Chapter 5
Cost Behavior: Analysis and Use

Solutions to Questions

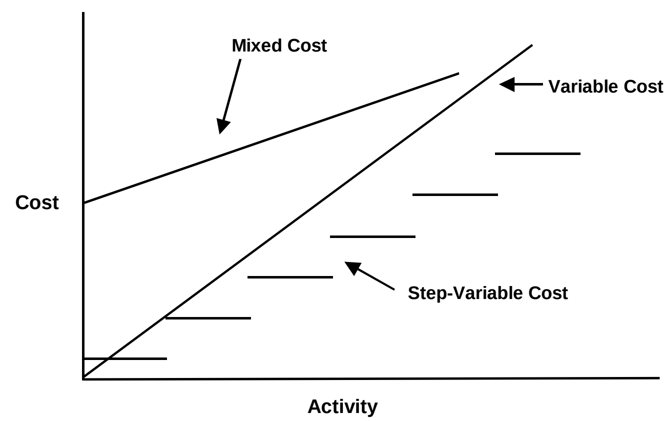
5-1
a. Variable cost: A variable cost remains constant on a per unit basis, but changes in *total* in direct relation to changes in volume.
b. Fixed cost: A fixed cost remains constant in total amount, but changes, if expressed on a per unit basis, inversely with changes in volume.
c. Mixed cost: A mixed cost contains both variable and fixed cost elements.

5-2
a. Unit fixed costs decrease as volume increases.
b. Unit variable costs remain constant as volume increases.
c. Total fixed costs remain constant as volume increases.
d. Total variable costs increase as volume increases.

5-3
a. Cost behavior: Cost behavior refers to the way in which costs change in response to changes in a measure of activity such as sales volume, production volume, or orders processed.
b. Relevant range: The relevant range is the range of activity within which assumptions about variable and fixed cost behavior are valid.

5-4 An activity base is a measure of whatever causes the incurrence of a variable cost. Examples of activity bases include units produced, units sold, letters typed, beds in a hospital, meals served in a cafe, service calls made, etc.

5-5
a. Variable cost: A variable cost remains constant on a per unit basis, but increases or decreases *in total* in direct relation to changes in activity.
b. Mixed cost: A mixed cost is a cost that contains both variable and fixed cost elements.
c. Step-variable cost: A step-variable cost is a cost that is incurred in large chunks, and which increases or decreases only in response to fairly wide changes in activity.



5-6 The linear assumption is reasonably valid providing that the cost formula is used only within the relevant range.

5-7 A discretionary fixed cost has a fairly short planning horizon—usually a year. Such costs arise from annual decisions by management to spend in certain fixed cost areas, such as advertising, research, and management development. A committed fixed cost has a long planning horizon—generally many years. Such costs relate to a company's investment in facilities, equipment, and basic organization. Once such costs have been incurred, a company becomes "locked in" for many years.

5-8

a. Committed	d. Committed
b. Discretionary	e. Committed
c. Discretionary	f. Discretionary

5-9 Yes. As the anticipated level of activity changes, the level of fixed costs needed to support operations will also change. Most fixed costs are adjusted upward and downward in large steps, rather than being absolutely fixed at one level for all ranges of activity.

5-10 The high-low method uses only two points to determine a cost formula. These two points are likely to be less than typical since they represent extremes of activity.

5-11 A mixed cost can be expressed in formula form as $Y = a + bX$. In cost analysis, the "a" term represents the fixed cost element, and the "b" term represents the variable cost element per unit of activity.

5-12 The term "least-squares regression" means that the sum of the squares of the deviations from the plotted points on a graph to the regression line is smaller than could be obtained from any other line that could be fitted to the data.

5-13 Ordinary single least-squares regression analysis is used when a variable cost is a function of only a single factor. If a cost is a function of more than one factor, multiple regression analysis should be used to analyze the behavior of the cost.

5-14 The contribution approach income statement organizes costs by behavior, first deducting variable expenses to obtain contribution margin, and then deducting fixed expenses to obtain net operating income. The traditional approach organizes costs by function, such as production, selling, and administration. Within a functional area, fixed and variable costs are intermingled.

5-15 The contribution margin is total sales revenue less total variable expenses.

Exercise 5-1 (15 minutes)

1.

	Cups of Coffee Served in a Week		
	2,000	*2,100*	*2,200*
Fixed cost	$1,200	$1,200	$1,200
Variable cost	440	462	484
Total cost	$1,640	$1,662	$1,684
Cost per cup of coffee served *	$0.820	$0.791	$0.765

* Total cost ÷ cups of coffee served in a week

2. The average cost of a cup of coffee declines as the number of cups of coffee served increases because the fixed cost is spread over more cups of coffee.

Exercise 5-2 (45 minutes)

1.

	Units Shipped	*Shipping Expense*
High activity level (June)	8	$2,700
Low activity level (July)	2	1,200
Change	6	$1,500

Variable cost element:

$$\frac{\text{Change in expense}}{\text{Change in activity}} = \frac{\$1{,}500}{6 \text{ units}} = \$250 \text{ per unit.}$$

Fixed cost element:

Shipping expense at high activity level	$2,700
Less variable cost element ($250 per unit × 8 units)	2,000
Total fixed cost	$ 700

The cost formula is $700 per month plus $250 per unit shipped or

Y = $700 + $250X,

where X is the number of units shipped.

2. a. See the scattergraph on the following page.

b. (Note: Students' answers will vary due to the imprecision of this method of estimating variable and fixed costs.)

Total cost at 5 units shipped per month [a point falling on the regression line in (a)]	$2,000
Less fixed cost element (intersection of the Y axis)	1,000
Variable cost element	$1,000

$1,000 ÷ 5 units = $200 per unit.

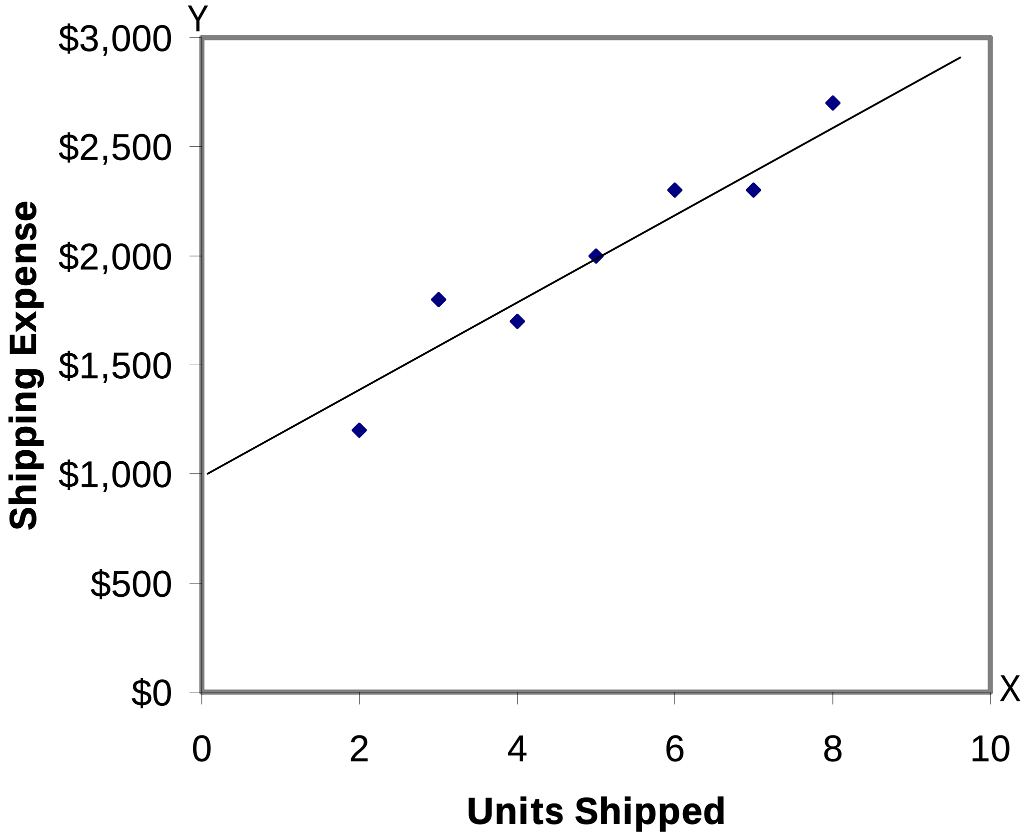
The cost formula is $1,000 per month plus $200 per unit shipped or

Y = $1,000 + $200X.

where X is the number of units shipped.

Exercise 5-2 (continued)

2. a. The scattergraph would be:



3. The cost of shipping units is likely to depend on the weight and volume of the units and the distance traveled as well as on the number of units shipped. In addition, higher cost shipping might be necessary in some situations to meet a deadline.

Exercise 5-3 (30 minutes)

1.

Month	*Units Shipped (X)*	*Shipping Expense (Y)*
January	3	$1,800
February	6	$2,300
March	4	$1,700
April	5	$2,000
May	7	$2,300
June	8	$2,700
July	2	$1,200

Statistical software or a spreadsheet application such as Excel can be used to compute the slope and intercept of the least-squares regression line for the above data. The results are:

Intercept (fixed cost)	$911
Slope (variable cost per unit)	$218
R^2	0.91

Therefore, the cost formula is $911 per month plus $218 per unit shipped or

Y = $911 + $218X.

Note that the R^2 is 0.91, which means that 91% of the variation in shipping costs is explained by the number of units shipped. This is a very high R^2 and indicates a good fit.

2.

	Variable Cost per Unit	*Fixed Cost per Month*
Quick-and-dirty scattergraph method.......	$200	$1,000
High-low method	$250	$700
Least-squares regression method	$218	$911

Note that the high-low method gives estimates that are quite different from the estimates provided by least-squares regression.

Exercise 5-4 (20 minutes)

1.

	Occupancy-Days	*Electrical Costs*
High activity level (August) ...	2,406	$5,148
Low activity level (October) ..	124	1,588
Change	2,282	$3,560

Variable cost = Change in cost ÷ Change in activity
= $3,560 ÷ 2,282 occupancy-days
= $1.56 per occupancy-day

Total cost (August)	$5,148
Variable cost element ($1.56 per occupancy-day × 2,406 occupancy-days) ...	3,753
Fixed cost element	$1,395

2. Electrical costs may reflect seasonal factors other than the just the variation in occupancy days. For example, common areas such as the reception area must be lighted for longer periods during the winter than in the summer. This will result in seasonal fluctuations in the fixed electrical costs. Additionally, the fixed costs will be affected by the number of days in a month. In other words, costs like the costs of lighting common areas are variable with respect to the number of days in the month, but are fixed with respect to how many rooms are occupied during the month. Other, less systematic, factors may also affect electrical costs such as the frugality of individual guests. Some guests will turn off lights when they leave a room. Others will not.

Exercise 5-5 (20 minutes)

1.

THE ALPINE HOUSE, INC.
Income Statement—Ski Department
For the Quarter Ended March 31

Sales		$150,000
Less variable expenses:		
Cost of goods sold (200 pairs* × $450 per pair)	$90,000	
Selling expenses (200 pairs × $50 per pair)	10,000	
Administrative expenses (20% × $10,000)	2,000	102,000
Contribution margin		48,000
Less fixed expenses:		
Selling expenses [$30,000 – (200 pairs × $50 per pair)]	20,000	
Administrative expenses (80% × $10,000)	8,000	28,000
Net operating income		$ 20,000

*$150,000 ÷ $750 per pair = 200 pairs.

2. Since 200 pairs of skis were sold and the contribution margin totaled $48,000 for the quarter, the contribution of each pair of skis toward covering fixed costs and toward earning of profits was $240 ($48,000 ÷ 200 pairs = $240 per pair). Another way to compute the $240 is:

Selling price per pair		$750
Less variable expenses:		
Cost per pair	$450	
Selling expenses	50	
Administrative expenses ($2,000 ÷ 200 pairs)	10	510
Contribution margin per pair		$240

Exercise 5-6 (20 minutes)

1. The company's variable cost per unit would be:

$$\frac{\$180{,}000}{30{,}000 \text{ units}} = \$6 \text{ per unit.}$$

   In accordance with the behavior of variable and fixed costs, the completed schedule would be:

	Units produced and sold		
	30,000	*40,000*	*50,000*
Total costs:			
Variable costs	$180,000	$240,000	$300,000
Fixed costs	300,000	300,000	300,000
Total costs	$480,000	$540,000	$600,000
Cost per unit:			
Variable cost	$ 6.00	$ 6.00	$ 6.00
Fixed cost	10.00	7.50	6.00
Total cost per unit	$16.00	$13.50	$12.00

2. The company's income statement in the contribution format would be:

Sales (45,000 units × $16 per unit)	$720,000
Less variable expenses (45,000 units × $6 per unit)	270,000
Contribution margin	450,000
Less fixed expense	300,000
Net operating income	$150,000

Exercise 5-7 (20 minutes)

1. a. Difference in cost:

Monthly operating costs at 80% occupancy:	
450 beds × 80% = 360 beds;	
360 beds × 30 days × $32 per bed-day	$345,600
Monthly operating costs at 60% occupancy (given)	326,700
Difference in cost	$ 18,900

Difference in activity:	
80% occupancy (450 beds × 80% × 30 days)	10,800
60% occupancy (450 beds × 60% × 30 days)	8,100
Difference in activity	2,700

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$18{,}900}{2{,}700 \text{ bed-days}} = \$7 \text{ per bed-day.}$$

b.

Monthly operating costs at 80% occupancy (above)	$345,600
Less variable costs:	
360 beds × 30 days × $7 per bed-day	75,600
Fixed operating costs per month	$270,000

2. 450 beds × 70% = 315 beds occupied.

Fixed costs	$270,000
Variable costs: 315 beds × 30 days × $7 per bed-day	66,150
Total expected costs	$336,150

Exercise 5-8 (20 minutes)

1.

	Guest-Days	*Custodial Supplies Expense*
High activity level (July)	12,000	$13,500
Low activity level (March)	4,000	7,500
Change	8,000	$ 6,000

Variable cost element:

$$\frac{\text{Change in expense}}{\text{Change in activity}} = \frac{\$6{,}000}{8{,}000 \text{ guest-days}} = \$0.75 \text{ per guest-day}$$

Fixed cost element:

Custodial supplies expense at high activity level	$13,500
Less variable cost element:	
12,000 guest-days × $0.75 per guest-day	9,000
Total fixed cost	$ 4,500

The cost formula is $4,500 per month plus $0.75 per guest-day or

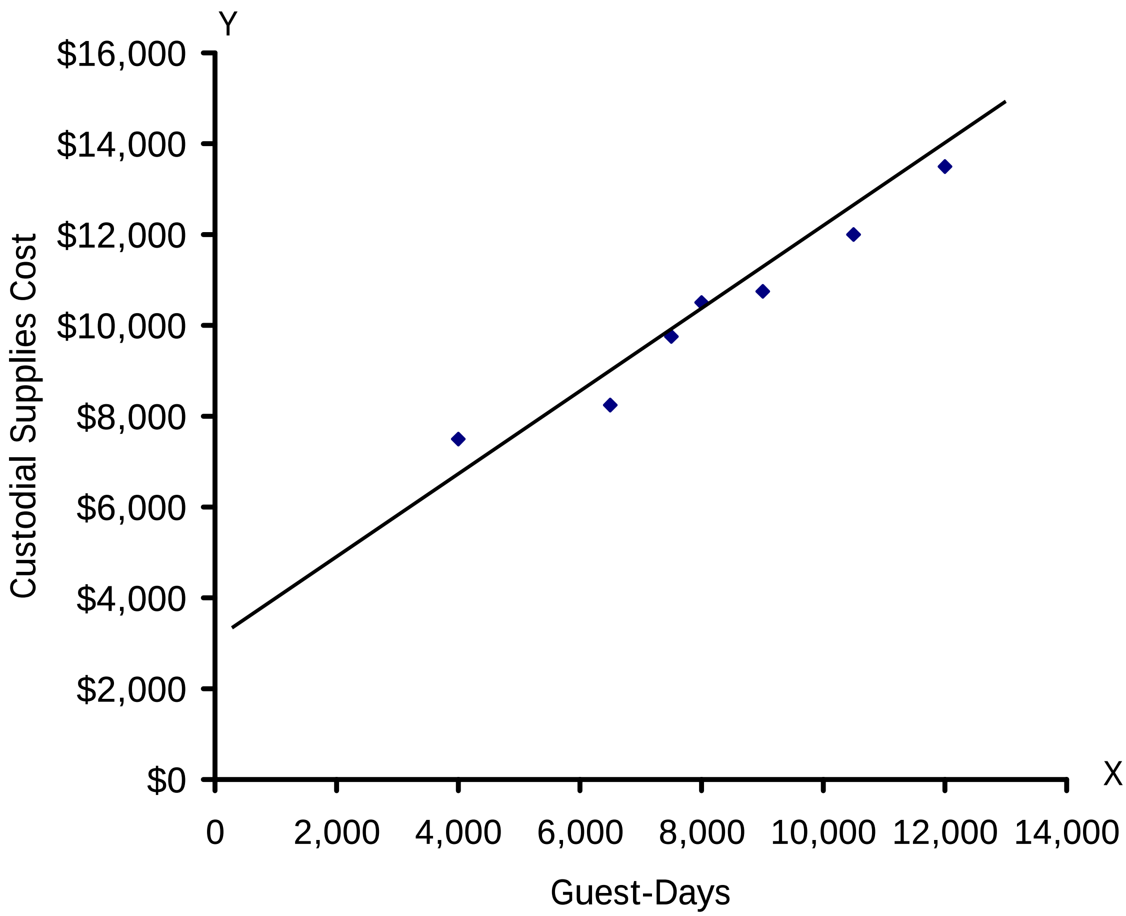
$$Y = \$4{,}500 + \$0.75X.$$

2. Custodial supplies expense for 11,000 guest-days:

Variable cost:	
11,000 guest-days × $0.75 per guest-day	$ 8,250
Fixed cost	4,500
Total cost	$12,750

Exercise 5-9 (30 minutes)

1. The scattergraph appears below:



Exercise 5-9 (continued)

2. (Note: Students' answers will vary considerably due to the inherent lack of precision and subjectivity of the quick-and-dirty method.)

Total costs at 7,500 guest-days per month [a point falling on the line in (1)]	$9,750
Less fixed cost element (intersection of the Y axis)	3,750
Variable cost element	$6,000

$6,000 ÷ 7,500 guest-days = $0.80 per guest-day.

The cost formula is therefore $3,750 per month, plus $0.80 per guest-day or

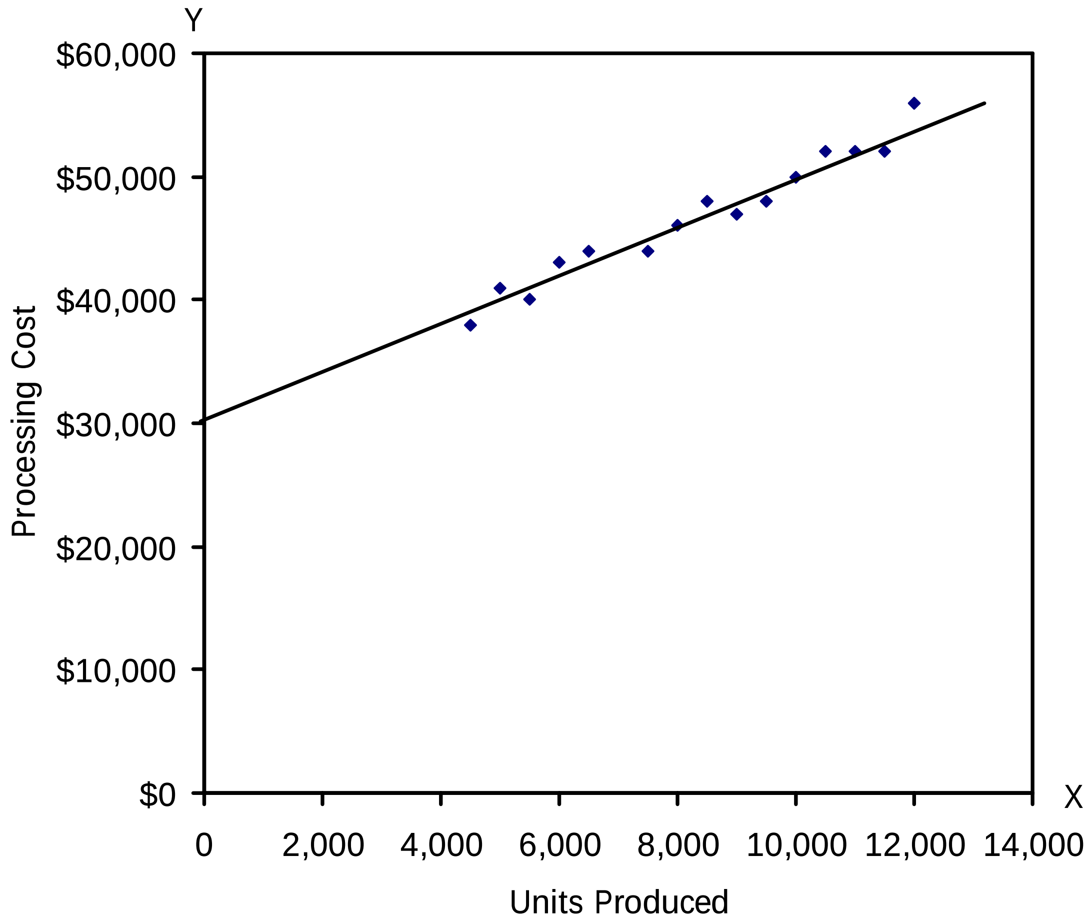
$$Y = \$3,750 + \$0.80X,$$

where X is the number of guest-days.

3. The high-low method would not provide an accurate cost formula in this situation since a line drawn through the high and low points would have a slope that is too flat and would be placed too high, cutting the cost axis at about $4,500 per month. The high and low points are not representative of all of the data in this situation.

Exercise 5-10 (30 minutes)

1. The scattergraph appears below:



Exercise 5-10 (continued)

2. (Students' answers will vary considerably due to the inherent imprecision of the quick-and-dirty method.)

   The approximate monthly fixed cost is $30,000—the point where the line intersects the cost axis. The variable cost per unit processed can be estimated using the 8,000-unit level of activity, which falls on the line:

Total cost at an 8,000-unit level of activity	$46,000
Less fixed costs...	30,000
Variable costs at an 8,000-unit level of activity	$16,000

   $16,000 ÷ 8,000 units = $2 per unit.

   Therefore, the cost formula is $30,000 per month plus $2 per unit processed.

   Observe from the scattergraph that if the company used the high-low method to determine the slope of the regression line, the line would be too steep. This would result in underestimating fixed costs and overestimating the variable cost per unit.

Exercise 5-11 (20 minutes)

1.

	Kilometers Driven	*Total Annual Cost**
High level of activity	105,000	$11,970
Low level of activity	70,000	9,380
Change	35,000	$ 2,590

* 105,000 kilometers × $0.114 per kilometer = $11,970
70,000 kilometers × $0.134 per kilometer = $9,380

Variable cost per kilometer:

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$2{,}590}{35{,}000 \text{ kilometers}} = \$0.074 \text{ per kilometer.}$$

Fixed cost per year:

Total cost at 105,000 kilometers	$11,970
Less variable portion:	
105,000 kilometers × $0.074 per kilometer	7,770
Fixed cost per year	$ 4,200

2. Y = $4,200 + $0.074X

3.

Fixed cost	$ 4,200
Variable cost:	
80,000 kilometers × $0.074 per kilometer	5,920
Total annual cost	$10,120

Exercise 5-12 (30 minutes)

1.

Week	*Units (X)*	*Total Etching Cost (Y)*
1	4	18
2	3	17
3	8	25
4	6	20
5	7	24
6	2	16

Statistical software or a spreadsheet application such as Excel can be used to compute the slope and intercept of the least-squares regression line for the above data. The results are:

Intercept (fixed cost)	SFr 12.32
Slope (variable cost per unit)	SFr 1.54
R^2	0.93

Therefore, the cost formula is SFr 12.32 per month plus SFr 1.54 per unit etched or

Y = SFr 12.32 + SFr 1.54.

Note that the R^2 is 0.93, which means that 93% of the variation in etching costs is explained by the number of units etched. This is a very high R^2 and indicates a good fit.

2. Y = SFr 12.32 + SFr 1.54X

3. Total expected etching cost if 5 units are processed:

Variable cost: 5 units × SFr 1.54 per unit ...	SFr 7.70
Fixed cost	12.32
Total expected cost	SFr 20.02

Problem 5-13 (45 minutes)

1. Cost of goods sold .... Variable
   Advertising expense .... Fixed
   Shipping expense...................... Mixed
   Salaries and commissions .... Mixed
   Insurance expense.................... Fixed
   Depreciation expense .... Fixed

2. Analysis of the mixed expenses:

	Units	*Shipping Expense*	*Salaries and Commission Expense*
High level of activity	5,000	A$38,000	A$90,000
Low level of activity.........	4,000	34,000	78,000
Change	1,000	A$ 4,000	A$12,000

Variable cost element:

$$\text{Variable rate} = \frac{\text{Change in cost}}{\text{Change in activity}}$$

$$\text{Shipping expense: } \frac{\text{A\$4,000}}{\text{1,000 units}} = \text{A\$4 per unit.}$$

$$\text{Salaries and Commission Expense: } \frac{\text{A\$12,000}}{\text{1,000 units}} = \text{A\$12 per unit.}$$

Fixed cost element:

	Shipping Expense	*Salaries and Commission Expense*
Cost at high level of activity	A$38,000	A$90,000
Less variable cost element:		
5,000 units × A$4 per unit....	20,000	
5,000 units × A$12 per unit..		60,000
Fixed cost element	A$18,000	A$30,000

Problem 5-13 (continued)

The cost formulas are:

Shipping expense:

A$18,000 per month plus A$4 per unit

or

Y = A$18,000 + A$4 X.

Salaries and Comm. expense:

A$30,000 per month plus A$12 per unit

or

Y = A$30,000 + A$12 X.

3.

Morrisey & Brown, Ltd.
Income Statement
For the Month Ended September 30

Sales revenue		
(5,000 units × A$100 per unit)		A$500,000
Less variable expenses:		
Cost of goods sold		
(5,000 units × A$60 per unit)	A$300,000	
Shipping expense		
(5,000 units × A$4 per unit)	20,000	
Salaries and commissions expense		
(5,000 units × A$12 per unit)	60,000	380,000
Contribution margin		120,000
Less fixed expenses:		
Advertising expense	21,000	
Shipping expense	18,000	
Salaries and commissions expense	30,000	
Insurance expense	6,000	
Depreciation expense	15,000	90,000
Net operating income		A$ 30,000

Problem 5-14 (45 minutes)

1\. MARWICK'S PIANOS, INC.
Income Statement
For the Month of August

Sales (40 pianos × $3,125 per piano)		$125,000
Less cost of goods sold		
(40 pianos × $2,450 per piano)		98,000
Gross margin		27,000
Less operating expenses:		
Selling expenses:		
Advertising	$ 700	
Sales salaries and commissions		
[$950 + (8% × $125,000)]	10,950	
Delivery of pianos		
(40 pianos × $30 per piano)	1,200	
Utilities	350	
Depreciation of sales facilities	800	
Total selling expenses	14,000	
Administrative expenses:		
Executive salaries	2,500	
Insurance	400	
Clerical		
[$1,000 + (40 pianos × $20 per piano)]	1,800	
Depreciation of office equipment	300	
Total administrative expenses	5,000	
Total operating expenses		19,000
Net operating income		$ 8,000

Problem 5-14 (continued)

2. MARWICK'S PIANOS, INC.
Income Statement
For the Month of August

	Total	*Per Piano*
Sales (40 pianos × $3,125 per piano)	$125,000	$3,125
Less variable expenses:		
Cost of goods sold		
(40 pianos × $2,450 per piano)	98,000	2,450
Sales commissions (8% × $125,000)	10,000	250
Delivery of pianos (40 pianos × $30 per piano)	1,200	30
Clerical (40 pianos × $20 per piano)	800	20
Total variable expenses	110,000	2,750
Contribution margin	15,000	$ 375
Less fixed expenses:		
Advertising	700	
Sales salaries	950	
Utilities	350	
Depreciation of sales facilities	800	
Executive salaries	2,500	
Insurance	400	
Clerical	1,000	
Depreciation of office equipment	300	
Total fixed expenses	7,000	
Net operating income	$ 8,000	

3. Fixed costs remain constant in total but vary on a per unit basis inversely with changes in the activity level. As the activity level increases, for example, the fixed costs will decrease on a per unit basis. Showing fixed costs on a per unit basis on the income statement might mislead management into thinking that the fixed costs behave in the same way as the variable costs. That is, management might be misled into thinking that the per unit fixed costs would be the same regardless of how many pianos were sold during the month. For this reason, fixed costs generally are shown only in totals on a contribution format income statement.

Problem 5-15 (45 minutes)

1.

Term	Number of Sections Offered (X)	Total Cost (Y)
Fall, last year	4	$10,000
Winter, last year	6	$14,000
Summer, last year	2	$7,000
Fall, this year	5	$13,000
Winter, this year	3	$9,500

A spreadsheet application such as Excel or a statistical software package can be used to compute the slope and intercept of the least-squares regression line for the above data. The results are:

Intercept (fixed cost)	$3,700
Slope (variable cost per unit)	$1,750
R^2	0.95

Therefore, the variable cost is $1,750 per section and the fixed cost is $3,700 per term.

Note that the R^2 is 0.95, which means that 95% of the variation in cost is explained by the number of sections. This is a very high R^2 and indicates a very good fit.

2. Y = $3,700 + $1,750X

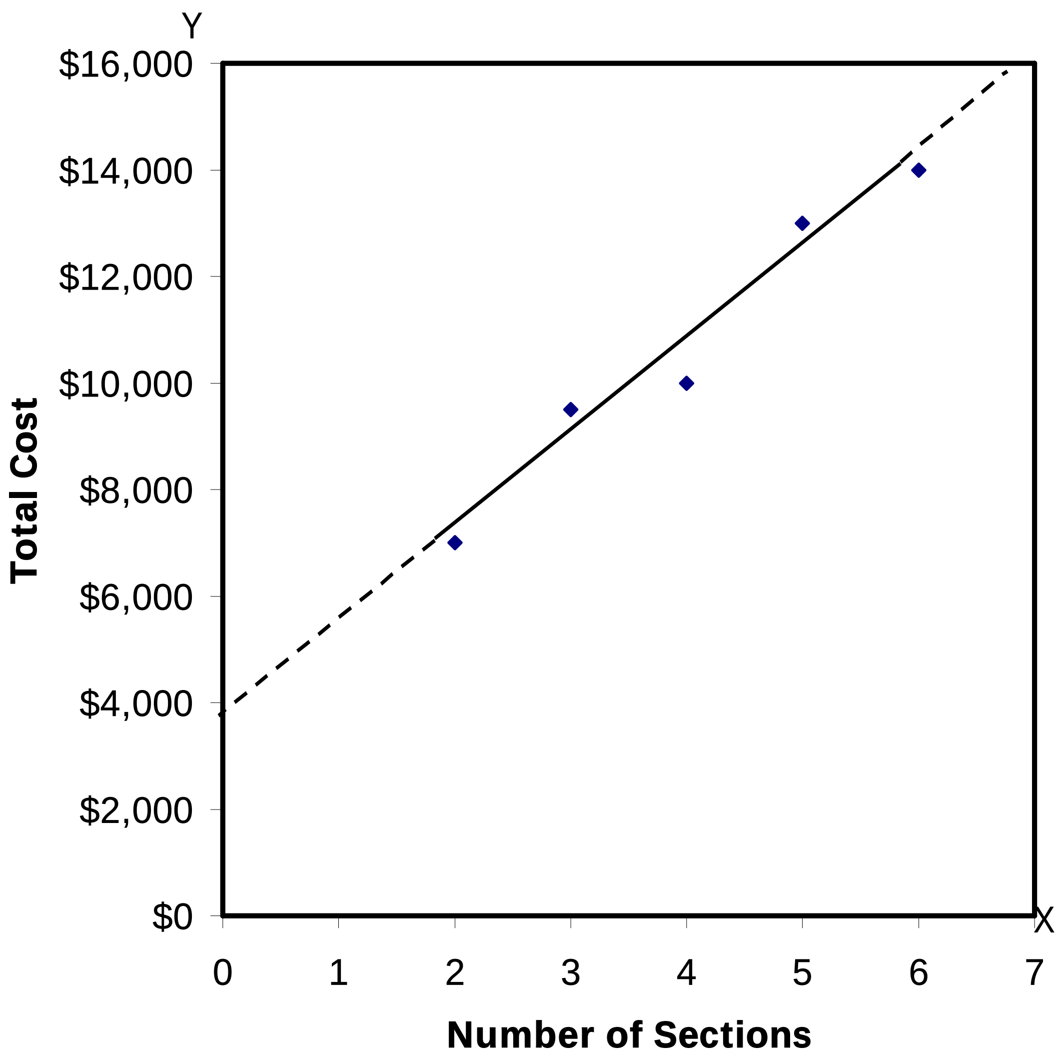
3. Expected total cost would be:

Fixed cost	$ 3,700
Variable cost (8 sections × $1,750 per section)...	14,000
Total cost	$17,700

The problem with using the cost formula from (2) to derive total cost is that an activity level of 8 sections may lie outside the relevant range—the range of activity within which the fixed cost is approximately $3,700 per term and the variable cost is approximately $1,750 per section offered. These approximations appear to be reasonably accurate within the range of 2 to 6 sections, but they may be invalid outside this range.

Problem 5-15 (continued)

4.



Problem 5-16 (30 minutes)

1.	a. 3	c. 11	e. 4	g. 2	i. 9
	b. 6	d. 1	f. 10	h. 7	

2. Without a knowledge of the underlying cost behavior patterns, it would be difficult if not impossible for a manager to properly analyze the firm's cost structure. The reason is that all costs don't behave in the same way. One cost might move in one direction as a result of a particular action, and another cost might move in an opposite direction. Unless the behavior pattern of each cost is clearly understood, the impact of a firm's activities on its costs will not be known until *after* the activity has occurred.

Problem 5-17 (45 minutes)

1. High-low method:

	Number of Scans	*Utilities Cost*
High level of activity....	150	$4,000
Low level of activity.....	60	2,200
Change	90	$1,800

Variable rate: $\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$1,800}{\text{90 scans}} = \$20$ per scan

Fixed cost:	Total cost at high level of activity............	$4,000
	Less variable element:	
	150 scans × $20 per scan	3,000
	Fixed cost element	$1,000

Therefore, the cost formula is: Y = $1,000 + $20X.

2. Scattergraph method (see the scattergraph on the following page):

(Note: Students' answers will vary due to the inherent imprecision of the quick-and-dirty method.)

The line intersects the cost axis at about $1,200. The variable cost can be estimated as follows:

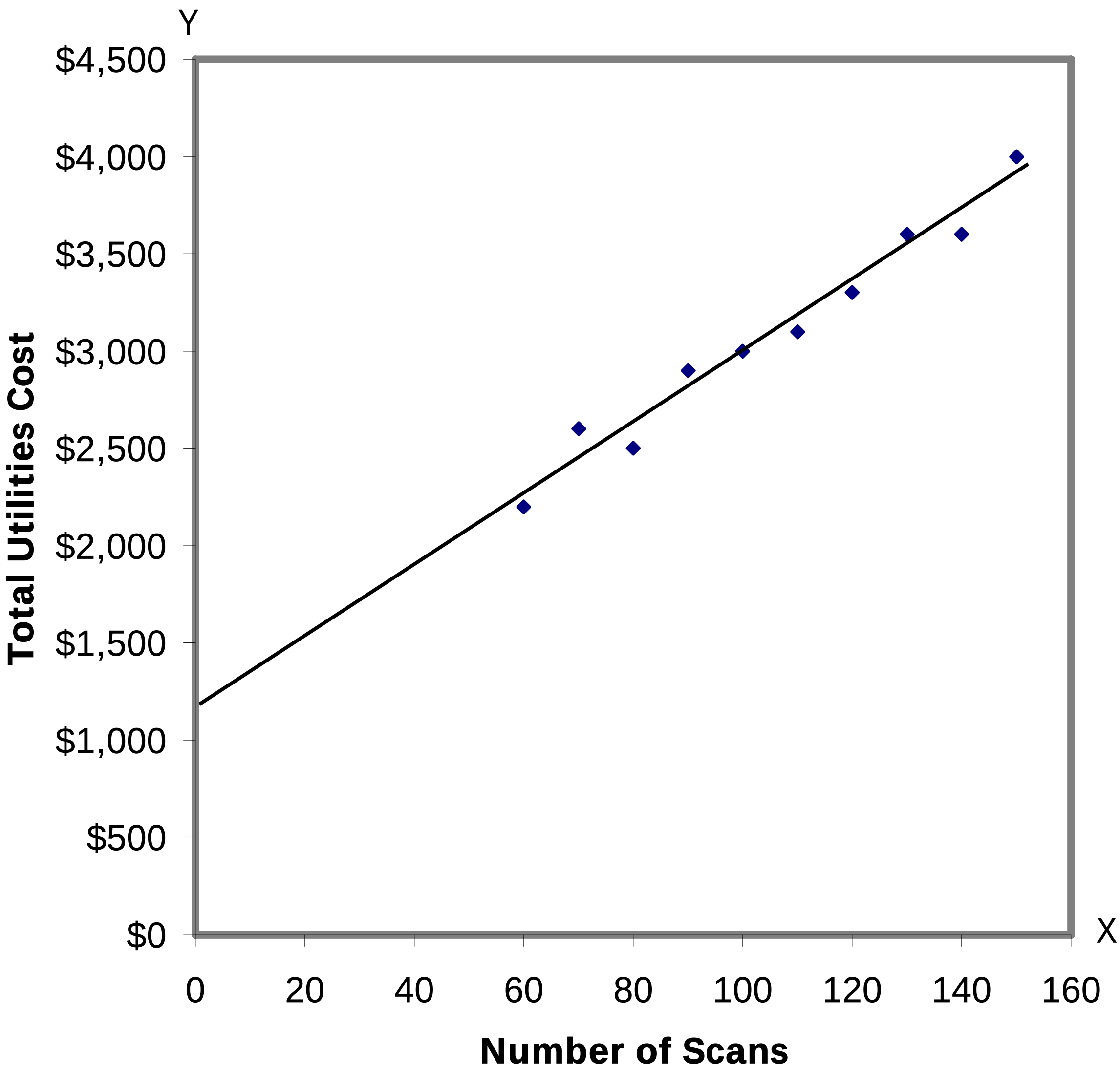
Total cost at 100 scans (a point that falls on the line)....	$3,000
Less the fixed cost element...	1,200
Variable cost element (total)	$1,800

$1,800 ÷ 100 scans = $18 per scan.

Therefore, the cost formula is: Y = $1,200 + $18X.

Problem 5-17 (continued)

The completed scattergraph:



Problem 5-18 (30 minutes)

1. The least-squares regression method:

Month	*Number of Scans (X)*	*Utilities Cost (Y)*
January	60	$2,200
February	70	$2,600
March	90	$2,900
April	120	$3,300
May	100	$3,000
June	130	$3,600
July	150	$4,000
August	140	$3,600
September	110	$3,100
October	80	$2,500

Statistical software or a spreadsheet application such as Excel or can be used to compute the slope and intercept of the least-squares regression line for the above data. The results are:

Intercept (fixed cost)	$1,171
Slope (variable cost per unit)	$18.18
R^2	0.97

Therefore, the variable cost of power per scan is $18.18 and the fixed cost of power is $1,171 per month and the cost formula is:

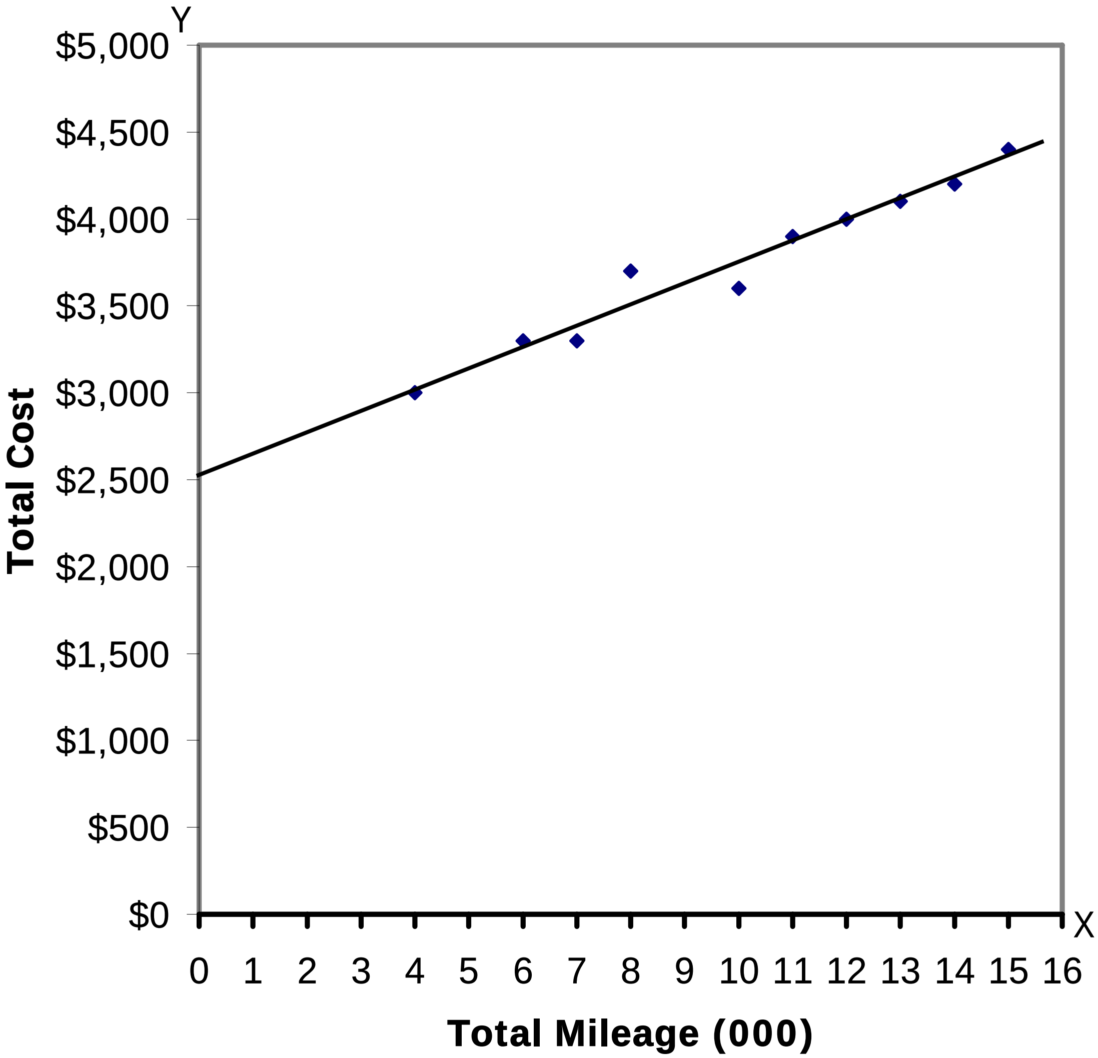
$$Y = \$1,171 + \$18.18X.$$

Note that the R^2 is 0.97, which means that 97% of the variation in utilities cost is explained by the number of scans. This is a very high R^2 and indicates a very good fit.

2. As shown in the graph in part (2) of problem 5-17, the high and low points in this case fall in such a way they are not representative of all points of cost data. A regression line drawn through these two points would be too steep and thus result in an inaccurate cost formula. This is the major defect in the high-low method; although it is simple to apply, the manager must be careful in its use or misleading information may result.

Problem 5-19 (30 minutes)

1. The scattergraph is presented below.



Problem 5-19 (continued)

2. (Note: Students' answers will vary due to the inherent imprecision of the quick-and-dirty method.)

   The fixed cost element can be obtained by noting the point where the line intersects the vertical (cost) axis. As shown on the scattergraph, this point is at approximately $2,500 per month. Given this figure, the variable cost element can be obtained by the following computation:

Total cost at 12,000 miles driven per month*	$4,000
Less fixed cost element	2,500
Variable cost element	$1,500

   *Note that total costs at this point fall on the line.

$$\frac{\text{Variable cost}}{\text{Number of miles driven}} = \frac{\$1,500}{12,000 \text{ miles}} = \$0.125 \text{ per mile.}$$

   Therefore, the cost of operating the autos can be expressed as $2,500 per month plus $0.125 per mile driven or

$$Y = \$2,500 + \$0.125X.$$

Problem 5-20 (30 minutes)

1. Least-squares regression analysis:

Month	*Miles Driven (000) (X)*	*Total Cost (Y)*
January	4	\$3,000
February	8	\$3,700
March	7	\$3,300
April	12	\$4,000
May	6	\$3,300
June	11	\$3,900
July	14	\$4,200
August	10	\$3,600
September	13	\$4,100
October	15	\$4,400

Statistical software or a spreadsheet application such as Excel can be used to compute the slope and intercept of the least-squares regression line for the above data. The results are:

Intercept (fixed cost per month)	\$2,542
Slope (variable cost per thousand miles).....	\$120.83
R^2	0.96

Therefore, the variable cost of operating the fleet of autos is \$120.83 per thousand miles driven or \$0.121 per mile (rounded) and the fixed cost is \$2,542 per month.

Note that the R^2 is 0.96, which means that 96% of the variation in the cost of operating the fleet of autos is explained by the number of miles driven. This is a very high R^2 and indicates a very good fit.

2. Y = \$2,542 + \$120.83X (where X = thousands of miles driven).

Problem 5-21 (45 minutes)

1.

Quarter	*Units Sold (000) (X)*	*Shipping Expense (Y)*
Year 1-1st	10	$119,000
2nd	16	$175,000
3rd	18	$190,000
4th	15	$164,000
Year 2-1st	11	$130,000
2nd	17	$185,000
3rd	20	$210,000
4th	13	$147,000

Statistical software or a spreadsheet application such as Excel can be used to compute the slope and intercept of the least-squares regression line for the above data. The results are:

Intercept (fixed cost per quarter)...............	$30,000
Slope (variable cost per thousand units).....	$9,000
R^2..	0.998

Therefore the cost formula for shipping expense is $30,000 per quarter plus $9,000 per thousand units sold ($9.00 per unit) or

$$Y = \$30,000 + \$9.00X.$$

where X is the number of units sold.

Note that the R^2 is 0.998, which means that 99.8% of the variation in shipping expense is explained by the number of units sold. This is an extremely high R^2 and indicates an excellent fit.

Problem 5-21 (continued)

2. MILDEN COMPANY
Budgeted Income Statement
For the First Quarter, Year 3

Sales (12,000 units × \$100 per unit)		\$1,200,000
Less variable expenses:		
Cost of goods sold (12,000 units × \$35 unit)	\$420,000	
Sales commission (6% × \$1,200,000)	72,000	
Shipping expense (12,000 units × \$9 per unit)	108,000	
Total variable expenses		600,000
Contribution margin		600,000
Less fixed expenses:		
Advertising expense	210,000	
Shipping expense	30,000	
Administrative salaries	145,000	
Insurance expense	9,000	
Depreciation expense	76,000	
Total fixed expenses		470,000
Net operating income		\$ 130,000

Problem 5-22 (45 minutes)

1.

	March—Low 6,000 Units	*June—High 9,000 Units*
Direct materials cost @ $6 per unit....	$ 36,000	$ 54,000
Direct labor cost @ $10 per unit........	60,000	90,000
Manufacturing overhead cost*	78,000	102,000
Total manufacturing costs.................	174,000	246,000
Add: Work in process, beginning.......	9,000	32,000
	183,000	278,000
Deduct: Work in process, ending.......	15,000	21,000
Cost of goods manufactured.............	$168,000	$257,000

*Computed by working upwards through the statements.

2.

	Units Produced	*Cost Observed*
June—High level of activity...........	9,000	$102,000
March—Low level of activity..........	6,000	78,000
Change	3,000	$ 24,000

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$24,000}{3,000\text{ units}} = \$8.00\text{ per unit}$$

Total cost at the high level of activity.............	$102,000
Less variable cost element ($8.00 per unit × 9,000 units).....................	72,000
Fixed cost element	$ 30,000

Therefore, the cost formula is: $30,000 per month, plus $8.00 per unit produced or

$$Y = \$30,000 + \$8.00X.$$

Problem 5-22 (continued)

3. The cost of goods manufactured if 7,000 units are produced:

Direct materials cost (7,000 units × $6.00 per unit) .		$ 42,000
Direct labor cost (7,000 units × $10.00 per unit)		70,000
Manufacturing overhead cost:		
Fixed portion	$30,000	
Variable portion (7,000 units × $8.00 per unit)	56,000	86,000
Total manufacturing costs		198,000
Add: Work in process, beginning		0
		198,000
Deduct: Work in process, ending		0
Cost of goods manufactured		$198,000

Problem 5-23 (45 minutes)

1. Maintenance cost at the 75,000 direct labor-hour level of activity can be isolated as follows:

	Level of Activity	
	50,000 DLH	*75,000 DLH*
Total factory overhead cost	¥14,250,000	¥17,625,000
Deduct:		
Indirect materials @ ¥100 per DLH*	5,000,000	7,500,000
Rent	6,000,000	6,000,000
Maintenance cost	¥ 3,250,000	¥ 4,125,000

* ¥5,000,000 ÷ 50,000 DLH = ¥100 per DLH

2. High-low analysis of maintenance cost:

	Direct Labor-Hours	*Maintenance Cost*
High level of activity	75,000	¥4,125,000
Low level of activity	50,000	3,250,000
Change	25,000	¥ 875,000

Variable cost element:

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{¥875{,}000}{25{,}000\text{ DLH}} = ¥35\text{ per DLH}$$

Fixed cost element:

Total cost at the high level of activity	¥4,125,000
Less variable cost element	
(75,000 DLH × ¥35 per DLH)	2,625,000
Fixed cost element	¥1,500,000

Therefore, the cost formula for maintenance is ¥1,500,000 per year plus ¥35 per direct labor-hour or

Y = ¥1,500,000 + ¥35X

Problem 5-23 (continued)

3. Total factory overhead cost at 70,000 direct labor-hours would be:

Indirect materials		
(70,000 DLH × ¥100 per DLH)		¥ 7,000,000
Rent		6,000,000
Maintenance:		
Variable cost element		
(70,000 DLH × ¥35 per DLH)...............	¥2,450,000	
Fixed cost element	1,500,000	3,950,000
Total factory overhead cost.......................		¥16,950,000

Problem 5-24 (45 minutes)

1. Maintenance cost at the 90,000 machine-hour level of activity can be isolated as follows:

	Level of Activity	
	60,000 MHs	*90,000 MHs*
Total factory overhead cost	$174,000	$246,000
Deduct:		
Utilities cost @ $0.80 per MH* ...	48,000	72,000
Supervisory salaries	21,000	21,000
Maintenance cost	$105,000	$153,000

*$48,000 ÷ 60,000 MHs = $0.80 per MH

2. High-low analysis of maintenance cost:

	Machine-Hours	*Maintenance Cost*
High activity level	90,000	$153,000
Low activity level......................	60,000	105,000
Change	30,000	$ 48,000

Variable rate:

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$48{,}000}{30{,}000\text{ MHs}} = \$1.60 \text{ per MH.}$$

Total fixed cost:

Total maintenance cost at the high activity level	$153,000
Less variable cost element	
(90,000 MHs × $1.60 per MH)	144,000
Fixed cost element	$ 9,000

Therefore, the cost formula for maintenance is: $9,000 per month plus $1.60 per machine-hour or

$$Y = \$9{,}000 + \$1.60X.$$

Problem 5-24 (continued)

3.

	Variable Cost per Machine-Hour	*Fixed Cost*
Maintenance cost	$1.60	$ 9,000
Utilities cost	0.80	
Supervisory salaries cost		21,000
Totals	$2.40	$30,000

Thus, the cost formula would be: Y = $30,000 + $2.40X.

4. Total overhead cost at an activity level of 75,000 machine-hours:

Fixed costs	$ 30,000
Variable costs: 75,000 MHs × $2.40 per MH	180,000
Total overhead costs	$210,000

Case 5-25 (90 minutes)

1. Direct labor-hour allocation base:

Electrical costs (a)	¥3,879,000
Direct labor-hours (b)	428,040 DLHs
Predetermined overhead rate (a) ÷ (b)	¥9.06 per DLH

Machine-hour allocation base:

Electrical costs (a)	¥3,879,000
Machine-hours (b)	369,600 MHs
Predetermined overhead rate (a) ÷ (b)	¥10.50 per MH

2. Electrical cost for the shipyard job under the old costing system:

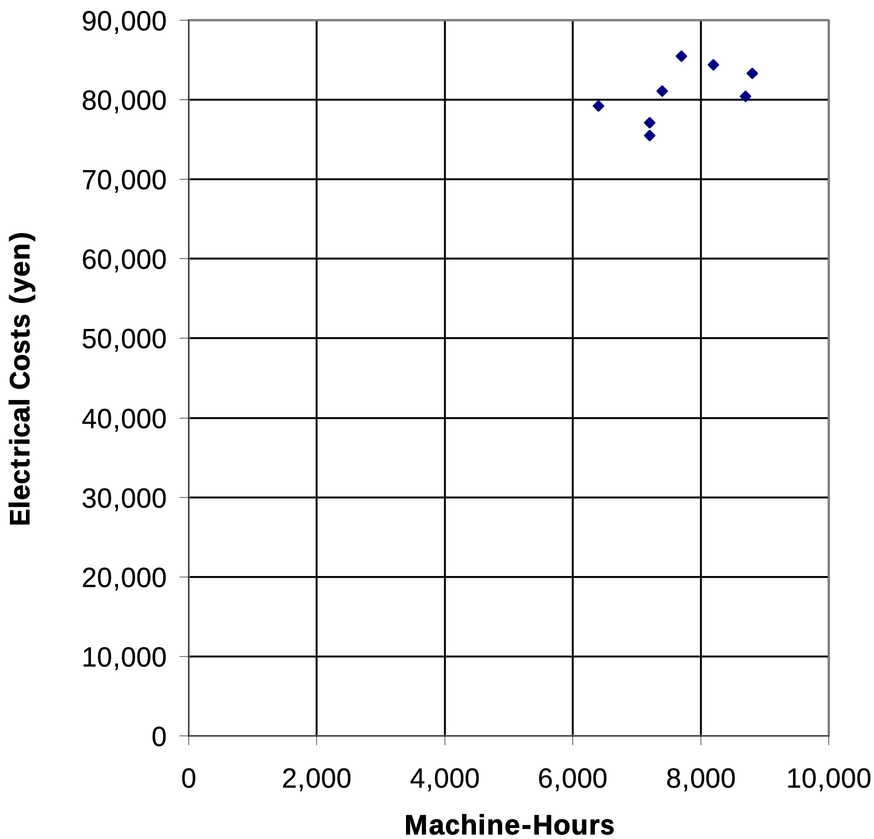
Predetermined overhead rate (a)	¥9.06 per DLH
Direct labor-hours for the job (b)	350 DLHs
Electrical cost applied to the job (a) × (b)	¥3,171

Electrical cost for the shipyard job under the new ABC system:

Predetermined overhead rate (a)	¥10.50 per MH
Machine-hours for the job (b)	270 MHs
Electrical cost applied to the job (a) × (b)	¥2,835

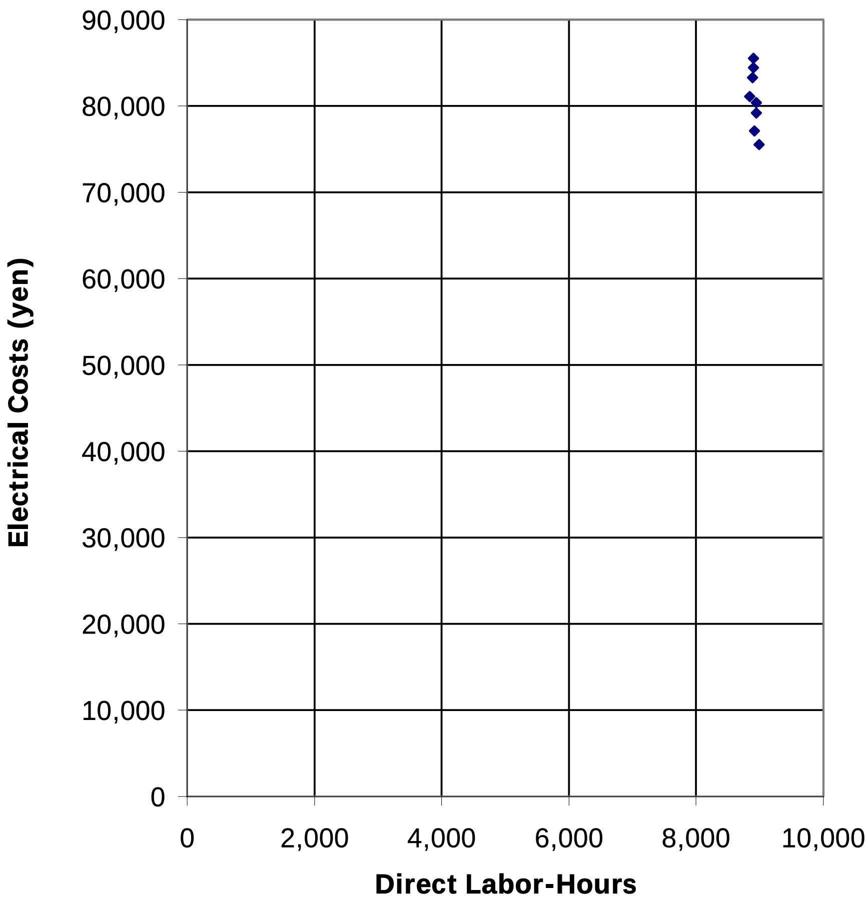
Case 5-25 (continued)

3. Scattergraph for electrical costs and machine-hours:



Case 5-25 (continued)

Scattergraph for electrical costs and direct labor-hours:



In general, the allocation base should actually cause the cost being allocated. If it doesn't, costs will be incorrectly assigned to jobs. Incorrectly assigned costs are worse than useless for decision-making.

Looking at the above scattergraph, electrical costs do not appear to be related to direct labor-hours. Electrical costs do vary, but apparently not in response to changes in direct labor-hours. On the other hand, looking at the scattergraph for machine-hours, there is some tendency for electrical costs to increase as the machine-hours increase. So if one must

Case 5-25 (continued)

choose between machine-hours and direct labor-hours as an allocation base, machine-hours seems to be the better choice. Even so, it looks like little of the overhead cost is really explained even by machine-hours. Electrical cost has a large fixed component and much of the variation in the cost is unrelated to machine hours.

4.

	Machine Hours	*Electrical Costs*
Week 1	7,200	¥77,100
Week 2	8,200	¥84,400
Week 3	8,700	¥80,400
Week 4	7,200	¥75,500
Week 5	7,400	¥81,100
Week 6	8,800	¥83,300
Week 7	6,400	¥79,200
Week 8	7,700	¥85,500

Using statistical software or a spreadsheet application such as Excel to compute estimates of the intercept and the slope for the above data, the results are:

Intercept (fixed cost per week)	¥63,528
Slope (variable cost per machine-hour).......	¥2.24
R^2	0.28

Therefore the cost formula for electrical costs is ¥63,528 per week plus ¥2.24 per machine-hour, or

Y = ¥63,528 + ¥2.24 X,

where X is machine-hours.

Note that the R^2 is 0.28, which means that only 28% of the variation in electrical cost is explained by machine-hours. Other factors, discussed in part (6) below, are responsible for most of the variation in electrical costs from week to week.

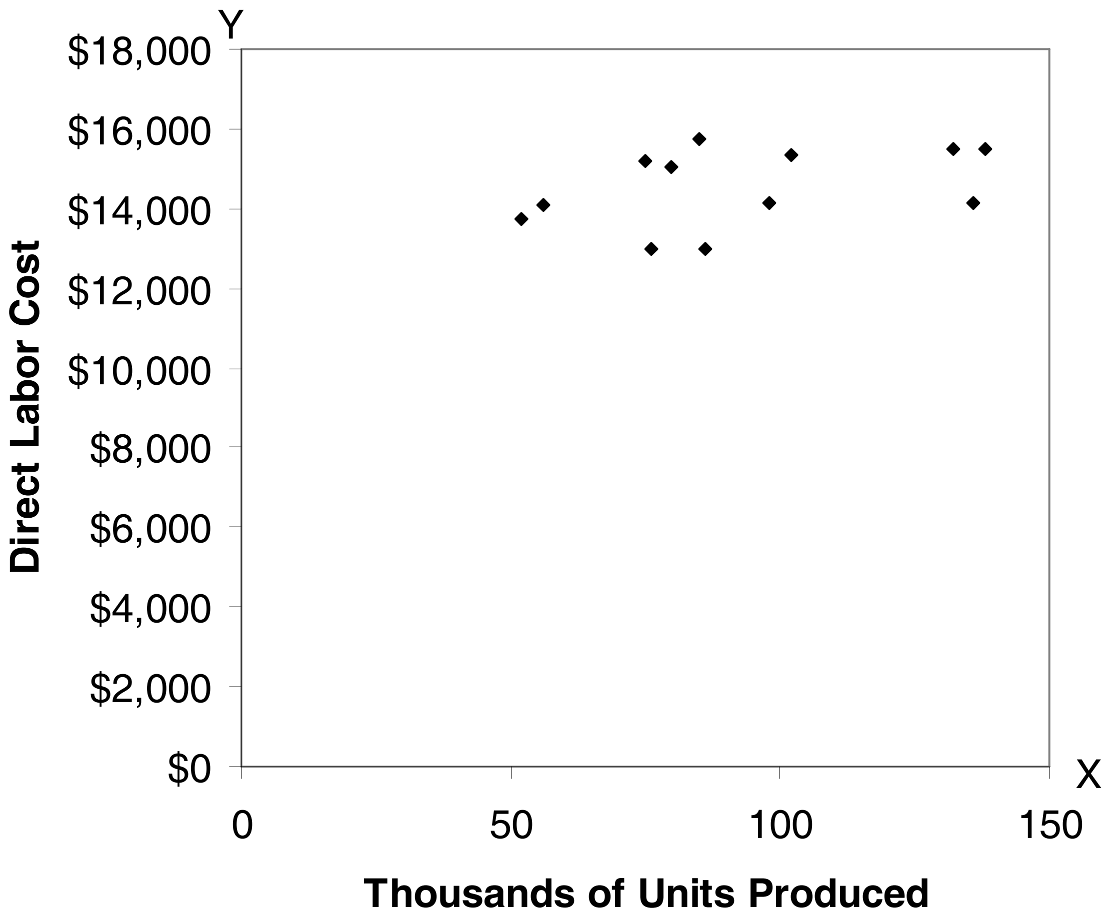
Case 5-25 (continued)

5. The shipyard job requires 270 machine-hours. At ¥2.24 per machine-hour, the electrical cost actually caused by the job would be only ¥604.80. This contrasts with the electrical cost of ¥3,171 under the old cost system and ¥2,835 under the new ABC system. Both the old cost system and the new ABC system grossly overstate the electrical costs of the job. This is because under both cost systems, the large fixed electrical costs of ¥63,528 per week are allocated to jobs along with the electrical costs that actually vary with the amount of work being done. In practice, almost all categories of overhead costs pose similar problems. As a consequence, the costs of individual jobs are likely to be seriously overstated for decision-making purposes under both traditional and ABC systems. Both systems provide acceptable cost data for external reporting, but both provide potentially misleading data for internal decision-making unless suitable adjustments are made.

6. Electricity is used for heating, cooling, and lighting the building as well as to run equipment. Therefore, consumption of electrical power is likely to be affected at least by the weather and by the time of the year as well as by how many hours the equipment is run. (Fewer daylight hours mean the lights have to be on longer.)

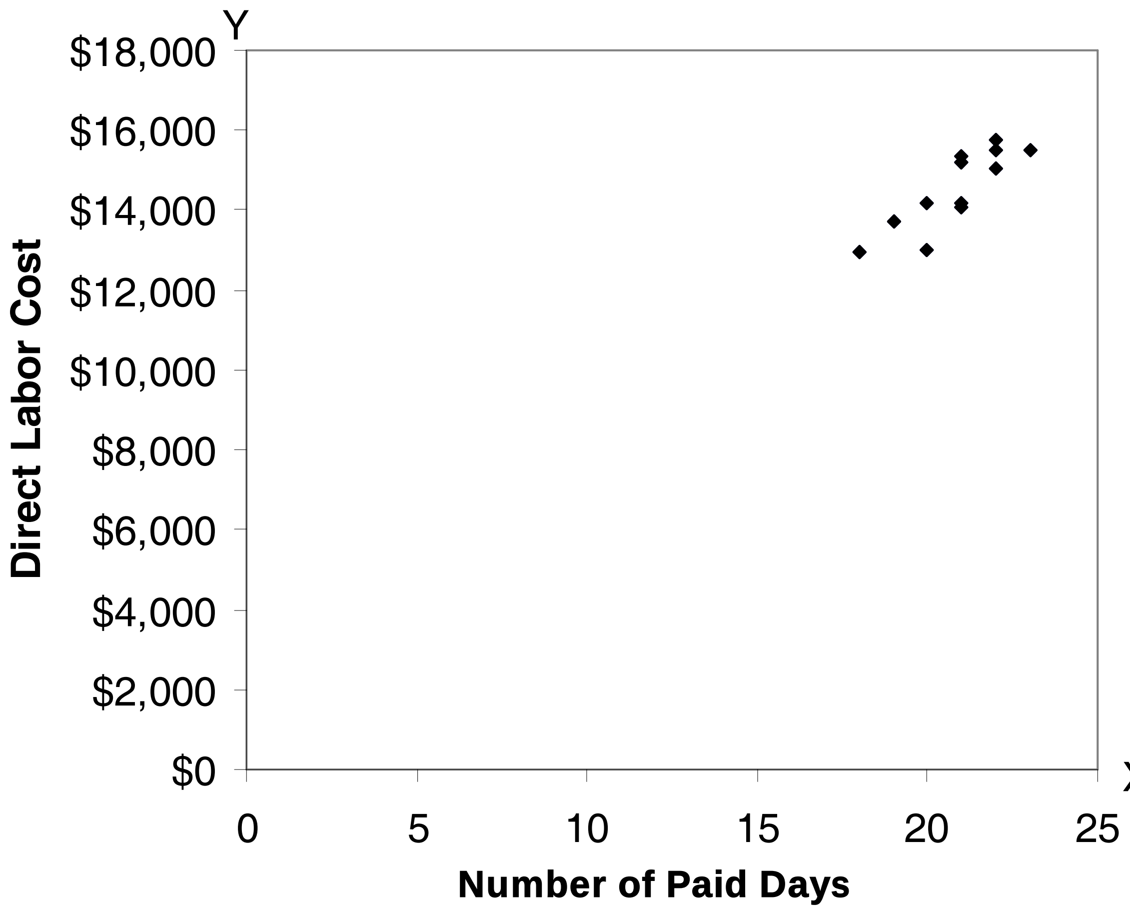
Case 5-26 (45 minutes)

1. The scattergraph of direct labor cost versus the number of units produced is presented below:



Case 5-26 (continued)

2. The scattergraph of the direct labor cost versus the number of paid days is presented below:



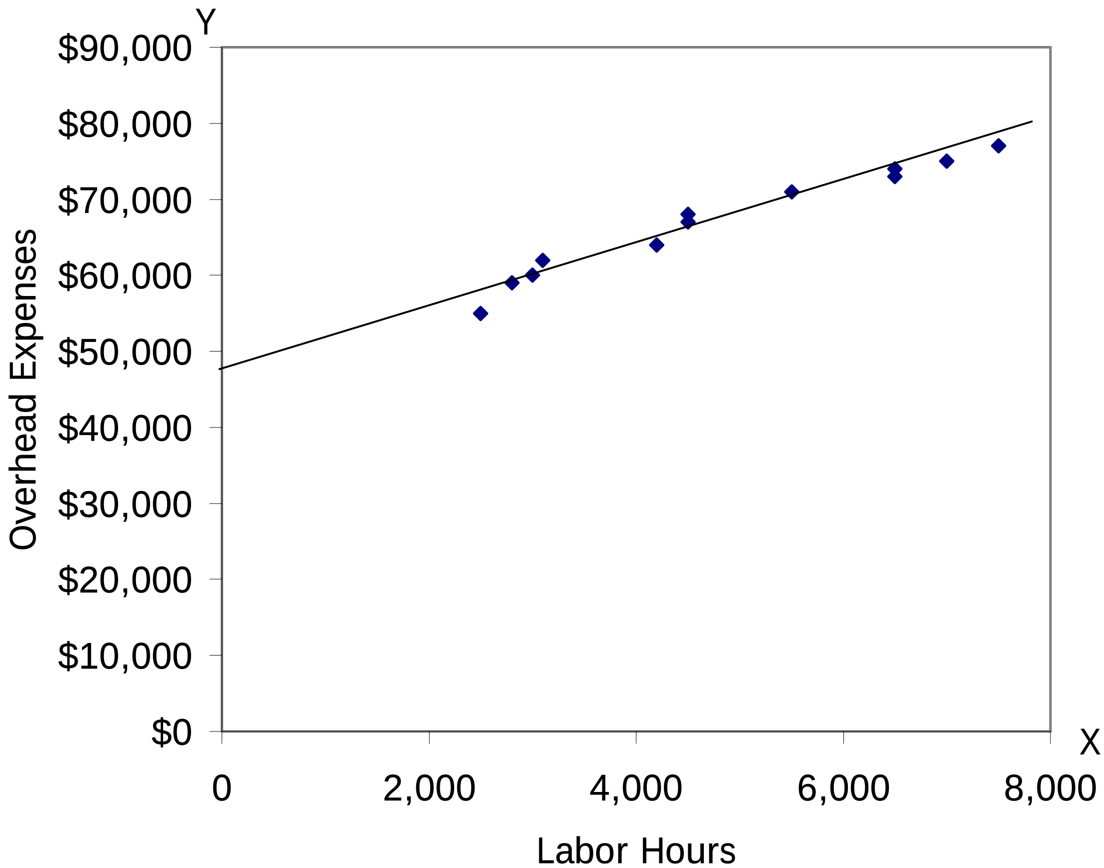
Case 5-26 (continued)

3. The number of paid days should be used as the activity base rather than the number of units produced. The scattergraphs reveal a much stronger relation (i.e., higher correlation) between direct labor costs and number of paid days than between direct labor costs and number of units produced. Variations in the direct labor costs apparently occur because of the number of paid days in the month and have little to do with the number of units that are produced. It appears that the direct labor costs are basically fixed with respect to how many units are produced in a month. This would happen if the direct labor workers are treated as full-time employees who are paid even if there is insufficient work to keep them busy. Moreover, for planning purposes, the company is likely to be able to predict the number of paid days in the month with much greater accuracy than the number of units that will be produced.

Case 5-27 (90 minutes)

Note to the instructor: This case requires the ability to build on concepts that are introduced only briefly in the text. To some degree, this case anticipates issues that will be covered in more depth in later chapters.

1. In order to estimate the contribution to profit of the charity event, it is first necessary to estimate the variable costs of catering the event. The costs of food and beverages and labor are all apparently variable with respect to the number of guests. However, the situation with respect overhead expenses is less clear. A good first step is to plot the labor hour and overhead expense data in a scattergraph as shown below.



Case 5-27 (continued)

This scattergraph reveals several interesting points about the behavior of overhead costs:

- The relation between overhead expense and labor hours is approximated reasonably well by a straight line. (However, there appears to be a slight downward bend in the plot as the labor hours increase. Such increasing returns to scale is a common occurrence. See Noreen & Soderstrom, "Are overhead costs strictly proportional to activity?" *Journal of Accounting and Economics*, vol. 17, 1994, pp. 255-278.)
- The data points are all fairly close to the straight line. This indicates that most of the variation in overhead expenses is explained by labor hours. As a consequence, there probably wouldn't be much benefit to investigating other possible cost drivers for the overhead expenses.
- Most of the overhead expense appears to be fixed. Maria should ask herself if this is reasonable. Are there in fact large fixed expenses such as rent, depreciation, and her own salary?

The overhead expenses could be decomposed into fixed and variable elements using the high-low method, least-squares regression method, or even the quick-and-dirty method based on the scattergraph.

- The high-low method throws away most of the data and bases the estimates of variable and fixed costs on data for only two months. For that reason, it is a decidedly inferior method in this situation. Nevertheless, if the high-low method were used, the estimates would be computed as follows:

	Labor Hours	*Overhead Expense*
High level of activity	7,500	$77,000
Low level of activity.........	2,500	55,000
Change	5,000	$22,000

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$22{,}000}{5{,}000\text{ labor hours}}$$

$$= \$4.40 \text{ per labor hour}$$

Case 5-27 (continued)

Fixed cost element	=	Total cost – Variable cost element
	=	\$77,000 – \$4.40 per labor-hour × 7,500 labor-hours
	=	\$44,000

- The quick-and-dirty method based on the scattergraph is probably better than the high-low method in this situation and should give acceptable estimates of the fixed and variable components of overhead expenses. The estimates should be fairly close (within the inherent imprecision of the method) to the estimates that would result from using least-squares regression.
- Using statistical software, the least-squares regression method yields estimates of \$3.95 per labor hour for the variable cost and \$48,126 per month for the fixed cost. The adjusted R^2 is 96%.

The total variable cost per guest is computed as follows:

Food and beverages	\$15.00
Labor (0.5 hour × \$10.00 per hour)	5.00
Overhead (0.5 hour × \$3.95 per hour)	1.98
Total variable cost per guest	\$21.98

And the total contribution from 180 guests paying \$31 each is computed as follows:

Revenue (180 guests × \$31.00 per guest)	\$5,580.00
Variable cost (180 guests × \$21.98 per guest)	3,956.40
Contribution to profit	\$1,623.60

Fixed costs are not included in the above computation because there is no indication that there would be any additional fixed costs incurred as a consequence of catering the cocktail party. If additional fixed costs were incurred, they should be subtracted from revenues as well to determine the profit of the party.

2. Assuming that no additional fixed costs are incurred as a result of catering the charity event, any price greater than the variable cost per guest of roughly \$22 would contribute to profits.

Case 5-27 (continued)

3. We would favor bidding slightly less than $30 to get the contract. Any bid above $22 would contribute to profits and a bid at the normal price of $31 is unlikely to land the contract. And apart from the contribution to profit, catering the event would show off the company's capabilities to potential clients. The danger is that a price lower than the normal bid of $31 might set a precedent for the future or it might embroil the company in a price war among caterers. However, the price need not be publicized and the lower price could be justified to future clients because this is a charity event. Another possibility would be for Maria to maintain her normal price but throw in additional services at no cost to the customer. Whether to compete based on price or service is a delicate issue that Maria will have to decide after getting to know the personality and preferences of her customers.

Case 5-28 (90 minutes)

1. High-low method:

	Hours	*Cost*
High level of activity	25,000	$99,000
Low level of activity	10,000	64,500
Change	15,000	$34,500

Variable element: $34,500 ÷ 15,000 DLH = $2.30 per DLH

Fixed element:

Total cost—25,000 DLH	$99,000
Less variable element:	
25,000 DLH × $2.30 per DLH............	57,500
Fixed element	$41,500

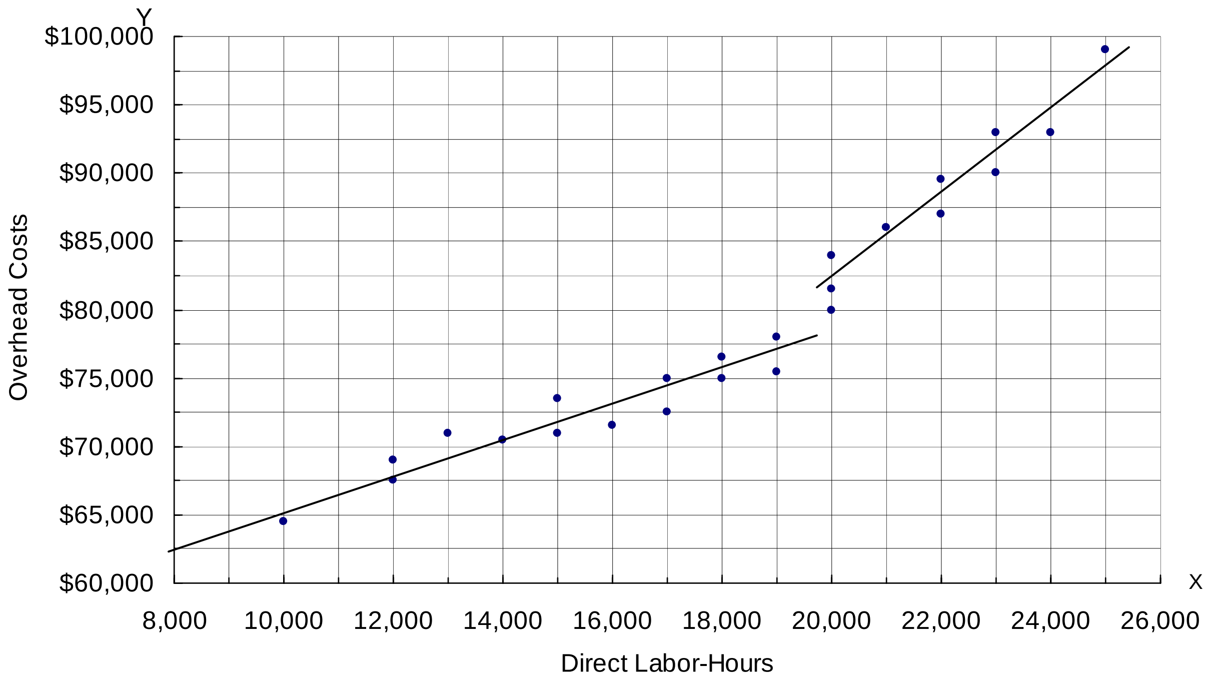
Therefore, the cost formula is: Y = $41,500 + $2.30X.

2. Using statistical software, the least-squares regression method yields estimates of $39,859 per month for the fixed cost and $2.15 per direct labor-hour for the variable cost. The R^2 is 0.91.

   Therefore, the cost formula is Y = $39,859 + $2.15X.

3. The scattergraph is shown below. The change in equipment lease cost from a fixed fee to an hourly rate causes the slope of the regression line to be steeper above 19,500 DLH, and to be discontinuous between the fixed fee and hourly rate points.

   There are in essence two relevant ranges—one below 19,500 DLH and one above 19,500 DLH. Within each relevant range, a single straight line provides a reasonable approximation to cost behavior.



Case 5-28 (continued)

4. a. High-low method:

Variable (22,500 DLH × $2.30 per DLH) .	$51,750
Fixed	41,500
Total cost	$93,250

b. Least-squares regression method:

Variable (22,500 DLH × $2.15 per DLH) ..	$48,375
Fixed	39,859
Total cost	$88,234

c. Scattergraph method:

Reading directly off the graph, total overhead cost at 22,500 DLH would be approximately $90,000.

5. This problem clearly illustrates the point that a scattergraph should be the starting point in all cost analysis work. In this case, it should be preferred over the other two methods as a cost estimating tool. The change in the basis for the lease payments above 19,500 direct labor-hours causes a discontinuity in the regression line. In fact, two lines rather than one provide the best fit. The cost formulas computed with the high-low and regression methods are faulty since they are based on the assumption that a single straight line provides the best fit to the data. The high-low method, of course, is always suspect since it relies on only two points (which in this case gives the regression line too steep of a slope). The least-squares regression method should be used in the Franklin plant only if two separate regression formulas are computed—one for the activity level over which a fixed fee on rented equipment is in effect, and one for the activity level over which hourly rates are in effect.

Group Exercise 5-29

Student answers will depend on who they contact. Perhaps surprisingly, many organizations make no attempt to formally distinguish between variable and fixed costs in their planning and in controlling operations.