
</tbody>
</table>
## Short-Run Pricing Decisions: Special Orders

### Analysis of Special Order: U-Develop

<table>
<thead>
<tr>
<th></th>
<th>Status Quo: Reject Special Offer</th>
<th>Alternative: Accept Special Offer</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparison of Totals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$2,500</td>
<td>$2,700</td>
<td>$200</td>
</tr>
<tr>
<td>Variable costs</td>
<td>(1,000)</td>
<td>(1,100)</td>
<td>(100)</td>
</tr>
<tr>
<td>Total contribution</td>
<td>$1,500</td>
<td>$1,600</td>
<td>$100</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>(1,200)</td>
<td>(1,200)</td>
<td>-0-</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$300</td>
<td>$400</td>
<td>$100</td>
</tr>
</tbody>
</table>

**Alternative Presentation: Differential Analysis**

- Differential sales, 500 at 40¢: $200
- Less: Differential costs, 500 at 20¢: $100
- Differential operating profit (before taxes): $100
Long-Run Pricing Decisions

L.O. 3 Understand several approaches for establishing prices based on costs for long-run pricing decisions.

• Full cost is the total cost to produce and sell a unit.
• Full costs are relevant for the long-term pricing decisions.
Long-Run versus Short-Run Pricing

• In the short run, differential costs may be very low.

• In the long run, differential costs are higher than in the short run.
Cost Analysis for Pricing

• In the long run an organization must cover all variable and fixed costs – both manufacturing and selling.
Life-Cycle Product Costing and Pricing

- Product life-cycle is concerned with covering costs in all categories of the life cycle.

R & D  
Design  
Manufacturing  
Marketing and distribution  
Customer service  
Take back (disposal)
Target Costing from Target Pricing

• Target price:
The price based on customers’ perceived value for the product and the price that competitors charge

• What would a customer pay?

• How much profit do I need?

• Can I make it at this cost?

Target price – Desired profit = Target cost
Legal Issues Relating to Costs and Sales Price

• Predatory pricing:
  Practice of setting price below cost with the intent to drive competitors out of business

• Dumping:
  Exporting a product to another country at a price below domestic cost

• Price discrimination:
  Practice of selling identical goods to different customers at different prices
Legal Issues Relating to Costs and Sales Price

• Peak-load pricing:
  Practice of setting prices highest when the quantity demanded for the product approaches capacity.

• Price fixing:
  Agreement among businesses to set prices at a particular level.
Use of Differential Analysis for Production Decision

L.O. 4 Understand how to apply differential analysis to production decisions.

- **Make or buy**
  - Decision to make goods or services internally or purchase them externally

- **Add or drop a segment**
  - Decision to add or drop a product line or close a business unit

- **Product choice**
  - Decision on what products or services to offer (product mix)
## Make-or-Buy Decisions

- U-Develop’s current costs of developing prints:

<table>
<thead>
<tr>
<th>Costs directly traceable:</th>
<th>Per unit</th>
<th>100,000 prints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$0.05</td>
<td>$ 5,000</td>
</tr>
<tr>
<td>Direct labor</td>
<td>0.12</td>
<td>12,000</td>
</tr>
<tr>
<td>Variable manufacturing overhead</td>
<td>.03</td>
<td>3,000</td>
</tr>
<tr>
<td>Fixed manufacturing overhead</td>
<td></td>
<td>4,000</td>
</tr>
<tr>
<td>Common costs allocated to this product line</td>
<td></td>
<td>10,000</td>
</tr>
<tr>
<td>Total costs</td>
<td></td>
<td><strong>$34,000</strong></td>
</tr>
</tbody>
</table>

- This year’s expected volume is 100,000 prints, so the full cost of processing a print is $34,000 ÷ 100,000 = $0.34
Make-or-Buy Decisions

• U-Develop received an offer from an outside developer to process any number of prints for 25¢ each.

• Should U-Develop accept this offer?

• The accounting department prepared cost analyses at volume levels of 50,000 and 100,000 prints per year.
# Make-or-Buy Decisions

## 100,000 prints

<table>
<thead>
<tr>
<th></th>
<th>Process prints</th>
<th>Outsource processing</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct costs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>$ 5,000</td>
<td>$25,000(^a)</td>
<td>$20,000 higher</td>
</tr>
<tr>
<td>Labor</td>
<td>12,000</td>
<td>-0-</td>
<td>12,000 lower</td>
</tr>
<tr>
<td>Variable overhead</td>
<td>3,000</td>
<td>-0-</td>
<td>3,000 lower</td>
</tr>
<tr>
<td>Fixed overhead</td>
<td>4,000</td>
<td>-0-</td>
<td>4,000 lower</td>
</tr>
<tr>
<td>Common costs</td>
<td>10,000(^b)</td>
<td>10,000(^b)</td>
<td>-0-</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td><strong>$34,000</strong></td>
<td><strong>$35,000</strong></td>
<td><strong>$1,000 higher</strong></td>
</tr>
</tbody>
</table>

\(^a\) 100,000 units purchased at $0.25 = $25,000

\(^b\) These common costs remain unchanged for these volumes. Because they do not change, they could be omitted from the analysis.

- Differential costs increase by $1,000, so reject alternative to buy.
# Make-or-Buy Decisions

## Direct costs:
- **Direct materials**
  - Process prints: $2,500
  - Outsource processing: $12,500<sup>a</sup>
  - Difference: $10,000 higher
- **Labor**
  - Process prints: 6,000
  - Outsource processing: -0- (invalid)
  - Difference: 6,000 lower
- **Variable overhead**
  - Process prints: 1,500
  - Outsource processing: -0- (invalid)
  - Difference: 1,500 lower
- **Fixed overhead**
  - Process prints: 4,000
  - Outsource processing: -0- (invalid)
  - Difference: 4,000 lower
- **Common costs**
  - Process prints: $10,000<sup>b</sup>
  - Outsource processing: $10,000<sup>b</sup>
  - Difference: -0- (invalid)
- **Total costs**
  - Process prints: $24,000
  - Outsource processing: $22,500
  - Difference: $1,500 lower

---

<sup>a</sup> 50,000 units purchased at $0.25 = $12,500

<sup>b</sup> These common costs remain unchanged for these volumes. Because they do not change, they could be omitted from the analysis.

- **Differential costs decrease by $1,500, so accept alternative to buy.**
Opportunity Costs of Making

- U-Develop’s expected volume is 100,000 prints.
- Assume that the facilities used to process prints could be used to offer a new service that would provide a $2,000 incremental contribution.
- Should U-Develop accept or reject the alternative?
Opportunity Costs of Making

<table>
<thead>
<tr>
<th>Total cost of 100,000 prints</th>
<th>Status quo: Process prints</th>
<th>Alternative: Outsource processing</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity cost of using facilities to process prints</td>
<td>$34,000</td>
<td>$35,000</td>
<td>$1,000 higher&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total costs, including opportunity costs</td>
<td>2,000</td>
<td>-0-</td>
<td>2,000 lower&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>$36,000</td>
<td>$35,000</td>
<td>$1,000 lower&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

a These indicate whether the alternative is higher or lower than the status quo.

- Differential costs decrease by $1,000, so **accept** the alternative.
## Add or Drop Decisions

**U-Develop**

**Fourth Quarter Product Line Income Statement**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Prints</th>
<th>Cameras</th>
<th>Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$80,000</td>
<td>$10,000</td>
<td>$50,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Cost of sales (all variable)</td>
<td>53,000</td>
<td>8,000</td>
<td>30,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$27,000</td>
<td>$ 2,000</td>
<td>$20,000</td>
<td>$ 5,000</td>
</tr>
<tr>
<td>Less fixed costs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>4,000</td>
<td>1,000</td>
<td>2,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Salaries</td>
<td>5,000</td>
<td>1,000</td>
<td>2,500</td>
<td>1,500</td>
</tr>
<tr>
<td>Marketing and admin</td>
<td>3,000</td>
<td>500</td>
<td>1,500</td>
<td>1,000</td>
</tr>
<tr>
<td>Operating profit (loss)</td>
<td>$15,000</td>
<td>$(500)</td>
<td>$14,000</td>
<td>$1,500</td>
</tr>
</tbody>
</table>
## Add or Drop Decisions

### U-Develop

#### Differential Analysis

<table>
<thead>
<tr>
<th></th>
<th>Status quo: Keep prints</th>
<th>Alternative: Drop prints</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$80,000</td>
<td>$70,000</td>
<td>$10,000 decrease</td>
</tr>
<tr>
<td>Cost of sales (all variable)</td>
<td>53,000</td>
<td>45,000</td>
<td>8,000 decrease</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$27,000</td>
<td>$25,000</td>
<td>$2,000 decrease</td>
</tr>
<tr>
<td>Less fixed costs:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>4,000</td>
<td>4,000</td>
<td>-0-</td>
</tr>
<tr>
<td>Salaries</td>
<td>5,000</td>
<td>4,000</td>
<td>1,000 decrease</td>
</tr>
<tr>
<td>Marketing and administrative</td>
<td>3,000</td>
<td>2,750</td>
<td>250 decrease</td>
</tr>
<tr>
<td>Operating profit (loss)</td>
<td>$15,000</td>
<td>$14,250</td>
<td>$750 decrease</td>
</tr>
</tbody>
</table>

- Profits decrease $750, so **keep** prints.
Product Choice Decisions

- **Constraints:**
  Activities, resources, or policies that limit the attainment of an objective.

- **Contribution margin per unit of scarce resource:**
  Contribution margin per unit of a particular input with limited availability.
## Product Choice Decisions

### U-Develop

#### Revenue and Cost Information

<table>
<thead>
<tr>
<th></th>
<th>Metal frames</th>
<th>Wood frames</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price</strong></td>
<td>$50</td>
<td>$80</td>
</tr>
<tr>
<td><strong>Less: Variable costs per unit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>$8</td>
<td>$22</td>
</tr>
<tr>
<td>Labor</td>
<td>$8</td>
<td>$24</td>
</tr>
<tr>
<td>Overhead</td>
<td>$4</td>
<td>$4</td>
</tr>
<tr>
<td><strong>Contribution margin per unit</strong></td>
<td>$30</td>
<td>$30</td>
</tr>
<tr>
<td><strong>Fixed costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing and administrative</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$3,000</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>$4,500</td>
<td></td>
</tr>
</tbody>
</table>
# Product Choice Decisions

## U-Develop

### Revenue and Cost Information

<table>
<thead>
<tr>
<th>Per unit:</th>
<th>Metal frames</th>
<th>Wood frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution margin</td>
<td>$30</td>
<td>$30</td>
</tr>
<tr>
<td>Machine hours required</td>
<td>$60</td>
<td>$30</td>
</tr>
<tr>
<td>Contribution margin per machine hour</td>
<td>$60</td>
<td>$30</td>
</tr>
</tbody>
</table>

- Metal Frames have a higher contribution margin per machine hour.

\[ \frac{30}{0.5} = 60 \]
\[ \frac{30}{1.0} = 30 \]
Product Choice Decisions

• Suppose U-Develop has 200 machine hours per month available.

<table>
<thead>
<tr>
<th></th>
<th>Metal frames</th>
<th>Wood frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Contribution margin per unit</td>
<td>× $30</td>
<td>× $30</td>
</tr>
<tr>
<td>Total contribution margin</td>
<td>$12,000</td>
<td>$6,000</td>
</tr>
<tr>
<td>Less: Fixed manufacturing costs</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Less: Fixed marketing and admin. costs</td>
<td>1,500</td>
<td>1,500</td>
</tr>
<tr>
<td>Operating profit</td>
<td>$ 7,500</td>
<td>$1,500</td>
</tr>
</tbody>
</table>

• Selling metal frames will result in higher profits than selling wooden frames.
The Theory of Constraints

L.O. 5 Understand the theory of constraints.

• Theory of constraints:
  Focuses on revenue and cost management when faced with bottlenecks

• Bottleneck:
  Operation where the work required limits production
  The bottleneck is the constraining resource.

• Throughput contribution:
  Sales dollars minus direct materials costs and variables such as energy and piecework labor
End of Chapter 4
Chapter 5

Cost Estimation
Learning Objectives

L.O. 1  Understand the reasons for estimating fixed and variable costs.
L.O. 2  Estimate costs using engineering estimates.
L.O. 3  Estimate costs using account analysis.
L.O. 4  Estimate costs using statistical analysis.
L.O. 5  Interpret the results of regression output.
L.O. 6  Identify potential problems with regression data.
L.O. 7  Evaluate the advantages and disadvantages of alternative cost estimation methods.
L.O. 8  (Appendix A)
        Use Microsoft Excel to perform a regression analysis.
L.O. 9  (Appendix B)
        Understand the mathematical relationship describing the learning phenomenon.
Why Estimate Costs?

• Managers make decisions and need to compare costs and benefits among alternative actions.

Key question:

• What adds value to the firm?
• Cost estimates can be an important element in helping managers make decisions.
Basic Cost Behavior Patterns

L.O. 1 Understand the reasons for estimating fixed and variable costs.

Costs

Fixed costs
- Total fixed costs do not change proportionately as activity changes.
- Per unit fixed costs change inversely as activity changes.

Variable costs
- Total variable costs change proportionately as activity changes.
- Per unit variable cost remain constant as activity changes.
Methods Used to Estimate Cost Behavior

• Charlene, owner of Charlene’s Computer Care (3C), wants to estimate the cost of a new computer repair center.

3 Methods:

• Engineering estimates
• Account analysis
• Statistical methods
Engineering Estimates

L.O. 2 Estimate costs using engineering estimates.

• Cost estimates are based on measuring and then pricing the work involved in a task.

• Identify the activities involved:
  – Labor
  – Rent
  – Insurance

• Estimate the time and cost for each activity.
Engineering Estimates

**Advantages:**
- Details each step required to perform an operation
- Permits comparison of other centers with similar operations
- Costs for totally new activities can be estimated without prior activity data.

**Disadvantages:**
- Can be quite expensive to use
- Based on optimal conditions
L.O. 3 Estimate costs using account analysis.

- Review each account comprising the total cost being analyzed.
- Identify each cost as either fixed or variable.
## Account Analysis

3C Cost estimation using account analysis

**Costs for 360 repair-hours**

<table>
<thead>
<tr>
<th>Account</th>
<th>Total</th>
<th>Variable cost</th>
<th>Fixed cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office rent</td>
<td>$3,375</td>
<td>$1,375</td>
<td>$2,000</td>
</tr>
<tr>
<td>Utilities</td>
<td>310</td>
<td>100</td>
<td>210</td>
</tr>
<tr>
<td>Administration</td>
<td>3,386</td>
<td>186</td>
<td>3,200</td>
</tr>
<tr>
<td>Supplies</td>
<td>2,276</td>
<td>2,176</td>
<td>100</td>
</tr>
<tr>
<td>Training</td>
<td>666</td>
<td>316</td>
<td>350</td>
</tr>
<tr>
<td>Other</td>
<td>613</td>
<td>257</td>
<td>356</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$10,626</td>
<td>$4,410</td>
<td>$6,216</td>
</tr>
<tr>
<td><strong>Per repair hour</strong></td>
<td></td>
<td><strong>$12.25</strong></td>
<td></td>
</tr>
</tbody>
</table>
Account Analysis

3C Cost estimation using account analysis

Fixed costs + (Variable cost/unit × No. of units) = Total cost

Cost at 360 repair-hours:
$6,216 + ($12.25 × 360) = $10,626

Cost at 480 repair-hours:
$6,216 + ($12.25 × 480) = $12,096
Account Analysis

**Advantages:**

- Managers and accountants are familiar with company operations and the way costs react to changes in activity levels.

**Disadvantages:**

- Managers and accountants may be biased.
- Decisions often have major economic consequences for managers and accountants.
L.O. 4 Estimate costs using statistical analysis.

- Analyze costs within a relevant range, which is the limits within which a cost estimate may be valid.
- Relevant range for a projection is usually between the upper and lower limits (bounds) of past activity levels for which data is available.
# Overhead Cost Estimation for 3C

<table>
<thead>
<tr>
<th>Month</th>
<th>Overhead Costs</th>
<th>Repair-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$9,891</td>
<td>248</td>
</tr>
<tr>
<td>2</td>
<td>$9,244</td>
<td>248</td>
</tr>
<tr>
<td>3</td>
<td>$13,200</td>
<td>480</td>
</tr>
<tr>
<td>4</td>
<td>$10,555</td>
<td>284</td>
</tr>
<tr>
<td>5</td>
<td>$9,054</td>
<td>200</td>
</tr>
<tr>
<td>6</td>
<td>$10,662</td>
<td>380</td>
</tr>
<tr>
<td>7</td>
<td>$12,883</td>
<td>568</td>
</tr>
<tr>
<td>8</td>
<td>$10,345</td>
<td>344</td>
</tr>
<tr>
<td>9</td>
<td>$11,217</td>
<td>448</td>
</tr>
<tr>
<td>10</td>
<td>$13,269</td>
<td>544</td>
</tr>
<tr>
<td>11</td>
<td>$10,830</td>
<td>340</td>
</tr>
<tr>
<td>12</td>
<td>$12,607</td>
<td>412</td>
</tr>
<tr>
<td>13</td>
<td>$10,871</td>
<td>384</td>
</tr>
<tr>
<td>14</td>
<td>$12,816</td>
<td>404</td>
</tr>
<tr>
<td>15</td>
<td>$8,464</td>
<td>212</td>
</tr>
</tbody>
</table>

These data will be used to estimate costs using a statistical analysis.
Does it look like a relationship exists between repair-hours and overhead costs?
We use “eyeball judgment” to determine the intercept and slope of the line.
Hi-Low Cost Estimation

- This is a method to estimate cost based on two cost observations, the highest and lowest activity level.

<table>
<thead>
<tr>
<th>Month</th>
<th>Overhead costs</th>
<th>Repair-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>$12,883</td>
<td>568</td>
</tr>
<tr>
<td>Low</td>
<td>$9,054</td>
<td>200</td>
</tr>
<tr>
<td>Change</td>
<td>$3,829</td>
<td>368</td>
</tr>
</tbody>
</table>
Hi-Low Cost Estimation

Variable cost per unit ($V$) =
\[
\frac{(\text{Cost at highest activity level} - \text{Cost at lowest activity level})}{(\text{Highest activity level} - \text{Lowest activity level})}
\]

Fixed cost ($F$) =
\[
\text{Total cost at highest activity} - (\text{Variable cost} \times \text{Highest activity level})
\]
or
\[
\text{Total cost at lowest activity} - (\text{Variable cost} \times \text{Lowest activity level})
\]
Hi-Low Cost Estimation

Variable cost per RH (V) = \( \frac{($12,883 - $9,054)}{568 \text{ RH} - 200 \text{ RH}} \) = $3,829 per RH

Fixed costs (F) = ($12,883 - ($10.40 \times 568 \text{ RH}) = $6,976

Fixed costs (F) = ($9,054 - ($10.40 \times 200 \text{ RH}) = $6,974

Rounding difference
Hi-Low Cost Estimation

• How do we estimate manufacturing overhead with 480 repair-hours?

\[ TC = F + VX \]

\[ TC = \$6,976 + (\$10.40 \times 480) = \$11,968 \]
Regression Analysis

• Regression is a statistical procedure to determine the relation between variables.

• It helps managers determine how well the estimated regression equation describes the relations between costs and activities.
Regression Analysis

• Hi-low method:
  Uses two data points

• Regression:
  Uses all of the data points
Regression Analysis

The Regression Equation:

\[ Y = a + bX \]

\[ Y = \text{Intercept} + (\text{Slope} \times X) \]

For 3C:
\[ \text{OH} = \text{Fixed costs} + (V \times \text{Repair-hours}) \]
Interpreting Regression

**L.O. 5** Interpret the results of regression output.

- **Independent variable:**
  - The $X$ term, or predictor
  - The activity that predicts (causes) the change in costs

- **Activities:**
  - Repair-hours

- **Dependent variable:**
  - The $Y$ term
  - The dependent variable
  - The cost to be estimated

- **Costs:**
  - Overhead costs
Interpreting Regression

• The computer output of 3C’s scattergraph gives the following formula:

\[
\text{Total overhead} = 6472 + (12.52 \text{ per RH} \times \text{No. of RH})
\]

• Estimate 3C’s overhead with 480 repair hours.

\[
TC = F + VX
\]

\[
TC = 6472 + (12.52 \times 480) = 12482
\]
Interpreting Regression

• Correlation coefficient ($R$):
  This measures the linear relationship between variables. The closer $R$ is to 1.0 the closer the points are to the regression line. The closer $R$ is to zero, the poorer the fit of the regression line.

• Coefficient of determination ($R^2$):
  This is the square of the correlation coefficient. It is the proportion of the variation in the dependent variable ($Y$) explained by the independent variable(s) ($X$).
Interpreting Regression

• T-statistic:
  This is the value of the estimated coefficient, $b$, divided by its estimated standard error ($Se_b$). Generally, if it is over 2, then it is considered significant. If significant, the cost is NOT totally fixed.

• From the data used in the 3C regression, the $t$-statistic is:

  $t = b \div Se_b$
  
  $= 12.5230 \div 1.5843$
  
  $= 7.9044$
Interpreting Regression

• Refer to Exhibit 5.3 in the textbook.

• A 0.91 correlation coefficient means that a linear relationship does exist between repair hours and overhead costs.

• A 0.828 coefficient of determination means that 82.8% of the changes in overhead costs can be explained by changes in repair-hours.

• Both have t-statistics that are greater than 2, so the cost is not totally fixed.
Multiple Regression

• Multiple regression: When more than one predictor (x) is in the model

• Is repair-hours the only activity that drives overhead costs at 3C?

• Predictors:
  $X_1$: Repair-hours
  $X_2$: Parts cost

• Equation:
  $TC = VC(X_1) + VC(X_2) + FC$
Multiple Regression Output

• The adjusted R-squared is the correlation coefficient squared and adjusted for the number of independent variables used to make the estimate.

• The statistics supplied with the output (rounded off) are:
  – Correlation coefficient (R) = 0.953
  – $R^2 = 0.908$
  – Adjusted $R^2 = 0.892$
Multiple Regression Output

\[ TC = F + V_1 X_1 + V_2 X_2 \]

\[ TC = $6,416 + ($8.61 \times 480) + (77\% \times 3,500) \]

\[ TC = $13,244 \]
Practical Implementation Problems

L.O. 6 Identify potential problems with regression data.

• Effect of:
  – Nonlinear relations
  – Outliers
  – Spurious relations
  – Using data that do not fit the assumptions of regression analysis
Practical Implementation Problems

The Effect of Nonlinear Relations

Cost

Volume

Assumed actual cost function
Regression estimate
Relevant range
Capacity

0 5 10 15 20 25 30 35 40
$0 $100 $200 $300 $400 $500 $600 $700 $800

LO6
Practical Implementation Problems

• Problem:
  Attempting to fit a linear model to nonlinear data
  Likely to occur near full-capacity

• Solution:
  Define a more limited relevant range.
  (Example: from 25-75% capacity)
  or design a nonlinear model.
Practical Implementation Problems

The Effect of Outliers on the Computed Regression

- **Compared regression line**
- **True regression line**
- "Outlier"
Practical Implementation Problems

• Problem:
  Outliers move the regression line.

• Solution:
  Prepare a scattergraph, analyze the graph, and eliminate highly unusual observations before running the regression.
Practical Implementation Problems

The Effect of Spurious Relations

- Problem:
  Using too many variables in the regression (i.e., using direct labor to explain materials costs). Although the association is very high, actually both are driven by output.

- Solution:
  Carefully analyze each variable and determine the relationship among all elements before using in the regression.
The Effect of Using Data That Do Not Fit the Assumptions of Regression

- **Problem:**
  If the assumptions in the regression are not satisfied, then the regression is not reliable.

- **Solution:**
  There is no clear solution. Limit time to help assure costs behavior remains constant, yet this causes the model to be weaker due to less data.
Learning Phenomenon

• Learning phenomenon is the systematic relationship between the amount of experience in performing a task and the time required to perform it.
Statistical Cost Estimation

L.O. 7 Evaluate the advantages and disadvantages of alternative cost estimation methods.

**Advantages:**
- Reliance on historical data is relatively inexpensive.
- Computational tools allow for more data to be used than for non-statistical methods.

**Disadvantages:**
- Reliance on historical data may be the only readily available, cost-effective basis for estimating costs.
- Analysts must be alert to cost-activity changes.
Effect of Different Methods on Cost Estimates

- Estimated manufacturing overhead with 480 repair-hours.

<table>
<thead>
<tr>
<th>Method</th>
<th>Total estimated costs</th>
<th>Estimated fixed costs</th>
<th>Estimated variable costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Account analysis</td>
<td>$12,096</td>
<td>$6,216</td>
<td>$12.25/repair-hour</td>
</tr>
<tr>
<td>High-low</td>
<td>$11,968</td>
<td>$6,976</td>
<td>$10.40/repair-hour</td>
</tr>
<tr>
<td>Simple regression</td>
<td>$12,482</td>
<td>$6,472</td>
<td>$12.52/repair-hour</td>
</tr>
<tr>
<td>Multiple regression</td>
<td>$13,244</td>
<td>$6,416</td>
<td>$8.61/repair-hour + 77% of parts cost</td>
</tr>
</tbody>
</table>
Data Problems

- Missing data
- Outliers
- Allocated and discretionary costs
- Inflation
- Mismatched time periods
Appendix A: Microsoft as a Tool

L.O. 8  (Appendix A) Use Microsoft Excel to perform a regression analysis.

• Many software programs exist to aid in performing regression analysis.

• In order to use Microsoft Excel, the Analysis Tool Pak must be installed.

• Data is entered and the user then selects the data and type of regression analysis to be generated.

• The analyst must be well schooled in regression in order to determine the meaning of the output.
Learning Phenomenon

L.O. 9 (Appendix B) Understand the mathematical relationship describing the learning phenomenon.

- This is the systematic relationship between the amount of experience in performing a task and the time required to perform it.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Time to produce</th>
<th>Calculation of time</th>
</tr>
</thead>
<tbody>
<tr>
<td>First unit</td>
<td>100.0 hours</td>
<td>(assumed) 80% × 100 hours</td>
</tr>
<tr>
<td>Second unit</td>
<td>80.0 hours</td>
<td>80% × 80 hours</td>
</tr>
<tr>
<td>Fourth unit</td>
<td>64.0 hours</td>
<td>80% × 64 hours</td>
</tr>
<tr>
<td>Eighth unit</td>
<td>51.2 hours</td>
<td></td>
</tr>
</tbody>
</table>

- Impact: It causes the unit price to decrease as production increases.
- This implies a nonlinear model.
End of Chapter 5
Chapter 7

Job Costing
Learning Objectives

L.O. 1 Explain what job and job shop mean.
L.O. 2 Assign costs in a job cost system.
L.O. 3 Account for overhead using predetermined rates.
L.O. 4 Apply job costing methods in service organizations.
L.O. 5 Understand the ethical issues in job costing.
L.O. 6 Describe the difference between jobs and projects.
Defining a Job

L.O. 1 Explain what *job* and *job shop* mean.

- **Job:**
  Unit of a product that is easily distinguishable from other units

- **Job shop:**
  Firm that produces jobs
Using Accounting Records in a Job Shop

- Job cost sheet:
  Record of the cost of the job kept in the accounting system

- Subsidiary ledger account:
  Account that records financial transactions for a specific job, customer, or vendor (Job 1 WIP, Job 2 WIP, Job 3 WIP, etc.)

- Control account:
  Account in the general ledger that summarizes a set of subsidiary ledger accounts
Production Process at InShape

L.O. 2 Assign costs in a job cost system.

- Suppose InShape, Inc. manufactures custom workout and training equipment for schools and gyms.
Records of Costs at InShape

Materials

Raw materials

Direct materials

Indirect materials

Work-in-process

12-03

01-01

01-02

Total WIP

Overhead
Records of Costs at InShape

- Labor
  - Direct labor
  - Indirect labor

- Work-in-process
  - 12-03
  - 01-01
  - 01-02

- Total WIP
• OH costs are applied to each job using the POHR.
Inventory Accounts

• On January 1, InShape has the following balances in each of its three inventory accounts:

<table>
<thead>
<tr>
<th>Inventory Account</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials inventory</td>
<td>$30,000</td>
</tr>
<tr>
<td>Work-in-process inventory (Job 12-03)</td>
<td>$41,000</td>
</tr>
<tr>
<td>Finished goods inventory (Job 12-02)</td>
<td>$27,000</td>
</tr>
</tbody>
</table>

• Now, let’s record January’s activities for InShape.
Direct Materials

- InShape purchased $135,000 of raw materials on account.

<table>
<thead>
<tr>
<th>Materials Inventory</th>
<th>Accounts Payable</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 30,000</td>
<td>17,000 BB</td>
</tr>
<tr>
<td>(1) 135,000</td>
<td>135,000 (1)</td>
</tr>
</tbody>
</table>
Direct Materials

- InShape used $12,000 of direct materials for 12-03. They also started 01-01 and 01-02 and used $102,000 and $15,000 of direct materials respectively.

<table>
<thead>
<tr>
<th>Materials Inventory</th>
<th>WIP Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 30,000</td>
<td>BB 41,000</td>
</tr>
<tr>
<td>(1) 135,000</td>
<td>(2) 129,000</td>
</tr>
<tr>
<td>129,000 (2)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIP 12-03</th>
<th>WIP 01-01</th>
<th>WIP 01-02</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 41,000</td>
<td>(2) 102,000</td>
<td>(2) 15,000</td>
</tr>
<tr>
<td>(2) 12,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Direct Materials

- Direct labor of $98,000 was incurred ($16,000 for 12-03, $71,000 for 01-01, and $11,000 for 01-02).

<table>
<thead>
<tr>
<th>WIP Inventory</th>
<th>Wages Payable</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 41,000</td>
<td>98,000 (3)</td>
</tr>
<tr>
<td>(2) 129,000</td>
<td></td>
</tr>
<tr>
<td>(3) 98,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIP 12-03</th>
<th>WIP 01-01</th>
<th>WIP 01-02</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 41,000</td>
<td>(2) 102,000</td>
<td>(2) 15,000</td>
</tr>
<tr>
<td>(2) 12,000</td>
<td>(3) 71,000</td>
<td>(3) 11,000</td>
</tr>
<tr>
<td>(3) 16,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Manufacturing Overhead

- InShape incurred the following “actual” overhead costs in January:

<table>
<thead>
<tr>
<th>JE#</th>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4)</td>
<td>Indirect material requisitioned</td>
<td>$12,000</td>
</tr>
<tr>
<td>(5)</td>
<td>Indirect labor incurred</td>
<td>9,500</td>
</tr>
<tr>
<td>(6)</td>
<td>Utilities &amp; other factory expenses (credit A/P)</td>
<td>13,750</td>
</tr>
<tr>
<td>(6)</td>
<td>Prepaid factory expenses used</td>
<td>5,000</td>
</tr>
<tr>
<td>(6)</td>
<td>Factory depreciation</td>
<td>11,200</td>
</tr>
<tr>
<td></td>
<td><strong>Total actual overhead expenses</strong></td>
<td><strong>$51,450</strong></td>
</tr>
</tbody>
</table>

- With this information, let’s continue recording InShape’s activities.
Manufacturing Overhead

<table>
<thead>
<tr>
<th>MOH Control</th>
<th>Prepaid Expense</th>
<th>Accum. Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) 12,000</td>
<td>5,000 (6)</td>
<td>11,200 (6)</td>
</tr>
<tr>
<td>(5) 9,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) 13,750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) 5,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) 11,200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials Inventory</th>
<th>Accounts Payable</th>
<th>Wages Payable</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 30,000 (1)</td>
<td>17,000 BB</td>
<td>98,000 (3)</td>
</tr>
<tr>
<td>(1) 135,000</td>
<td>135,000 (1)</td>
<td>9,500 (5)</td>
</tr>
<tr>
<td></td>
<td>13,750 (6)</td>
<td></td>
</tr>
</tbody>
</table>
How Manufacturing Overhead Costs Are Recorded at InShape

• Two common events that lead to manufacturing overhead being recorded are:

1. Preparing financial statements
2. Completing a job
Predetermined Rate

L.O. 3  Account for overhead using predetermined rates.

• The estimated manufacturing overhead predetermined rate is the estimated overhead divided by the estimated activity for the allocation base.

• InShape uses estimates based on annual manufacturing overhead and annual production volume.

Why?

• Because it does not want erratic or monthly costs or production volumes to affect the long-run production costs.
Application of Manufacturing Costs to Jobs

• Overhead is allocated to jobs using direct labor cost as its base.

• InShape estimated that the manufacturing overhead for the coming year would be $600,000 and that direct labor cost would be $1,200,000.

• What is the predetermined overhead rate?
Application of Manufacturing Costs to Jobs

POHR = Estimated overhead $ / Estimated allocation base

POHR = $600,000 / $1,200,000 = $0.50/DL$
Application of Manufacturing Costs to Jobs

<table>
<thead>
<tr>
<th>Job #</th>
<th>DL$</th>
<th>Rate</th>
<th>OH Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-03</td>
<td>$16,000</td>
<td>0.50</td>
<td>$8,000</td>
</tr>
<tr>
<td>01-01</td>
<td>71,000</td>
<td>0.50</td>
<td>35,500</td>
</tr>
<tr>
<td>01-02</td>
<td>11,000</td>
<td>0.50</td>
<td>5,500</td>
</tr>
<tr>
<td>Total</td>
<td>$98,000</td>
<td>0.50</td>
<td>$49,000</td>
</tr>
</tbody>
</table>
# Application of Manufacturing Costs to Jobs

<table>
<thead>
<tr>
<th>MOH - Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>43,500 (7)</td>
</tr>
<tr>
<td>5,500 (11)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIP 12-03</th>
<th>WIP 01-01</th>
<th>WIP 01-02</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 41,000</td>
<td>(2) 102,000</td>
<td>(2) 15,000</td>
</tr>
<tr>
<td>(2) 12,000</td>
<td>(3) 71,000</td>
<td>(3) 11,000</td>
</tr>
<tr>
<td>(3) 16,000</td>
<td>(7) 35,500</td>
<td>(11) 5,500</td>
</tr>
<tr>
<td>(7) 8,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cost of Jobs Completed in January

- InShape completed Jobs 12-03 and 01-01 and transferred them to Finished Goods.

<table>
<thead>
<tr>
<th>Job Ticket Summary</th>
<th>Job 12-03</th>
<th>Job 01-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning inventory January 1</td>
<td>$41,000</td>
<td>$0</td>
</tr>
<tr>
<td>Direct materials – January</td>
<td>12,000</td>
<td>102,000</td>
</tr>
<tr>
<td>Direct labor – January</td>
<td>16,000</td>
<td>71,000</td>
</tr>
<tr>
<td>OH applied – January</td>
<td>8,000</td>
<td>35,500</td>
</tr>
<tr>
<td>Total cost on job tickets</td>
<td>$77,000</td>
<td>$208,500</td>
</tr>
</tbody>
</table>

- What is the journal entry?
# Cost of Jobs Completed in January

<table>
<thead>
<tr>
<th>Inventory (12-03)</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finished Goods</td>
<td>77,000</td>
</tr>
<tr>
<td>Work-in-Process</td>
<td>77,000</td>
</tr>
<tr>
<td>Inventory (01-01)</td>
<td>208,500</td>
</tr>
<tr>
<td>Work-in-Process</td>
<td>208,500</td>
</tr>
</tbody>
</table>

- Jobs 12-02 and 12-03 were sold for $35,000 and $95,000, respectively.
- What are the journal entries?
Cost of Jobs Sold in January

<table>
<thead>
<tr>
<th>Description</th>
<th>January 12-02</th>
<th>January 12-03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Goods Sold (12-02)</td>
<td>27,000</td>
<td></td>
</tr>
<tr>
<td>Cost of Goods Sold (12-03)</td>
<td>77,000</td>
<td></td>
</tr>
<tr>
<td>Finished Goods Inventory (12-02)</td>
<td>27,000</td>
<td></td>
</tr>
<tr>
<td>Finished Goods Inventory (12-03)</td>
<td>77,000</td>
<td></td>
</tr>
<tr>
<td>Accounts Receivable (12-02)</td>
<td>35,000</td>
<td></td>
</tr>
<tr>
<td>Accounts Receivable (12-03)</td>
<td>95,000</td>
<td></td>
</tr>
<tr>
<td>Revenue (12-02)</td>
<td>35,000</td>
<td></td>
</tr>
<tr>
<td>Revenue (12-03)</td>
<td>95,000</td>
<td></td>
</tr>
</tbody>
</table>
Cost Flows Through T-Accounts

<table>
<thead>
<tr>
<th>Materials Inventory</th>
<th>Work-in-Process Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB 24,000</td>
<td>EB 31,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Finished Goods Inventory</th>
<th>Cost of Goods Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB 208,500</td>
<td>EB 104,000</td>
</tr>
</tbody>
</table>
The Job Cost Sheet

INSHAPE, INC.

Job Number: 01-01  Customer: Eastern State College
Date Started: 1/11  Date completed: 1/26
Description: Assemble and test athletic equipment

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>Req.#</th>
<th>Cost</th>
<th>Date</th>
<th>BN</th>
<th>Cost</th>
<th>Date</th>
<th>Cost</th>
<th>Cost.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td></td>
<td>$</td>
</tr>
</tbody>
</table>

INSHAPE, INC.

Job Number: 01-01  Customer: Eastern State College
Date Started: 1/11  Date completed: 1/26
Description: Assemble and test athletic equipment

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>Req.#</th>
<th>Cost</th>
<th>Date</th>
<th>BN</th>
<th>Cost</th>
<th>Date</th>
<th>Cost</th>
<th>Cost.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td>$</td>
<td></td>
<td></td>
<td></td>
<td>$</td>
</tr>
</tbody>
</table>
# The Job Cost Sheet

## Total Costs for Job 01-01

<table>
<thead>
<tr>
<th>Component</th>
<th>Direct materials</th>
<th>Direct labor</th>
<th>Manufacturing overhead</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$102,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct labor</td>
<td></td>
<td>71,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing overhead</td>
<td></td>
<td></td>
<td>35,500</td>
<td>$208,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$102,000</strong></td>
<td><strong>71,000</strong></td>
<td><strong>35,500</strong></td>
<td><strong>$208,500</strong></td>
</tr>
</tbody>
</table>

Transferred to finished goods inventory

<table>
<thead>
<tr>
<th>Component</th>
<th>Direct materials</th>
<th>Direct labor</th>
<th>Manufacturing overhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$102,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct labor</td>
<td></td>
<td>71,000</td>
<td></td>
</tr>
<tr>
<td>Manufacturing overhead</td>
<td></td>
<td></td>
<td>35,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$102,000</strong></td>
<td><strong>71,000</strong></td>
<td><strong>35,500</strong></td>
</tr>
</tbody>
</table>

**$208,500**
An Alternative Method of Recording and Applying Manufacturing Overhead

• Assume InShape maintains two manufacturing overhead accounts:
  • Manufacturing Overhead Control
    Used to track all actual overhead expenses
  • Applied Manufacturing Overhead
    Used to allocate overhead to jobs based on the predetermined OH rate
• Some companies combine these two accounts into one account.
An Alternative Method of Recording and Applying Manufacturing Overhead

• Underapplied overhead
  The excess of actual overhead costs incurred over applied overhead costs

• Overapplied overhead
  The excess of applied overhead costs over actual overhead costs incurred
Writing Off Over- or Underapplied Overhead

• The two manufacturing overhead accounts are not balance sheet accounts.
• The combined ending balance must be zero.
• The combined OH is $2,450 underapplied.

<table>
<thead>
<tr>
<th>Manufacturing Overhead</th>
<th>Applied Manufacturing Overhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>12,000</td>
<td></td>
</tr>
<tr>
<td>9,500</td>
<td>49,000</td>
</tr>
<tr>
<td>13,750</td>
<td></td>
</tr>
<tr>
<td>5,000</td>
<td>49,000</td>
</tr>
<tr>
<td>11,200</td>
<td></td>
</tr>
<tr>
<td>51,450</td>
<td></td>
</tr>
</tbody>
</table>
Writing Off Over- or Underapplied Overhead

<table>
<thead>
<tr>
<th>Applied Manufacturing Overhead</th>
<th>Cost of Goods Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>49,000</td>
<td>104,000</td>
</tr>
<tr>
<td>2,450</td>
<td>2,450</td>
</tr>
<tr>
<td>51,450</td>
<td>106,450</td>
</tr>
</tbody>
</table>

After entry, the applied and control overhead accounts sum to zero.
Writing Off Over- or Underapplied Overhead

- Some firms use only one OH account.
- In this condition, the debit side of the OH account contains actual data and the credit side contains applied data.
- For either condition of under- or overapplied, actual must equal applied in the Overhead control account at the end of the period.

<table>
<thead>
<tr>
<th>Overhead</th>
<th>Cost of Goods Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,000</td>
<td>104,000</td>
</tr>
<tr>
<td>9,500</td>
<td>2,450</td>
</tr>
<tr>
<td>13,750</td>
<td></td>
</tr>
<tr>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td>11,200</td>
<td></td>
</tr>
<tr>
<td>51,450</td>
<td>106,450</td>
</tr>
</tbody>
</table>

51,450  51,450
Allocating Over- or Underapplied Overhead

• Some companies prorate the over/under applied MOH to WIP, FG, and COGS.

Accounts at January 31

<table>
<thead>
<tr>
<th></th>
<th>Costs</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work-in-Process Inventory</td>
<td>$ 31,500</td>
<td>9.2%</td>
</tr>
<tr>
<td>Finished Goods Inventory</td>
<td>208,500</td>
<td>60.6%</td>
</tr>
<tr>
<td>Cost of Goods Sold</td>
<td>104,000</td>
<td>30.2%</td>
</tr>
<tr>
<td>Total</td>
<td>$344,000</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
## Allocating Over- or Underapplied Overhead

- Allocate underapplied overhead to finished goods, cost of good sold and WIP.

<table>
<thead>
<tr>
<th>Work-in-Process Inventory</th>
<th>Finished Goods Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>31,500</td>
<td>208,500</td>
</tr>
<tr>
<td>225</td>
<td>1,485</td>
</tr>
<tr>
<td><em>(2,450 × 0.092)</em></td>
<td><em>(2,450 × 0.606)</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost of Goods Sold</th>
<th>Overhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>104,000</td>
<td>51,450</td>
</tr>
<tr>
<td>740</td>
<td>49,000</td>
</tr>
<tr>
<td><em>(2,450 × 0.302)</em></td>
<td><em>(2,450)</em></td>
</tr>
</tbody>
</table>
Using Normal, Actual, and Standard Costing

- Normal:
  Cost of job determined by actual direct material, actual direct labor, and applied overhead using the POHR and the actual allocation base.

- Actual:
  Cost of job determined by actual direct material, actual direct labor, and applied overhead using actual overhead rate and the actual allocation base.

- Standard:
  Cost of job determined by standard (budgeted) direct material, standard direct labor, and applied overhead using the POHR and a standard (budgeted) allocation base.
Using Job Costing in Service Organizations

L.O. 4  Apply job costing methods in service organizations.

• Service organizations use fewer direct materials than manufacturing companies.

• Service companies’ overhead accounts have slightly different names.

• Finished goods (or services) are charged to Cost of Services Billed.
Using Job Costing in Service Organizations

Labor

Direct labor

Indirect labor

Work in process

Client A

Client B

Client C

Overhead

Total WIP
Ethical Issues

L.O. 5 Understand the ethical issues in job costing.

• Improprieties Include:
  – Misstating the stage of completion
  – Charging costs to the wrong jobs
  – Misrepresenting the cost of jobs
Managing Projects

L.O. 6  Describe the difference between jobs and projects.

• A project is a complex job that often takes months or years to complete and requires the work of many departments, divisions, or subcontractors.
End of Chapter 7
Chapter 8

Process Costing
Learning Objectives

L.O. 1 Explain the concept and purpose of equivalent units.
L.O. 2 Assign costs to products using a five-step process.
L.O. 3 Assign costs to products using weighted-average costing.
L.O. 4 Prepare and analyze a production cost report.
L.O. 5 Assign costs to products using first-in, first-out (FIFO) costing.
L.O. 6 Analyze the accounting choice between FIFO and weighted-average costing.
L.O. 7 Know when to use process or job costing.
L.O. 8 Compare and contrast operation costing with job costing and process costing.
Comparison of Cost Flows

Job Costing

Direct materials, direct labor, and factory overhead → Job 121 → Finished goods → Cost of goods sold
  ↓                   ↓                   ↓                   ↓
  Job 122             Job 123             

Process Costing

Direct materials, direct labor, and factory overhead → Process A → Process B → Process C → Finished goods → Cost of goods sold
  ↓                   ↓                   ↓                   ↓                   ↓
  
8-3
L.O. 1 Explain the concept and purpose of equivalent units.

• Equivalent units:
Number of complete physical units to which units in
inventories are equal in terms of work done to date.
Determining Equivalent Units

• At month end, three cans of paint are filled as indicated.

\[
\frac{30\% + 75\% + 90\%}{3} = 65\%
\]

• Therefore, ending work-in-process inventory is 65 percent complete, on average.
Using Product Costing in a Process Industry

L.O. 2 Assign costs to products using a five-step process.

Step 1: Measure the physical flow of resources.

Step 2: Compute the equivalent units of production.

Step 3: Identify the product costs for which to account.

Step 4: Compute the costs per equivalent unit.

Step 5: Assign product cost to batches of work.
Using Product Costing in a Process Industry

- Torrance Tape, Inc. (2T), manufactures adhesives and tapes.
- Production at 2T’s Valley Plant takes place in three steps.

1. Compounding Department
2. Coating Department
2. Cutting and Packaging Department

Warehouse
Measure the Physical Flow of Resources (Step 1)

<table>
<thead>
<tr>
<th>Gallons of Compound</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Work in process, March 1</td>
<td>20,000(^a)</td>
</tr>
<tr>
<td>+ Gallons of adhesive started</td>
<td>92,000</td>
</tr>
<tr>
<td>Total gallons to account for</td>
<td>112,000</td>
</tr>
<tr>
<td>=Transferred out to Coating Department</td>
<td>96,000</td>
</tr>
<tr>
<td>+ Work-in-process, March 31</td>
<td>16,000(^b)</td>
</tr>
<tr>
<td>Total units accounted for</td>
<td>112,000</td>
</tr>
</tbody>
</table>

\(^a\) 25% complete with respect to conversion costs
\(^b\) 30% complete with respect to conversion costs
## Compute the Equivalent Units of Production (Step 2)

### Compounding Department, March: Equivalent Units

<table>
<thead>
<tr>
<th></th>
<th>Physical units</th>
<th>Equivalent units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Materials</td>
</tr>
<tr>
<td>Transferred out</td>
<td>96,000</td>
<td>96,000</td>
</tr>
<tr>
<td>Work-in-process, March 31</td>
<td>16,000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16,000</td>
</tr>
<tr>
<td>Total work</td>
<td>112,000</td>
<td>100,800</td>
</tr>
</tbody>
</table>

<sup>a</sup> 30% complete with respect to conversion costs
Identify the Product Costs for Which to Account (Step 3)

Costs:
- Work-in-process costs
- Current period costs

Work (EU)
- Work-in-process EU*
- Current period EU

Weighted-average:

**Weighted-Average Unit Costs**
\[
\text{Weighted-Average Unit Costs} = \frac{(\text{Work-in-process costs} + \text{Current period costs})}{(\text{Work-in-process EU} + \text{Current period EU})}
\]

**FIFO:**
- **Work-in Process Unit Costs**
  - Work-in-process costs
  - Work-in-process EU
- **Current Period Unit Costs**
  - Current period costs
  - Current period EU

*Note: EU is equivalent unit.*
L.O. 3 Assign costs to products using weighted-average costing.

- Compute the costs per equivalent unit: Weighted-average (Step 4)
- First, Steps 1, 2, and 3 must be revisited.
Measure the Physical Flow of Resources (Step 1)

<table>
<thead>
<tr>
<th>Gallons of Compound</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Work in process, March 1</td>
<td>20,000\textsuperscript{a}</td>
</tr>
<tr>
<td>+ Gallons of adhesive started</td>
<td>92,000</td>
</tr>
<tr>
<td>Total gallons to account for</td>
<td>112,000</td>
</tr>
<tr>
<td>=Transferred out to Coating Department</td>
<td>96,000</td>
</tr>
<tr>
<td>+ Work-in-process, March 31</td>
<td>16,000\textsuperscript{b}</td>
</tr>
<tr>
<td>Total units accounted for</td>
<td>112,000</td>
</tr>
</tbody>
</table>

\textsuperscript{a} 25\% complete with respect to conversion costs
\textsuperscript{b} 30\% complete with respect to conversion costs
## Compute the Equivalent Units of Production (Step 2)

### Compounding Department, March: Equivalent Units

<table>
<thead>
<tr>
<th></th>
<th>Physical units</th>
<th>Equivalent units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Materials</td>
</tr>
<tr>
<td>Transferred out</td>
<td>96,000</td>
<td>96,000</td>
</tr>
<tr>
<td>Work-in-process, March 31</td>
<td>16,000</td>
<td>16,000a</td>
</tr>
<tr>
<td>Total work</td>
<td>112,000</td>
<td>112,000</td>
</tr>
</tbody>
</table>

- a 16,000 units × 100% (all materials added in beginning)
- b 16,000 units × 30%
Identify the Product Costs for Which to Account (Step 3)

<table>
<thead>
<tr>
<th></th>
<th>Total costs</th>
<th>Materials costs</th>
<th>Conversion costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work in process, March 1</td>
<td>$24,286</td>
<td>$16,160</td>
<td>$8,126</td>
</tr>
<tr>
<td>Current costs, March</td>
<td>$298,274</td>
<td>$84,640</td>
<td>$213,634</td>
</tr>
<tr>
<td>Total</td>
<td>$322,560</td>
<td>$100,800</td>
<td>$221,760</td>
</tr>
</tbody>
</table>
## Compute the Cost per Equivalent Unit (Step 4)

<table>
<thead>
<tr>
<th></th>
<th>Total costs</th>
<th>Materials costs</th>
<th>Conversion costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs (Step 3)</td>
<td>$322,560</td>
<td>$100,800</td>
<td>$221,760</td>
</tr>
<tr>
<td>Total equivalent units (Step 2)</td>
<td>112,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per equivalent unit</td>
<td>$0.90</td>
<td></td>
<td>$2.20</td>
</tr>
</tbody>
</table>
**Assign Product Costs to Batches of Work (Step 5)**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Materials costs</th>
<th>Conversion costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transferred out:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent units</td>
<td>24,960</td>
<td>16,000</td>
<td>4,800</td>
</tr>
<tr>
<td>Cost per equivalent unit</td>
<td>$0.90</td>
<td>$0.90</td>
<td>$2.20</td>
</tr>
<tr>
<td>Cost assigned</td>
<td>$24,960</td>
<td>$14,400</td>
<td>$10,560</td>
</tr>
<tr>
<td><strong>Total cost assigned</strong></td>
<td>$322,560</td>
<td>$100,800</td>
<td>$221,760</td>
</tr>
<tr>
<td><strong>Work-in-process, March 31</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per equivalent unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost assigned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total cost assigned</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Production Cost Report

L.O. 4  Prepare and analyze a production cost report.

• The production cost report summarizes the production and cost results for a period.
• It is used by managers to monitor production and cost flows
• Following is 2T’s Compounding Department production cost report (weighted-average processing costing) for March.
# Production Cost Report: Weighted-Average Process Costing

## Flow of units

<table>
<thead>
<tr>
<th>Units to be accounted for:</th>
<th>Physical units</th>
<th>Equivalent units</th>
</tr>
</thead>
<tbody>
<tr>
<td>In work-in-process beginning inventory</td>
<td>20,000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20,000&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Units started this period</td>
<td>92,000</td>
<td>92,000</td>
</tr>
<tr>
<td>Total units to account for</td>
<td>112,000</td>
<td></td>
</tr>
</tbody>
</table>

| Units accounted for:                                          |                |                  |
| Completed and transferred out                                 | 96,000         | 96,000           |
| In work-in-process ending inventory                           | 16,000         | 16,000<sup>a</sup> |
| Total units accounted for                                     | 112,000        | 112,000          |

<sup>a</sup> 100% complete with respect to materials  
<sup>b</sup> 30% complete with respect to conversion
**Production Cost Report: Weighted-Average Process Costing**

<table>
<thead>
<tr>
<th>Flow of costs</th>
<th>Total</th>
<th>Materials Costs</th>
<th>Conversion Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs to be accounted for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work-in-process beginning inventory</td>
<td>$24,286</td>
<td>$16,160</td>
<td>$8,126</td>
</tr>
<tr>
<td>Current period costs</td>
<td>298,274</td>
<td>84,640</td>
<td>213,634</td>
</tr>
<tr>
<td>Total costs to be accounted for</td>
<td>$322,560</td>
<td>$100,800</td>
<td>$221,760</td>
</tr>
<tr>
<td>Cost per equivalent unit</td>
<td></td>
<td>$0.90</td>
<td>$2.20</td>
</tr>
<tr>
<td>Costs accounted for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs assigned to transferred-out units</td>
<td>$297,600</td>
<td>$86,400</td>
<td>$211,200</td>
</tr>
<tr>
<td>Costs assigned to WIP ending inventory</td>
<td>24,960</td>
<td>14,400</td>
<td>10,560</td>
</tr>
<tr>
<td>Total costs accounted for</td>
<td>$322,560</td>
<td>$100,800</td>
<td>$221,760</td>
</tr>
</tbody>
</table>

- c $100,000 ÷ 112,000 EU
- d $221,760 ÷ 100,800 EU
- e 96,000 EU × $0.90 per EU
- f 96,000 EU × $2.20 per EU
- g 16,000 EU × $0.90 per EU
- h 4,800 EU × $2.20 per EU
Assigning Costs Using FIFO

L.O. 5 Assign costs to products using first-in, first-out (FIFO) costing.

- Use the same five-step process.
- Step 1: Measure the physical flow of resources.
- Step 2: Compute the equivalent units of production.
- Step 3: Identify the product costs for which to account.
- Step 4: Compute the costs per equivalent unit.
- Step 5: Assign product cost to batches of work.
Measure the Physical Flow of Resources (Step 1)

- Exactly the same as weighted-average.

<table>
<thead>
<tr>
<th>Gallons of Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work in process, March 1</td>
</tr>
<tr>
<td>+ Gallons of adhesive started</td>
</tr>
<tr>
<td>Total gallons to account for</td>
</tr>
<tr>
<td>= Transferred out to Coating Department</td>
</tr>
<tr>
<td>+ Work-in-process, March 31</td>
</tr>
<tr>
<td>Total units accounted for</td>
</tr>
</tbody>
</table>

<sup>a</sup> 25% complete with respect to conversion costs

<sup>b</sup> 30% complete with respect to conversion costs
## Compute the Equivalent Units of Production (Step 2)

<table>
<thead>
<tr>
<th></th>
<th>Physical units</th>
<th>Equivalent units</th>
</tr>
</thead>
<tbody>
<tr>
<td>From beginning work in process</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Started and completed</td>
<td>76,000</td>
<td>76,000</td>
</tr>
<tr>
<td>Total completed and transferred out</td>
<td>96,000</td>
<td>96,000</td>
</tr>
<tr>
<td>In work-in-process inventory</td>
<td>16,000</td>
<td>16,000</td>
</tr>
<tr>
<td>Total units accounted for</td>
<td>112,000</td>
<td>100,800</td>
</tr>
<tr>
<td>Less work from beginning WIP</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>New work done in March</td>
<td>92,000</td>
<td>95,800</td>
</tr>
</tbody>
</table>

- **a** 100% complete with respect to materials
- **b** 30% complete with respect to conversion
- **c** 20,000 units × 25% complete

<table>
<thead>
<tr>
<th>Materials</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>76,000</td>
<td>76,000</td>
</tr>
<tr>
<td>96,000</td>
<td>96,000</td>
</tr>
<tr>
<td>16,000</td>
<td>4,800b</td>
</tr>
<tr>
<td>112,000</td>
<td>100,800</td>
</tr>
<tr>
<td>20,000</td>
<td>5,000c</td>
</tr>
<tr>
<td>92,000</td>
<td>95,800</td>
</tr>
</tbody>
</table>
Identify the Product Costs for Which to Account (Step 3)

- Exactly the same as weighted-average.

<table>
<thead>
<tr>
<th></th>
<th>Total costs</th>
<th>Materials costs</th>
<th>Conversion costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work-in-process, March 1</td>
<td>$24,286</td>
<td>$16,160</td>
<td>$8,126</td>
</tr>
<tr>
<td>Current costs, March</td>
<td>$298,274</td>
<td>$84,640</td>
<td>$213,624</td>
</tr>
<tr>
<td>Total</td>
<td>$322,560</td>
<td>$100,800</td>
<td>$221,760</td>
</tr>
</tbody>
</table>

LO5
Compute the Cost per Equivalent Unit (Step 4)

<table>
<thead>
<tr>
<th></th>
<th>Total costs</th>
<th>Materials costs</th>
<th>Conversion costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current costs, March</td>
<td>$298,274</td>
<td>$84,640</td>
<td>$213,634</td>
</tr>
<tr>
<td>Total equivalent units (Step 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per equivalent unit</td>
<td></td>
<td>$0.92</td>
<td>$2.23</td>
</tr>
<tr>
<td></td>
<td>$84,640 ÷ 92,000 equivalent units</td>
<td>92,000^d</td>
<td>95,800^e</td>
</tr>
<tr>
<td></td>
<td>$213,634 ÷ 92,000 equivalent units</td>
<td>$213,634</td>
<td>$213,634</td>
</tr>
</tbody>
</table>

- Note: Include only current period costs and activities.
## Assign Product Costs to Batches of Work (Step 5)

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Materials costs</th>
<th>Conversion costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs from beginning WIP</td>
<td>$ 24,286</td>
<td>$ 16,160</td>
<td>$ 8,126</td>
</tr>
<tr>
<td>Current costs to complete</td>
<td>33,450</td>
<td>-0-</td>
<td>33,450</td>
</tr>
<tr>
<td>beginning WIP inventory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs from beginning</td>
<td>$ 57,736</td>
<td>$ 16,160</td>
<td>$ 41,576</td>
</tr>
<tr>
<td>WIP inventory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current costs of units started</td>
<td>239,400</td>
<td>69,920</td>
<td>169,480</td>
</tr>
<tr>
<td>and completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs transferred out</td>
<td>$297,136</td>
<td>$ 86,080</td>
<td>$211,056</td>
</tr>
<tr>
<td>Costs assigned to WIP ending</td>
<td>25,424</td>
<td>14,720</td>
<td>10,704</td>
</tr>
<tr>
<td>inventory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs accounted for</td>
<td>$322,560</td>
<td>$100,800</td>
<td>$221,760</td>
</tr>
</tbody>
</table>

- $ 15,000 EU × $2.23 per EU
- $ 76,000 EU × $0.92
- $ 76,000 EU × $2.23 per EU
- $ 4,800 EU × $2.23 per EU
Determining Which is Better: FIFO or Weighted-Average?

**L.O. 6** Analyze the accounting choice between FIFO and weighted-average costing.

- **Weighted-average:**
  Does not separate prior period and current period activities and costs.

- **FIFO:**
  Separates prior period and current period activities and traces the prior period and current period costs to the respective units.
Determining Which is Better: FIFO or Weighted Average?

- Comparison of weighted-average and FIFO process costing (2T’s Compounding Department)

<table>
<thead>
<tr>
<th>Equivalent unit costs:</th>
<th>Weighted-average</th>
<th>FIFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>$0.90</td>
<td>$0.93</td>
</tr>
<tr>
<td>Conversion costs</td>
<td>2.20</td>
<td>2.23</td>
</tr>
<tr>
<td>Batch costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost goods transferred out</td>
<td>$297,600</td>
<td>$297,136</td>
</tr>
<tr>
<td>Work-in-process, ending inventory</td>
<td>24,960</td>
<td>25,424</td>
</tr>
<tr>
<td>Total costs assigned</td>
<td>$322,560</td>
<td>$322,560</td>
</tr>
</tbody>
</table>

LO6
Using Costs Transferred in from Prior Departments

• Prior department costs are costs incurred in one department and transferred to a subsequent department.

• It is important to distinguish between prior department costs and prior period costs.

• Prior period costs are costs that were incurred in a previous accounting period.
Choosing between Job and Process Costing

L.O. 7 Know when to use process or job costing.

**Job Costing**
- An accounting system that traces costs to individual units or to specific jobs, contracts, or batches of goods.
  - Custom homes
  - Movies
  - Services

**Process Costing**
- An accounting system used when identical units are produced through a series of uniform production steps.
  - Corn flakes
  - Beverages
  - Paint
L.O. 8  Compare and contrast operation costing with job costing and process costing.

• Operation costing is a hybrid of job and process costing.

• It is used in manufacturing goods that have some common characteristics plus some individual characteristics.
Operation Costing

Job Costing
Job shops make customized products.

Operations Costing
Operations separate materials for each batch; common processes are used to produce products.

Process Costing
Mass production is used in continuous processes.
Product Costing in Operations

• St. Ignace Sports Company makes two models of snowmobiles, Ocelots and Tigers.

• The Ocelot has a larger engine and requires more expensive materials.
Product Costing in Operations

Operations—St. Ignace Sports Company

Materials

Conversion costs

Tigers

Assembly

Painting

Customization

Finished goods

Ocelots
End of Chapter 8