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 some underlying activity, such as sales volume, production volume, or orders processed.

b. Relevant range: The relevant range is the range of activity within which assumptions relative to variable and fixed cost behavior are valid.

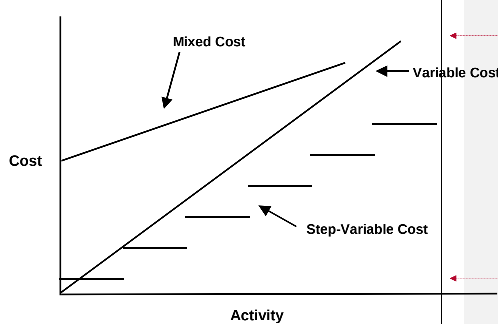
5-4 An activity base is a measure of whatever causes the incurrence of a variable cost. Examples of activity bases include units produced, units sold, letters typed, beds in a hospital, meals served in a cafe, service calls made, etc.

5-5 (See the exhibit below.)

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 the cost formula is used only within the relevant range.

5-7 A discretionary fixed cost is one that 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 is one that 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" to the decision for many years.

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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. In essence, fixed costs should be viewed as being adjustable upward and downward in broad steps, rather than being absolutely fixed at one level for all ranges of activity.

5-10 The major disadvantage of the high-low method is that it uses only two points to determine a cost formula and these two points are likely to be less than typical since they represent extremes of activity.

5-11 A regression line 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, then multiple regression analysis must be used to accurately analyze the behavior of the cost.

5-14 The contribution approach to the 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.

~~Chapter 5~~

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Exercise 5-1 (45 minutes)

1.

	Units Shipped	*Shipping Expense*
High activity level	8	$3,600
Low activity level	2	1,500
Change	6	$2,100

Variable cost element:

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$2,100}{6\text{ units}} = \$350\text{ per unit}$$

Fixed cost element:

Shipping expense at the high activity level	$3,600
Less variable cost element ($350 per unit × 8 units)	2,800
Total fixed cost	$ 800

The cost formula is $800 per month plus $350 per unit shipped or

Y = $800 + $350X,

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 and subjective nature of this method of estimating variable and fixed costs.)

Total cost at 5 units shipped per month [a point falling on the line in (a)]	$2,600
Less fixed cost element (intersection of the Y axis)	1,100
Variable cost element	$1,500

$1,500 ÷ 5 units = $300 per unit.

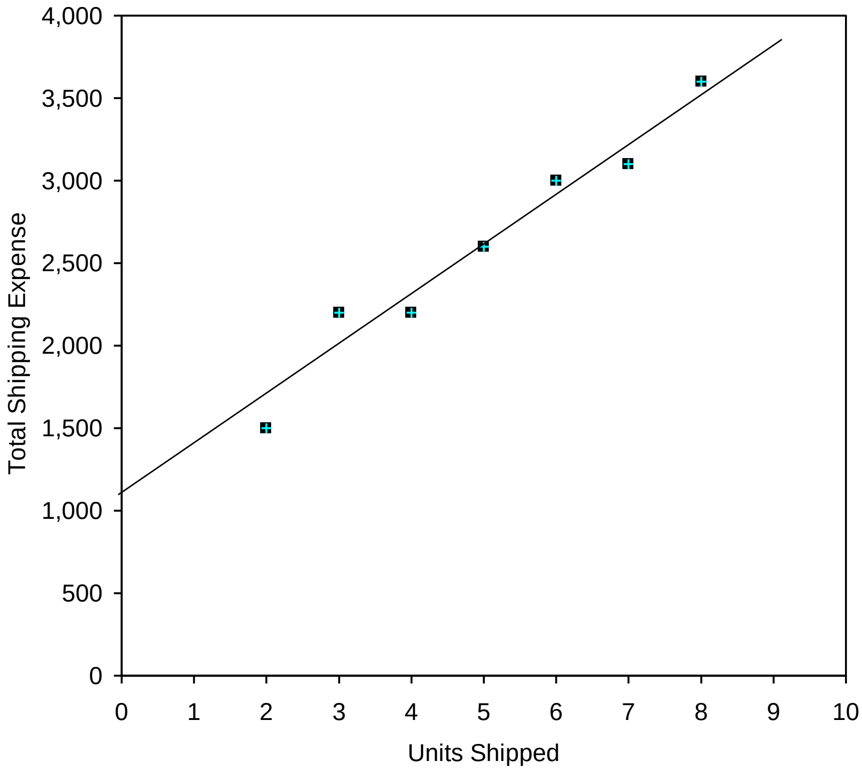
The cost formula is $1,100 per month plus $300 per unit shipped or

Y = $1,100 + 300X,

where X is the number of units shipped.

Exercise 5-1 (continued)

2. a. The scattergraph appears below:



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

Exercise 5-2 (30 minutes)

1.

Month	*Units Shipped (X)*	*Shipping Expense (Y)*
January	4	$2,200
February	7	3,100
March	5	2,600
April	2	1,500
May	3	2,200
June	6	3,000
July	8	3,600

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)	$1,011
Slope (variable cost per unit)	$318
R^2	0.96

Therefore, the cost formula is $1,011 per month plus $318 per unit shipped or

$$Y = \$1,011 + \$318X.$$

Note that the R^2 is 0.96, which means that 96% of the variation in shipping costs is explained by the number of units shipped. This is a very high R^2 and indicates a very good fit.

2.

	Variable Cost per Unit	*Fixed Cost per Month*
Quick-and-dirty scattergraph method	$300	$1,100
High-low method	350	800
Least-squares regression method	318	1,011

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

Exercise 5-3 (20 minutes)

1.

	X-rays Taken	*X-ray Costs*
High activity level (February)	7,000	$29,000
Low activity level (June)	3,000	17,000
Change	4,000	$12,000

Variable cost per X-ray:

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$12{,}000}{4{,}000\text{ X-rays}} = \$3.00\text{ per X-ray}$$

Fixed cost per month:

X-ray cost at the high activity level	$29,000
Less variable cost element:	
7,000 X-rays × $3.00 per X-ray	21,000
Total fixed cost	$ 8,000

The cost formula is $8,000 per month plus $3.00 per X-ray taken or, in terms of the equation for a straight line:

Y = $8,000 + $3.00X

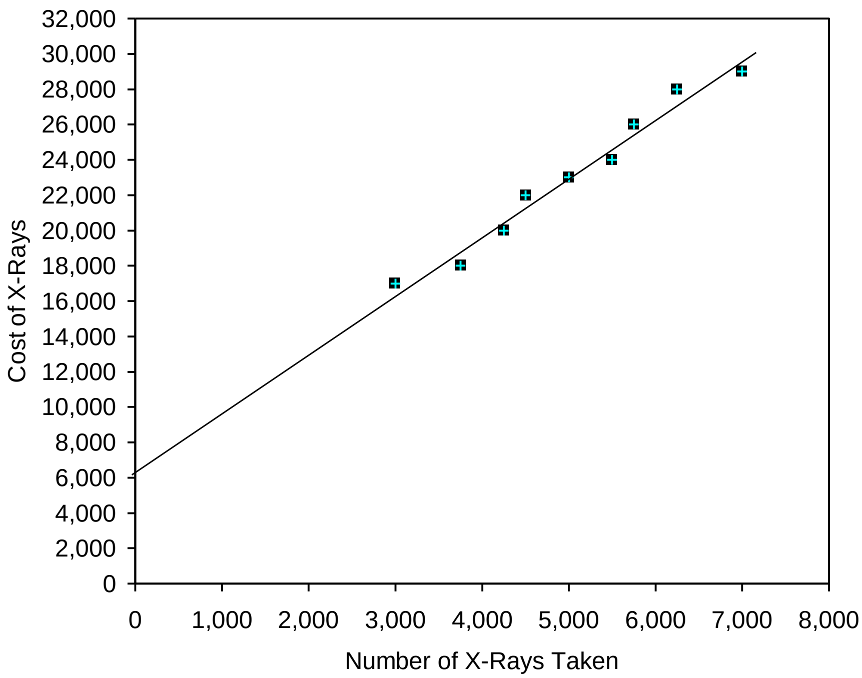
where X is the number of X-rays taken.

2. Expected X-ray costs when 4,600 X-rays are taken:

Variable cost: 4,600 X-rays × $3.00 per X-ray	$13,800
Fixed cost	8,000
Total cost	$21,800

Exercise 5-4 (30 minutes)

1. The scattergraph appears below.



Exercise 5-4 (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 5,000 X-rays per month [a point falling on the line in (1)]	$23,000
Less fixed cost element (intersection of the Y axis)	6,500
Variable cost element	$16,500

$$\$16,500 \div 5,000 \text{ X-rays} = \$3.30 \text{ per X-ray.}$$

The cost formula is therefore $6,500 per month plus $3.30 per X-ray taken. Written in equation form, the cost formula is:

$$Y = \$6,500 + \$3.30X,$$

where X is the number of X-rays taken.

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. Consequently, the high-low method would overestimate the fixed cost and underestimate the variable cost per unit.

Exercise 5-5 (20 minutes)

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

$$\frac{\$150{,}000}{60{,}000 \text{ units}} = \$2.50 \text{ per unit.}$$

Taking into account the difference in behavior between variable and fixed costs, the completed schedule would be:

	Units produced and sold		
	60,000	80,000	100,000
Total costs:			
Variable costs	$150,000 *	$200,000	$250,000
Fixed costs	360,000 *	360,000	360,000
Total costs	$510,000 *	$560,000	$610,000
Cost per unit:			
Variable cost	$2.50	$2.50	$2.50
Fixed cost	6.00	4.50	3.60
Total cost per unit	$8.50	$7.00	$6.10

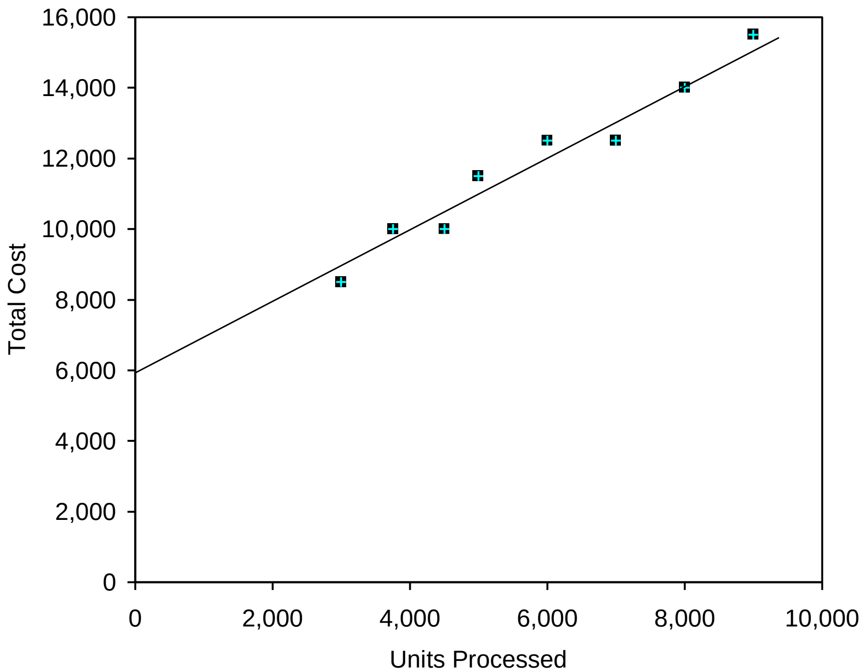
*Given.

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

Sales (90,000 units × $7.50 per unit)	$675,000
Less variable expenses (90,000 units × $2.50 per unit)	225,000
Contribution margin	450,000
Less fixed expenses	360,000
Net operating income	$ 90,000

Exercise 5-6 (30 minutes)

1. The completed scattergraph is presented below:



Exercise 5-6 (continued)

2. (Students' answers will vary considerably due to the inherent imprecision and subjectivity of the quick-and-dirty scattergraph method of estimating variable and fixed costs.)

   The approximate monthly fixed cost is $6,000—the point where the straight line intersects the cost axis.

   The variable cost per unit processed can be estimated as follows using the 8,000-unit level of activity, which falls on the straight line:

Total cost at the 8,000-unit level of activity	$14,000
Less fixed costs	6,000
Variable costs at the 8,000-unit level of activity	$ 8,000

   $8,000 ÷ 8,000 units = $1 per unit.

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

Exercise 5-7 (30 minutes)

1. Monthly operating costs at 70% occupancy:

2,000 rooms × 70% = 1,400 rooms;	
1,400 rooms × $21 per room per day × 30 days	$882,000
Monthly operating costs at 45% occupancy (given)...	792,000
Change in cost	$ 90,000

Difference in rooms occupied:	
70% occupancy (2,000 rooms × 70%)..................	1,400
45% occupancy (2,000 rooms × 45%)..................	900
Difference in rooms (change in activity)	500

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$90{,}000}{500\text{ rooms}} = \$180 \text{ per room.}$$

$180 per room ÷ 30 days = $6 per room per day.

2.

Monthly operating costs at 70% occupancy (above)....	$882,000
Less variable costs:	
1,400 rooms × $6 per room per day × 30 days........	252,000
Fixed operating costs per month	$630,000

3. 2,000 rooms × 60% = 1,200 rooms occupied.

Fixed costs...	$630,000
Variable costs:	
1,200 rooms × $6 per room per day × 30 days........	216,000
Total expected costs..	$846,000

Exercise 5-8 (20 minutes)

1.

	Miles Driven	*Total Annual Cost**
High level of activity	120,000	$13,920
Low level of activity	80,000	10,880
Change	40,000	$ 3,040

* 120,000 miles × $0.116 per mile = $13,920
80,000 miles × $0.136 per mile = $10,880

Variable cost per mile:

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$3,040}{40,000 \text{ miles}} = \$0.076 \text{ per mile}$$

Fixed cost per year:

Total cost at 120,000 miles	$13,920
Less variable cost element:	
120,000 miles × $0.076 per mile	9,120
Fixed cost per year	$ 4,800

2. Y = $4,800 + $0.076X

3.

Fixed cost	$ 4,800
Variable cost: 100,000 miles × $0.076 per mile	7,600
Total annual cost	$12,400

Exercise 5-9 (20 minutes)

1. THE HAAKI SHOP, INC.
Income Statement—Surfboard Department
For the Quarter Ended May 31

Sales		$800,000
Less variable expenses:		
Cost of goods sold ($150 per surfboard × 2,000 surfboards*)	$300,000	
Selling expenses ($50 per surfboard × 2,000 surfboards)	100,000	
Administrative expenses (25% × $160,000)	40,000	440,000
Contribution margin		360,000
Less fixed expenses:		
Selling expenses	150,000	
Administrative expenses	120,000	270,000
Net operating income		$ 90,000

*$800,000 sales ÷ $400 per surfboard = 2,000 surfboards.

2. Since 2,000 surfboards were sold and the contribution margin totaled $360,000 for the quarter, the contribution of each surfboard toward fixed expenses and profits was $180 ($360,000 ÷ 2,000 surfboards = $180 per surfboard). Another way to compute the $180 is:

Selling price per surfboard		$400
Less variable expenses:		
Cost per surfboard	$150	
Selling expenses	50	
Administrative expenses ($40,000 ÷ 2,000 surfboards)	20	220
Contribution margin per surfboard		$180

Exercise 5-10 (30 minutes)

1.

Units (X)	*Total Glazing Cost (Y)*
8	$270
5	200
10	310
4	190
6	240
9	290

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)	$107.50
Slope (variable cost per unit)	$20.36
R^2	0.98

Therefore, the cost formula is $107.50 per week plus $20.36 per unit.

Note that the R^2 is 0.98, which means that 98% of the variation in glazing costs is explained by the number of units glazed. This is a very high R^2 and indicates a very good fit.

2. Y = $107.50 + $20.36X, where X is the number of units glazed.

3. Total expected glazing cost if 7 units are processed:

Variable cost: 7 units × $20.36 per unit	$142.52
Fixed cost	107.50
Total expected cost	$250.02

Problem 5-11 (45 minutes)

1.

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

2. Analysis of the mixed expenses:

	Units	*Shipping Expense*	*Salaries and Comm. Expense*
High level of activity	4,500	£56,000	£143,000
Low level of activity	3,000	44,000	107,000
Change	1,500	£12,000	£ 36,000

Variable cost element:

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

$$\text{Shipping expense: } \frac{£12{,}000}{1{,}500 \text{ units}} = £8 \text{ per unit}$$

$$\text{Salaries and comm. expense: } \frac{£36{,}000}{1{,}500 \text{ units}} = £24 \text{ per unit}$$

Fixed cost element:

	Shipping Expense	*Salaries and Comm. Expense*
Cost at high level of activity	£56,000	£143,000
Less variable cost element:		
4,500 units × £8 per unit	36,000	
4,500 units × £24 per unit		108,000
Fixed cost element	£20,000	£ 35,000

Problem 5-11 (continued)

The cost formulas are:

Shipping expense: £20,000 per month plus £8 per unit or
$$Y = £20,000 + £8X.$$

Salaries and Comm. expense: £35,000 per month plus £24 per unit or
$$Y = £35,000 + £24X.$$

3. FRANKEL LTD.
Income Statement
For the Month Ended June 30

Sales revenue		£630,000
Less variable expenses:		
Cost of goods sold		
(4,500 units × £56 per unit)	£252,000	
Shipping expense		
(4,500 units × £8 per unit)	36,000	
Salaries and commissions expense		
(4,500 units × £24 per unit)	108,000	396,000
Contribution margin		234,000
Less fixed expenses:		
Shipping expense	20,000	
Advertising	70,000	
Salaries and commissions	35,000	
Insurance	9,000	
Depreciation	42,000	176,000
Net operating income		£ 58,000

Problem 5-12 (45 minutes)

1.

HOUSE OF ORGANS, INC.
Income Statement
For the Month Ended November 30

Sales (60 organs × $2,500 per organ)		$150,000
Less cost of goods sold		
(60 organs × $1,500 per organ)		90,000
Gross margin		60,000
Less operating expenses:		
Selling expenses:		
Advertising	$ 950	
Delivery of organs		
(60 organs × $60 per organ)	3,600	
Sales salaries and commissions		
[$4,800 + (4% × $150,000)]	10,800	
Utilities	650	
Depreciation of sales facilities	5,000	
Total selling expenses	21,000	
Administrative expenses:		
Executive salaries	13,500	
Depreciation of office equipment	900	
Clerical		
[$2,500 + (60 organs × $40 per organ)]	4,900	
Insurance	700	
Total administrative expenses	20,000	
Total operating expenses		41,000
Net operating income		$ 19,000

Problem 5-12 (continued)

2.

HOUSE OF ORGANS, INC.
Income Statement
For the Month Ended November 30

	Total	*Per Unit*
Sales (60 organs × $2,500 per organ)	$150,000	$2,500
Less variable expenses:		
Cost of goods sold		
(60 organs × $1,500 per organ)	90,000	1,500
Delivery of organs		
(60 organs × $60 per organ)	3,600	60
Sales commissions (4% × $150,000)	6,000	100
Clerical (60 organs × $40 per organ)	2,400	40
Total variable expenses	102,000	1,700
Contribution margin	48,000	$ 800
Less fixed expenses:		
Advertising	950	
Sales salaries	4,800	
Utilities	650	
Depreciation of sales facilities	5,000	
Executive salaries	13,500	
Depreciation of office equipment	900	
Clerical	2,500	
Insurance	700	
Total fixed expenses	29,000	
Net operating income	$ 19,000	

3. Fixed costs remain constant in total but vary on a per unit basis with changes in the activity level. For example, as the activity level increases, fixed costs decrease on a per unit basis. Showing fixed costs on a per unit basis on the income statement make them appear to be 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 should be shown only in totals on a contribution-type income statement.

Problem 5-13 (45 minutes)

1.

Number of Leagues (X)	*Total Cost (Y)*
5	$13,000
2	7,000
4	10,500
6	14,000
3	10,000

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)	$4,100
Slope (variable cost per unit)	$1,700
R^2	0.96

Therefore, the variable cost per league is $1,700 and the fixed cost is $4,100 per year.

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

2. Y = $4,100 + $1,700X

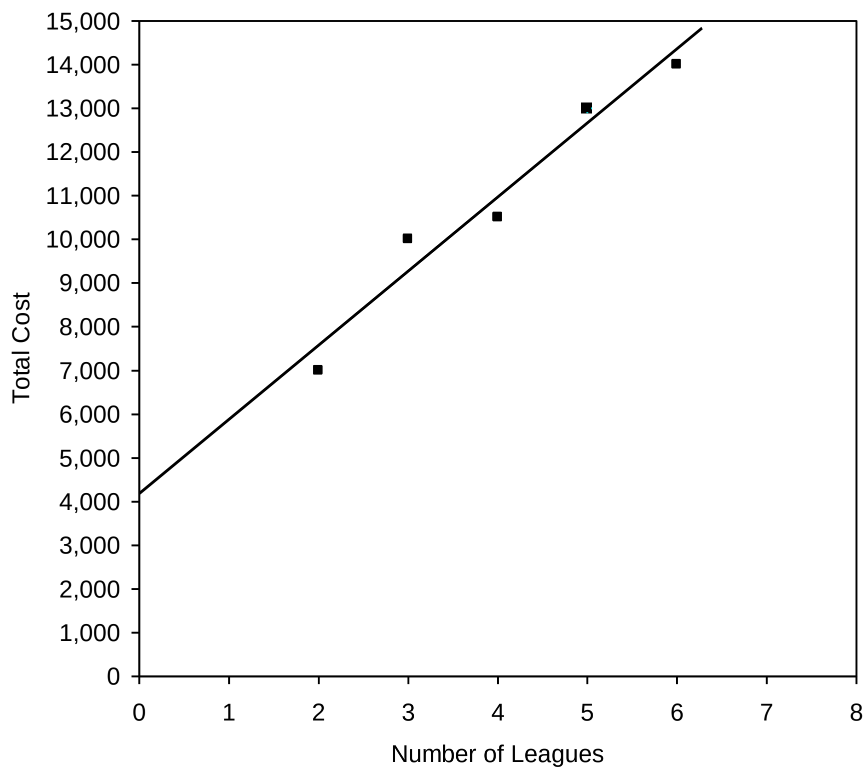
3. The expected total cost for 7 leagues would be:

Fixed cost	$ 4,100
Variable cost (7 leagues × $1,700 per league)	11,900
Total cost	$16,000

The problem with using the cost formula from (2) to estimate total cost in this particular case is that an activity level of 7 leagues may be outside the relevant range—the range of activity within which the fixed cost is approximately $4,100 per year and the variable cost is approximately $1,700 per league. These approximations appear to be reasonably accurate within the range of 2 to 6 leagues, but they may be invalid outside this range.

Problem 5-13 (continued)

4.



Problem 5-14 (30 minutes)

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

2. Without a knowledge of 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 5-15 (45 minutes)

1. Maintenance cost at the 70,000 machine-hour level of activity can be isolated as follows:

	Level of Activity	
	40,000 MH	*70,000 MH*
Total factory overhead cost	$170,200	$241,600
Deduct:		
Utilities cost @ $1.30 per MH*	52,000	91,000
Supervisory salaries	60,000	60,000
Maintenance cost	$ 58,200	$ 90,600

*$52,000 ÷ 40,000 MHs = $1.30 per MH

2. High-low analysis of maintenance cost:

	Maintenance Cost	*Machine-Hours*
High activity level	$90,600	70,000
Low activity level	58,200	40,000
Change	$32,400	30,000

Variable cost per unit of activity:

$$\frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$32{,}400}{30{,}000\text{ MHs}} = \$1.08\text{ per MH}$$

Total fixed cost:

Total maintenance cost at the low activity level	$58,200
Less the variable cost element	
(40,000 MHs × $1.08 per MH)	43,200
Fixed cost element	$15,000

Therefore, the cost formula is $15,000 per month plus $1.08 per machine-hour or Y = $15,000 + $1.08X, where X represents machine-hours.

Problem 5-15 (continued)

3.

	Variable Rate per Machine-Hour	*Fixed Cost*
Maintenance cost.................	$1.08	$15,000
Utilities cost	1.30	
Supervisory salaries cost	____	60,000
Totals	$2.38	$75,000

Therefore, the cost formula would be $75,000 plus $2.38 per machine-hour, or Y = $75,000 + $2.38X.

4.

Fixed costs..	$ 75,000
Variable costs: $2.38 per MH × 45,000 MHs...........	107,100
Total overhead costs	$182,100

Problem 5-16 (30 minutes)

1. Maintenance cost at the 80,000 machine-hour level of activity can be isolated as follows:

	Level of Activity	
	60,000 MH	*80,000 MH*
Total factory overhead cost...	274,000 pesos	312,000 pesos
Deduct:		
Indirect materials @ 1.50 pesos per MH*	90,000	120,000
Rent................................	130,000	130,000
Maintenance cost................	54,000 pesos	62,000 pesos

* 90,000 pesos ÷ 60,000 MHs = 1.50 pesos per MH

2. High-low analysis of maintenance cost:

	Maintenance Cost	*Machine-Hours*
High activity level..............	62,000 pesos	80,000
Low activity level	54,000	60,000
Change observed..............	8,000 pesos	20,000

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

$$= \frac{8{,}000 \text{ pesos}}{20{,}000 \text{ MHs}} = 0.40 \text{ peso per MH}$$

Fixed cost element = Total cost - Variable cost element

= 54,000 pesos - (60,000 MHs × 0.40 pesos)

=30,000 pesos

Therefore, the cost formula is 30,000 pesos per year, plus 0.40 peso per machine-hour or

Y = 30,000 pesos + 0.40 peso X.

Problem 5-16 (continued)

3. Indirect materials (65,000 MHs × 1.50 pesos per MH)

Indirect materials (65,000 MHs × 1.50 pesos per MH)		97,500 pesos
Rent		130,000
Maintenance:		
Variable cost element (65,000 MHs × 0.40 peso per MH)	26,000 pesos	
Fixed cost element	30,000	56,000
Total factory overhead cost		283,500 pesos

Problem 5-17 (45 minutes)

1.

	July—Low 9,000 Units	*October—High 12,000 Units*
Direct materials cost @ $15 per unit..	$135,000	$180,000
Direct labor cost @ $6 per unit	54,000	72,000
Manufacturing overhead cost	107,000 *	131,000 *
Total manufacturing costs.................	296,000	383,000
Add: Work in process, beginning	14,000	22,000
	310,000	405,000
Deduct: Work in process, ending.......	25,000	15,000
Cost of goods manufactured	$285,000	$390,000

*Computed by working upwards through the statements.

2.

	Units Produced	*Cost Observed*
October—High level of activity	12,000	$131,000
July—Low level of activity	9,000	107,000
Change..	3,000	$ 24,000

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

$$= \frac{\$24{,}000}{3{,}000 \text{ units}} = \$8 \text{ per unit}$$

Total cost at the high level of activity.....................	$131,000
Less variable cost element ($8 per unit × 12,000 units)	96,000
Fixed cost element	$ 35,000

Therefore, the cost formula is: $35,000 per month plus $8 per unit produced, or Y = $35,000 + $8X, where X represents the number of units produced.

Problem 5-17 (continued)

3. The cost of goods manufactured if 9,500 units are produced:

Direct materials cost (9,500 units × $15 per unit) ..		$142,500
Direct labor cost (9,500 units × $6 per unit)..........		57,000
Manufacturing overhead cost:		
Fixed portion	$35,000	
Variable portion (9,500 units × $8 per unit)	76,000	111,000
Total manufacturing costs		310,500
Add: Work in process, beginning		16,000
		326,500
Deduct: Work in process, ending		19,000
Cost of goods manufactured		$307,500

Problem 5-18 (45 minutes)

1. High-low method:

	Number of Ingots	*Power Cost*
High activity level	130	$6,000
Low activity level	40	2,400
Change	90	$3,600

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

$$= \frac{\$3,600}{90 \text{ ingots}} = \$40 \text{ per ingot}$$

Fixed cost:	Total power cost at high activity level	$6,000
	Less variable element:	
	130 ingots × $40 per ingot	5,200
	Fixed cost element	$ 800

Therefore, the cost formula is: Y = $800 + $40X.

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

(Note: Students' answers will vary due to the inherent imprecision and subjectivity of the quick-and-dirty scattergraph method of estimating fixed and variable costs.)

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

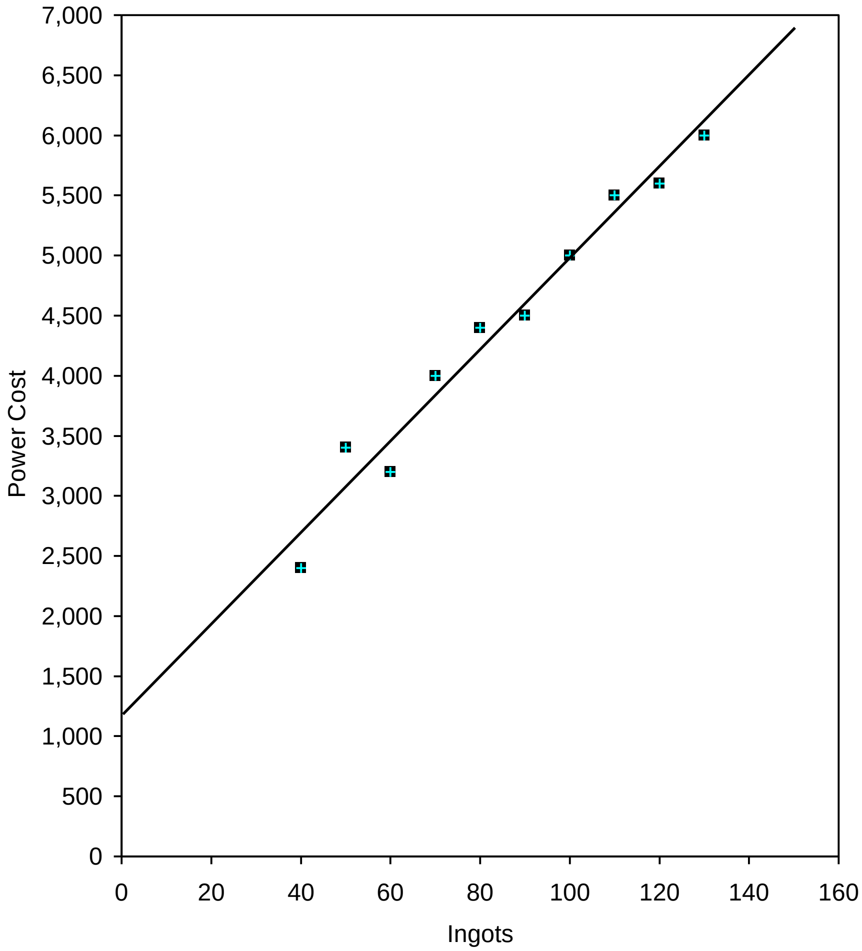
Total cost at 100 ingots (a point that falls on the line)	$5,000
Less the fixed cost element (intersection of the Y axis on the graph)	1,200
Variable cost element at 100 ingots (total)	$3,800

$3,800 ÷ 100 ingots = $38 per ingot.

Therefore, the cost formula is: Y = $1,200 + $38X.

Problem 5-18 (continued)

The completed scattergraph follows:



Problem 5-19 (30 minutes)

1. The least squares regression method:

Number of Ingots (X)	*Power Cost (Y)*
110	$5,500
90	4,500
80	4,400
100	5,000
130	6,000
120	5,600
70	4,000
60	3,200
50	3,400
40	2,400

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)	$1,185
Slope (variable cost per unit)	$37.82
R^2	0.97

Therefore, the variable cost of power per ingot is $37.82 and the fixed cost of power is $1,185 per month and the cost formula is:

$$Y = \$1,185 + \$37.82X.$$

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

Problem 5-19 (continued)

2.

Method	*Total Fixed Cost*	*Variable Cost per Ingot*
High-low	$ 800	$40.00
Quick-and-dirty scattergraph	1,200	38.00
Least squares	1,185	37.82

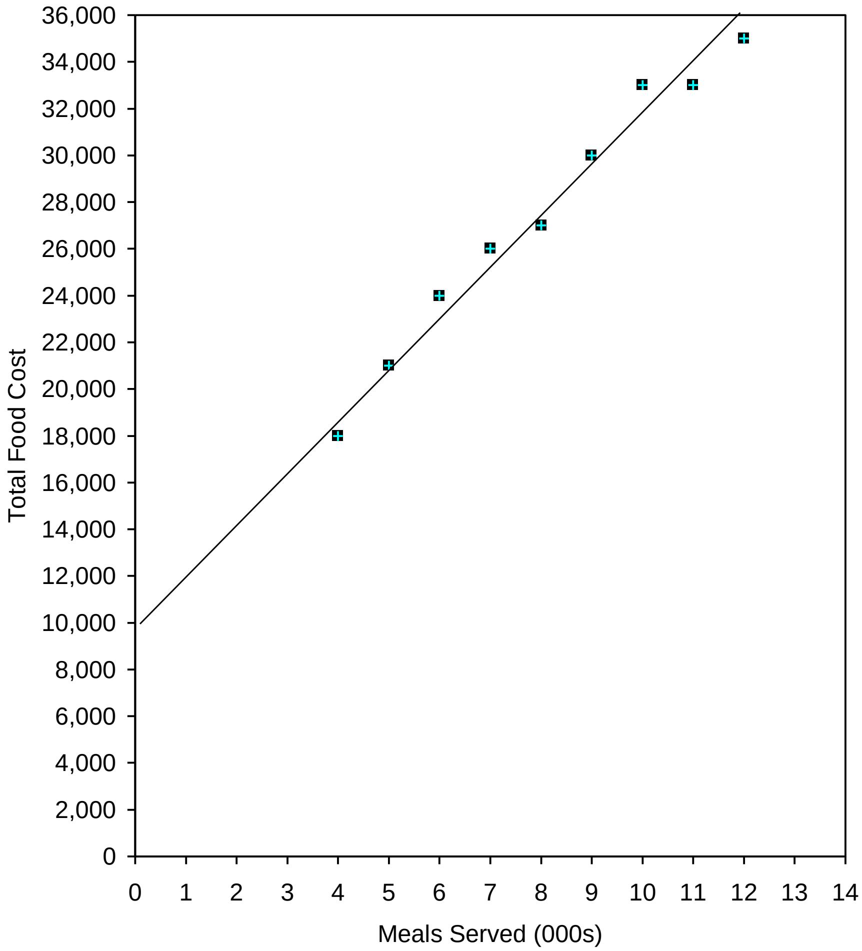
The high-low method is accurate only in those situations where the variable cost is truly constant, or where the high and the low points *happen* to fall on the correct regression line. Due to the high degree of potential inaccuracy, this method is less useful than the least-squares regression method.

The quick-and-dirty scattergraph method is imprecise and the results will depend on where the analyst chooses to place the line. However, the scattergraph plot can provide invaluable clues about nonlinearities and other problems with the data.

The least squares regression method is generally considered to be the most accurate method of cost analysis. However, it should always be used in conjunction with a scattergraph plot to ensure that the underlying relation really is linear.

Problem 5-20 (30 minutes)

1. The scattergraph is presented below.



Problem 5-20 (continued)

2. Yes, the president is correct. It is evident from the scattergraph and fitted straight line that the total food cost contains both fixed and variable elements. The positive vertical intercept suggests a rather large fixed cost and the positive slope of the straight line is consistent with a variable cost for the meals served.

   (Note: Students' estimates of the fixed and variable costs will vary due to the inherent imprecision and subjectivity of the quick-and-dirty scattergraph method for estimating variable and fixed costs.)

   The fixed cost element can be estimated by noting the point where the line intersects the vertical axis. The variable cost element can be estimated using the point through which the straight line has been drawn, which represents a food cost of $21,000 for 5,000 meals served:

Total cost at 5,000 meals served per month............	$21,000
Less fixed cost element	10,000
Variable cost for 5,000 meals	$11,000

   The average variable cost per unit is estimated as follows:

   $$\$11,000 \div 5,000 \text{ meals} = \$2.20 \text{ per meal.}$$

   Therefore, the cost formula is approximately $10,000 fixed cost per month plus $2.20 per meal served, or in equation form:

   $$Y = \$10,000 + \$2.20X,$$

   where X is the number of meals served.

Problem 5-21 (30 minutes)

1. Least squares regression analysis:

Meals Served (000s) (X)	*Total Cost (Y)*
4	$18,000
5	21,000
6	24,000
10	33,000
12	35,000
11	33,000
9	30,000
8	27,000
7	26,000

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)	$10,644
Slope (variable cost per unit)	$2,100
R^2	0.98

Therefore, the variable cost of food per thousand meals is $2,100 and the fixed cost of food is $10,644 per month.

Note that the R^2 is 0.98, which means that 98% of the variation in food cost is explained by the number of meals served. This is a very high R^2 and indicates a very good fit.

2. The cost formula for food is: Y = $10,644 + $2.10X, where X = meals served.

Problem 5-22 (45 minutes)

1.

Units Sold (000s) (X)	*Shipping Expense (Y)*
16	$160,000
18	175,000
23	210,000
19	180,000
17	170,000
20	190,000
25	230,000
22	205,000

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)	$40,000
Slope (variable cost per unit)	$7,500
R^2	0.99

Therefore the cost formula for shipping expense is $40,000 per quarter plus $7,500 per thousand units sold ($7.50 per unit), or

Y = $40,000 + $7.50X,

where X is the number of units sold.

Note that the R^2 is 0.99, which means that 99% of the variation in food cost is explained by the number of meals served. This is a very high R^2 and indicates a very good fit.

Problem 5-22 (continued)

2.

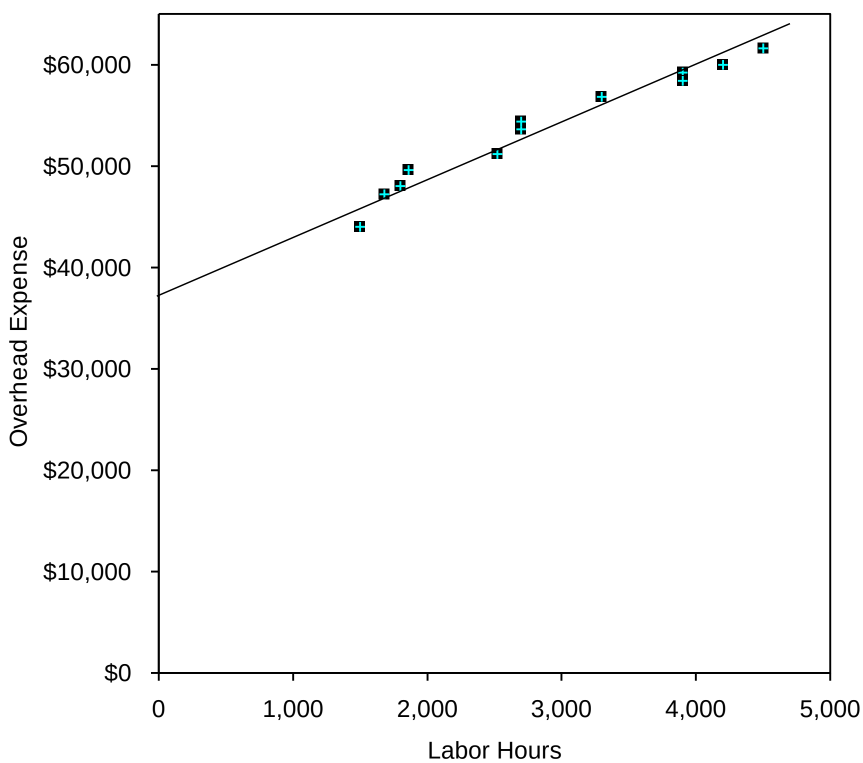
ALDEN COMPANY
Budgeted Income Statement
For the First Quarter of Year 3

Sales (21,000 units × $50 per unit)		$1,050,000
Less variable expenses:		
Cost of goods sold		
(21,000 units × $20 per unit)	$420,000	
Shipping expense		
(21,000 units × $7.50 per unit)	157,500	
Sales commission ($1,050,000 × 0.05)	52,500	
Total variable expenses		630,000
Contribution margin		420,000
Less fixed expenses:		
Shipping expenses	40,000	
Advertising expense	170,000	
Administrative salaries	80,000	
Depreciation expense	50,000	
Total fixed expenses		340,000
Net operating income		$ 80,000

CASE 5-23 (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 5-23 (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—evidence of increasing returns to scale. This is a common occurrence in practice. 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. Jasmine should ask herself if this is reasonable. Does the company have large fixed expenses such as rent, depreciation, and salaries?

The overhead expenses can 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	4,500	$61,600
Low level of activity	1,500	44,000
Change	3,000	$17,600

CASE 5-23 (continued)

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

$$= \frac{\$17{,}600}{3{,}000 \text{ labor hours}} = \$5.87 \text{ per labor hour}$$

Fixed cost element = Total cost - Variable cost element

= $61,600 - ($5.87 × 4,500)

= $35,185

- In contrast, the least-squares regression method yields estimates of $5.27 per labor hour for the variable cost and $38,501 per month for the fixed cost using statistical software. (The adjusted R^2 is 96%.) To obtain these estimates, use a statistical software package or a spreadsheet application such as Excel.

Using the least-squares regression estimates of the variable overhead cost, the total variable cost per guest is computed as follows:

Food and beverages	$17.00
Labor (0.5 hour @ $10 per hour)	5.00
Overhead (0.5 hour @ $5.27 per hour)....	2.64
Total variable cost per guest..................	$24.64

The total contribution from 120 guests paying $45 each is computed as follows:

Revenue (120 guests @ $45.00 per guest)	$5,400.00
Variable cost (120 guests @ $24.64 per guest)......	2,956.80
Contribution to profit	$2,443.20

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

CASE 5-23 (continued)

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 $24.64 would contribute to profits.

3. We would favor bidding slightly less than $42 to get the contract. Any bid above $24.64 would contribute to profits and a bid at the normal price of $45 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 that is lower than the normal bid of $45 might set a precedent for the future or it might initiate 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 Jasmine to maintain her normal price but throw in additional services at no cost to the customer. Whether to compete on price or service is a delicate issue that Jasmine will have to decide after getting to know the personality and preferences of the customer.

CASE 5-24 (90 minutes)

1. Direct labor-hour allocation base:

Electrical costs (a)	SFr 3,865,800	
Direct labor-hours (b)	427,500	DLHs
Predetermined overhead rate (a) ÷ (b)	SFr 9.04	per DLH

Machine-hour allocation base:

Electrical costs (a)	SFr 3,865,800	
Machine-hours (b)	365,400	MHs
Predetermined overhead rate (a) ÷ (b)	SFr 10.58	per MH

2. Electrical cost for the custom tool job using direct labor-hours:

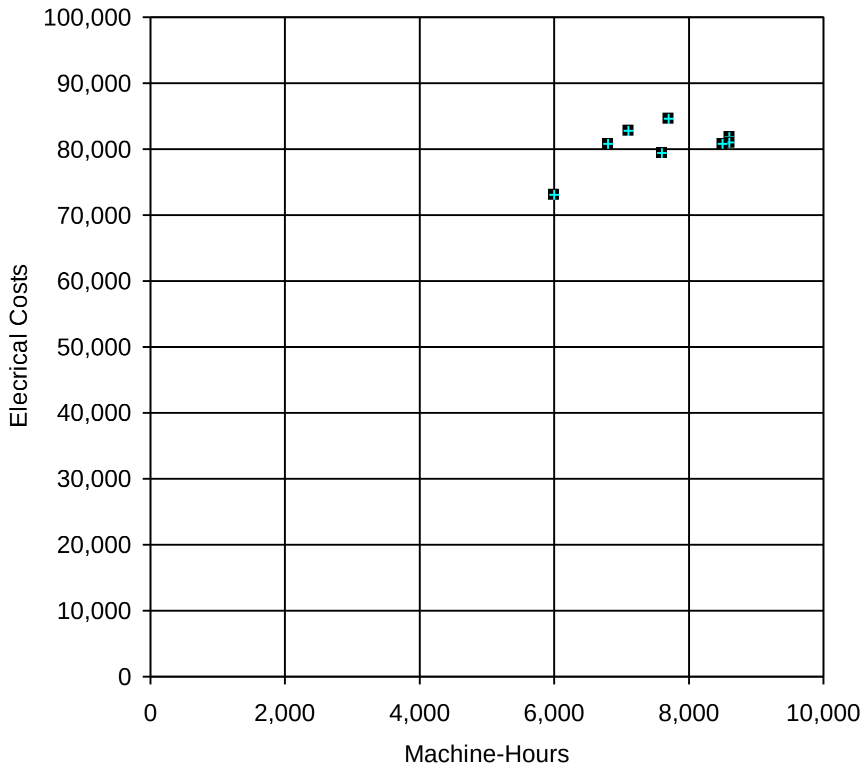
Predetermined overhead rate (a)	SFr 9.04	per DLH
Direct labor-hours for the job (b)	30	DLHs
Electrical cost applied to the job (a) × (b)	SFr 271.20	

Electrical cost for the custom tool job using machine-hours:

Predetermined overhead rate (a)	SFr 10.58	per MH
Machine-hours for the job (b)	25	MHs
Electrical cost applied to the job (a) × (b)	SFr 264.50	

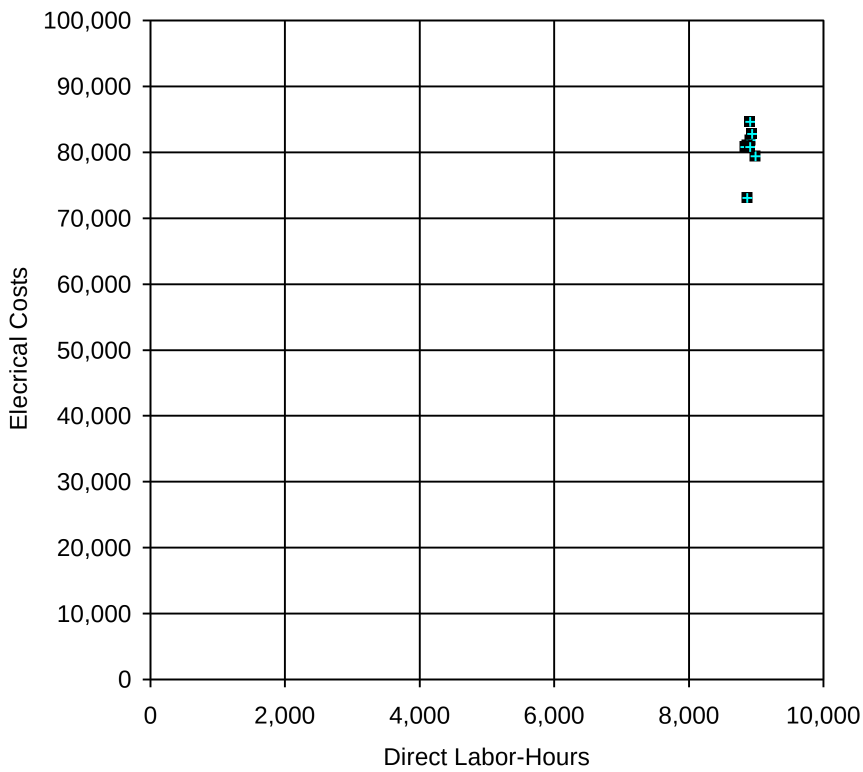
CASE 5-24 (continued)

3. The scattergraph for electrical costs and machine-hours appears below:



CASE 5-24 (continued)

The scattergraph for electrical costs and direct labor-hours appears below:



CASE 5-24 (continued)

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.

Examining the two scattergraphs reveals that 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, electrical costs do tend to increase as the machine-hours increase. So if one must 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*
7,700	84,600
8,600	81,800
8,600	81,000
8,500	80,800
7,600	79,400
7,100	82,800
6,000	73,100
6,800	80,800

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)	SFr 64,840
Slope (variable cost per unit)	SFr 2.06
R^2	0.33

Therefore the cost formula for electrical costs is SFr 64,840 per week plus SFr 2.06 per machine-hour, or

Y = SFr 64,840 + SFr 2.06 X,

where X is machine-hours.

CASE 5-24 (continued)

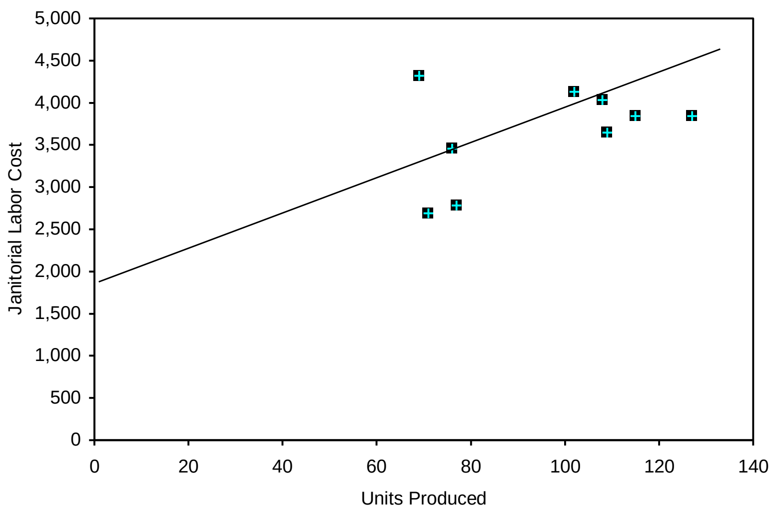
Note that the R^2 is 0.33, which means that only 33% of the variation in electrical cost is explained by machine-hours. Other factors, discussed in part (6) below, are responsible for most of the variation in electrical costs from week to week.

5. The custom tool job requires 25 machine-hours. At SFr 2.06 per machine-hour, the electrical cost actually caused by the job would be only SFr 51.5. This contrasts with the electrical cost of SFr 271.20 under the old cost system and SFr 264.50 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 SFr 64,840 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 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. (Longer days mean the lights have to be on longer.)

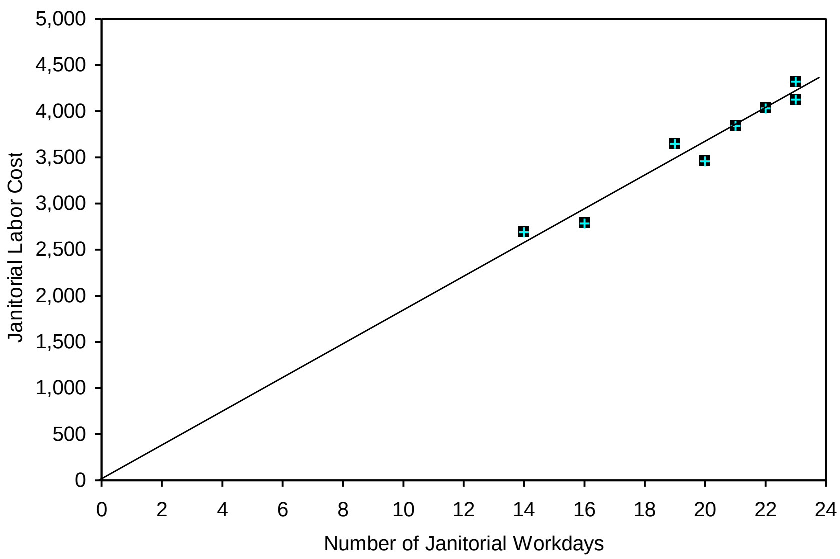
Case 5-25 (30 minutes)

1. The completed scattergraph for the number of units produced as the activity base is presented below:



Case 5-25 (continued)

2. The completed scattergraph for the number of workdays as the activity base is presented below:



Case 5-25 (continued)

3. The number of workdays should be used as the activity base rather than the number of units produced. There are several reasons for this. First, the scattergraphs reveal that there is a much stronger relationship (i.e., higher correlation) between janitorial costs and number of workdays than between janitorial costs and number of units produced. Second, from the description of the janitorial costs, one would expect that variations in those costs have little to do with the number of units produced. Two janitors each work an eight-hour shift—apparently irrespective of the number of units produced or how busy the company is. Variations in the janitorial labor costs apparently occur because of the number of workdays in the month and the number of days the janitors call in sick. Third, for planning purposes, the company is likely to be able to predict the number of working days in the month with much greater accuracy than the number of units that will be produced.

   Note that the scattergraph in part (1) seems to suggest that the janitorial labor costs are variable with respect to the number of units produced. This is false. Janitorial labor costs do vary, but the number of units produced isn't the cause of the variation. However, since the number of units produced tends to go up and down with the number of workdays and since the janitorial labor costs are driven by the number of workdays, it *appears* on the scattergraph that the number of units drives the janitorial labor costs to some extent. Analysts must be careful not to fall into this trap of using the wrong measure of activity as the activity base just because it appears there is some relationship between cost and the measure of activity. Careful thought and analysis should go into the selection of the activity base.

Case 5-26 (90 minutes)

1. a.

Tons Mined (000s) (X)	*Utilities Cost (Y)*
15	$ 50,000
11	45,000
21	60,000
12	75,000
18	100,000
25	105,000
30	85,000
28	120,000

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)	$28,352
Slope (variable cost per unit)	$2,582
R^2	0.47

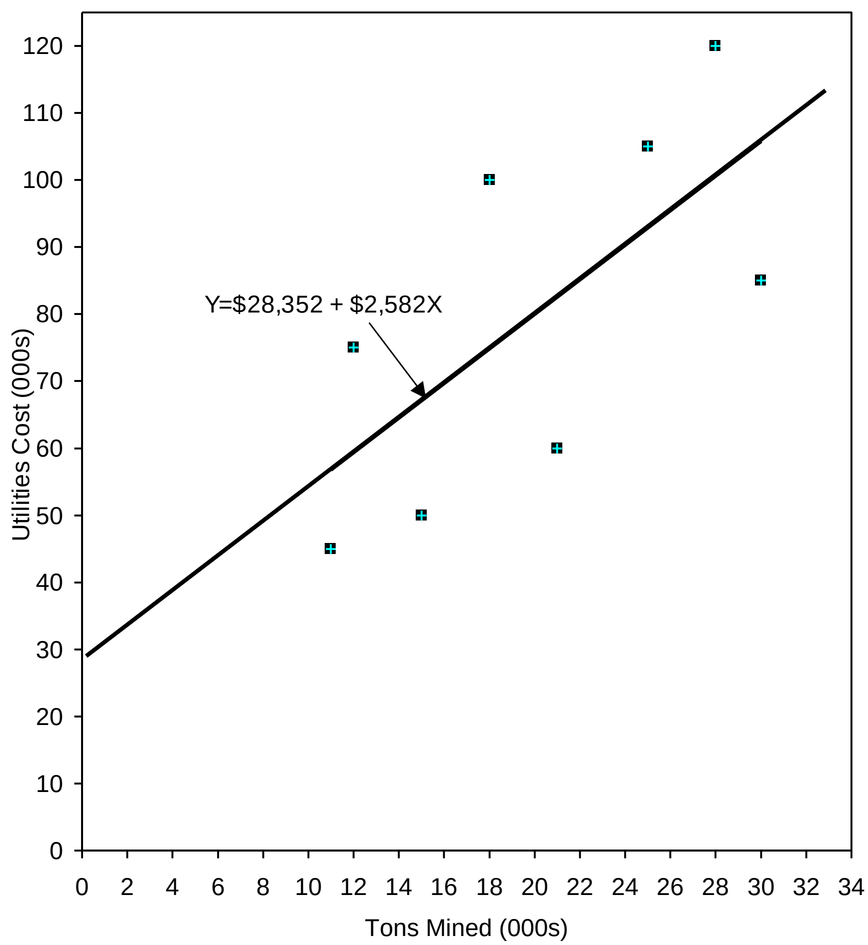
Therefore, the cost formula using tons mined as the activity base is $28,352 per quarter plus $2,582 per thousand tons mined, or

$$Y = \$28,352 + \$2,582X.$$

Note that the R^2 is 0.47, which means that only 47% of the variation in utility costs is explained by the number of tons mined.

Case 5-26 (continued)

b. The scattergraph plot of utility costs versus tons mined appears below:



Case 5-26 (continued)

2. a.

DLHs (000) (X)	*Utilities Cost (Y)*
5	$ 50,000
3	45,000
4	60,000
6	75,000
10	100,000
9	105,000
8	85,000
11	120,000

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)	$17,000
Slope (variable cost per unit)	$9,000
R^2	0.93

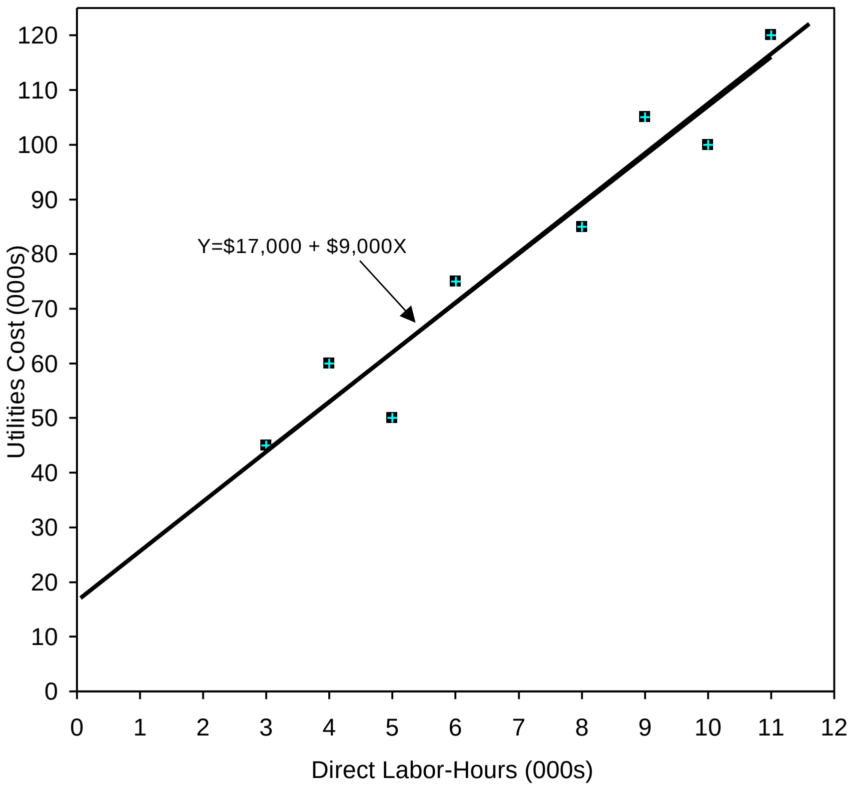
Therefore, the cost formula using direct labor-hours as the activity base is $17,000 per quarter plus $9,000 per thousand direct labor-hours, or

$$Y = \$17,000 + \$9,000X.$$

Note that the R^2 is 0.93, which means that 93% of the variation in utility costs is explained by the number of direct labor-hours. This is a very high R^2 and is an indication of a good fit.

Case 5-26 (continued)

b. The scattergraph plot of utility costs versus direct labor-hours appears below:



3. The company should probably use direct labor-hours as the activity base, since the fit of the regression line to the data is much tighter than it is with tons mined. The R^2 for the regression using direct labor-hours as the activity base is twice as large as for the regression using tons mined as the activity base. However, managers should look more closely at the costs and try to determine why utilities costs are more closely tied to direct labor-hours than to the number of tons mined.

Group Exercise 5-27

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.