Chapter 5
Cost Behavior: Analysis and Use

Solutions to Questions

5-1

a. Variable cost: The variable cost per unit is constant, but total variable cost changes in in direct proportion to changes in volume.
b. Fixed cost: The total fixed cost is constant within the relevant range. The *average* fixed cost per unit varies 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.

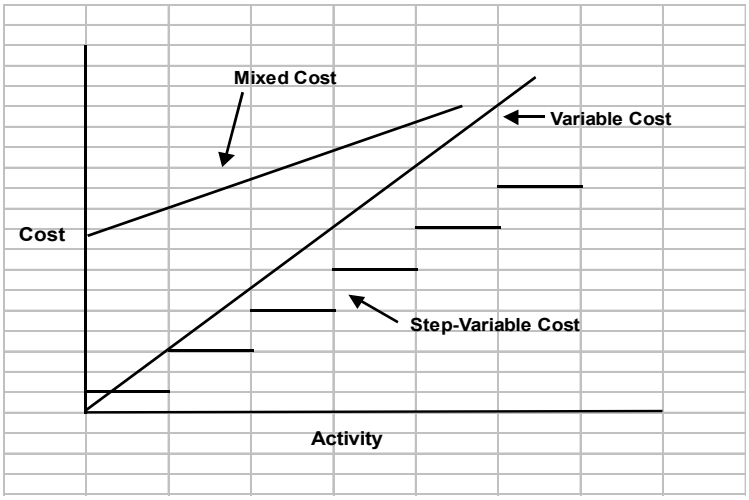
5-3

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 on certain fixed cost items, 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, they are "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 may 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 because they represent extremes of activity.

5-11 The formula for a mixed cost is Y = a + bX. In cost analysis, the "a" term represents the fixed cost and the "b" term represents the variable cost per unit of activity.

5-12 In a least-squares regression, 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.

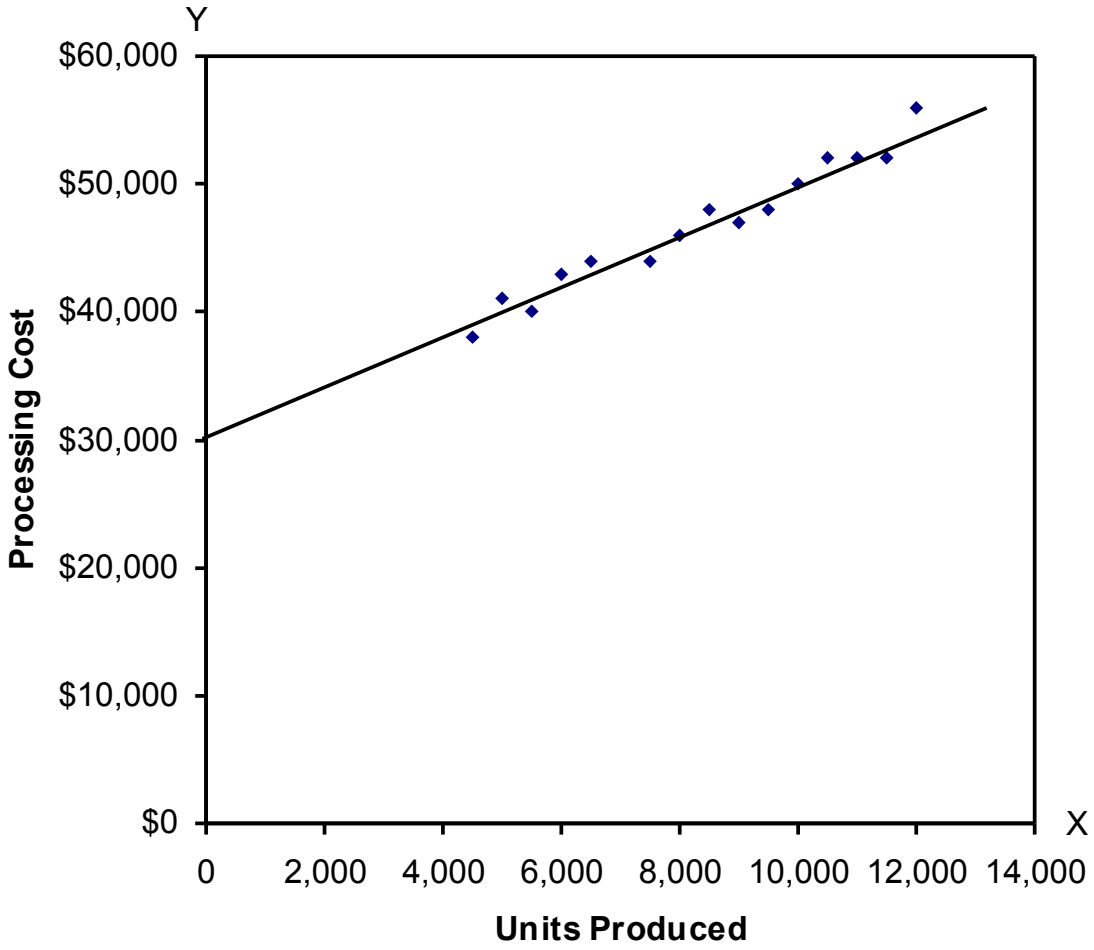
	Cups of Coffee Served in a Week		
	2,000	*2,100*	*2,200*
Fixed cost.....	$1,200	$1,200	$1,200
Variable cost.....	440	462	484
Total cost.....	$1,640	$1,662	$1,684
Average cost per cup of coffee served *.....	$0.820	$0.791	$0.765

* 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 (30 minutes)

1. The scattergraph appears below:



Exercise 5-2 (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 5-3 (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 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, 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 5-4 (20 minutes)

1.

The Alpine House, Inc.
Income Statement—Ski Department
For the Quarter Ended March 31

Sales		$150,000
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
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
Variable expenses:		
Cost per pair	$450	
Selling expenses	50	
Administrative expenses ($2,000 ÷ 200 pairs)	10	510
Contribution margin per pair		$240

Exercise 5-5 (20 minutes)

1. The company's variable cost per unit is:

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

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

	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 is:

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

Exercise 5-6 (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

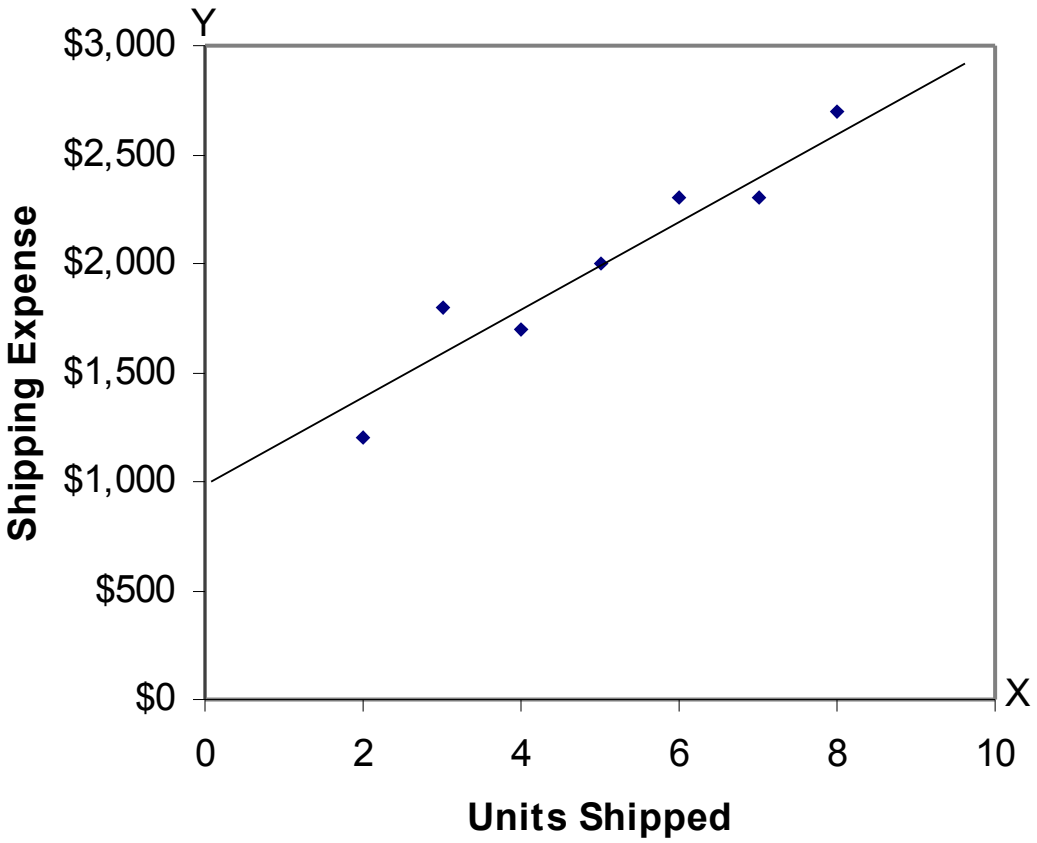
The cost formula is $1,000 per month plus $200 per unit shipped or

$$Y = \$1,000 + \$200X$$

where X is the number of units shipped.

Exercise 5-6 (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 to meet a deadline.

Exercise 5-7 (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 5-8 (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

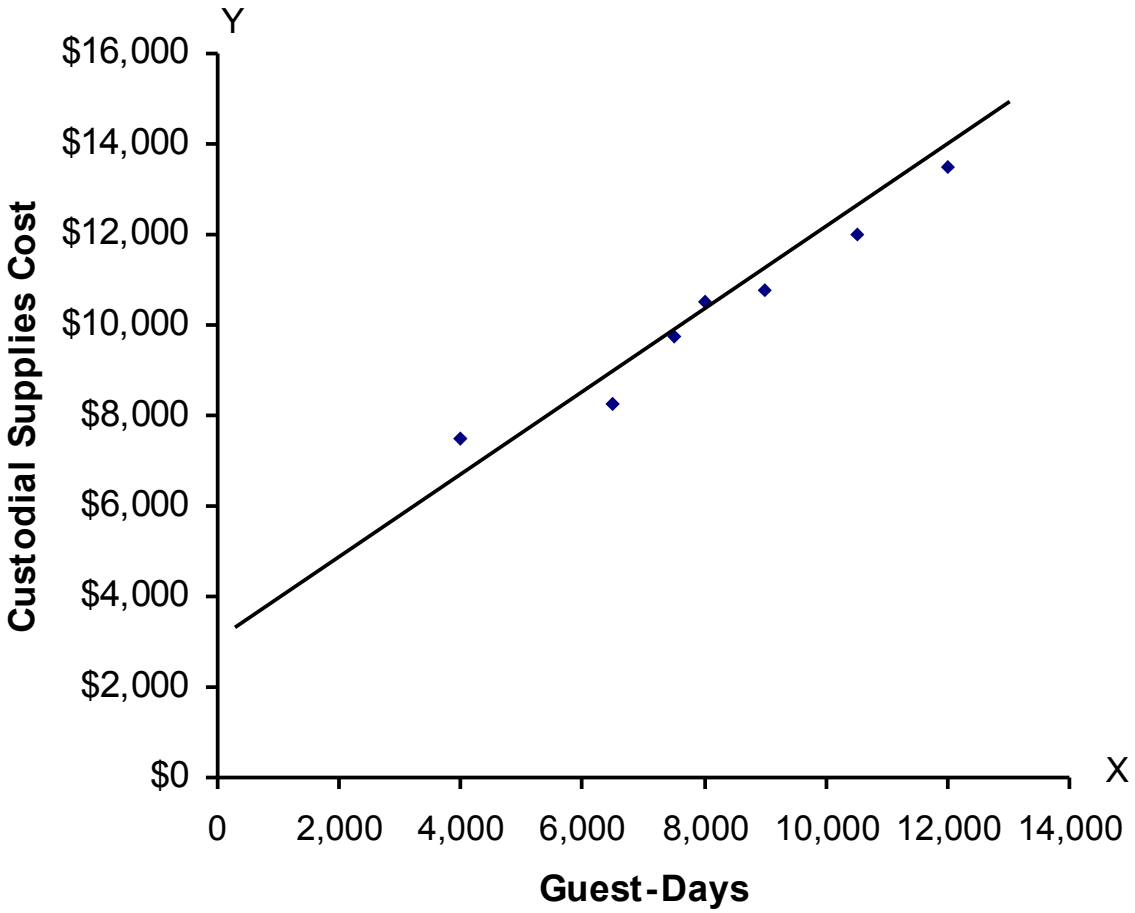
$$Y = \$4{,}500 + \$0.75X$$

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 because 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 (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

Problem 5-11 (45 minutes)

1.

Marwick's Pianos, Inc.
Income Statement
For the Month of August

Sales (40 pianos × $3,125 per piano)		$125,000
Cost of goods sold (40 pianos × $2,450 per piano)		98,000
Gross margin		27,000
Selling and administrative 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 selling and administrative expenses		19,000
Net operating income		$ 8,000

Problem 5-11 (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
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
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 5-12 (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 Commissions 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:

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

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

$$\text{Salaries and commissions expense: } \frac{\text{A\$12,000}}{\text{1,000 units}} = \text{A\$12 per unit}$$

Fixed cost element:

	Shipping Expense	*Salaries and Commissions 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 5-12 (continued)

The cost formulas are:

Shipping expense:

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

or

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

Salaries and commissions expense:

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

or

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

3.

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

Sales (5,000 units × A$100 per unit).....		A$500,000
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$12 per unit).....	60,000	380,000
Contribution margin.....		120,000
Fixed expenses:		
Advertising expense.....	21,000	
Shipping expense.....	18,000	
Salaries and commissions expense.....	30,000	
Insurance expense.....	6,000	
Depreciation expense.....	15,000	90,000
Net operating income.....		A$ 30,000

Problem 5-14 (45 minutes)

1. 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

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

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:

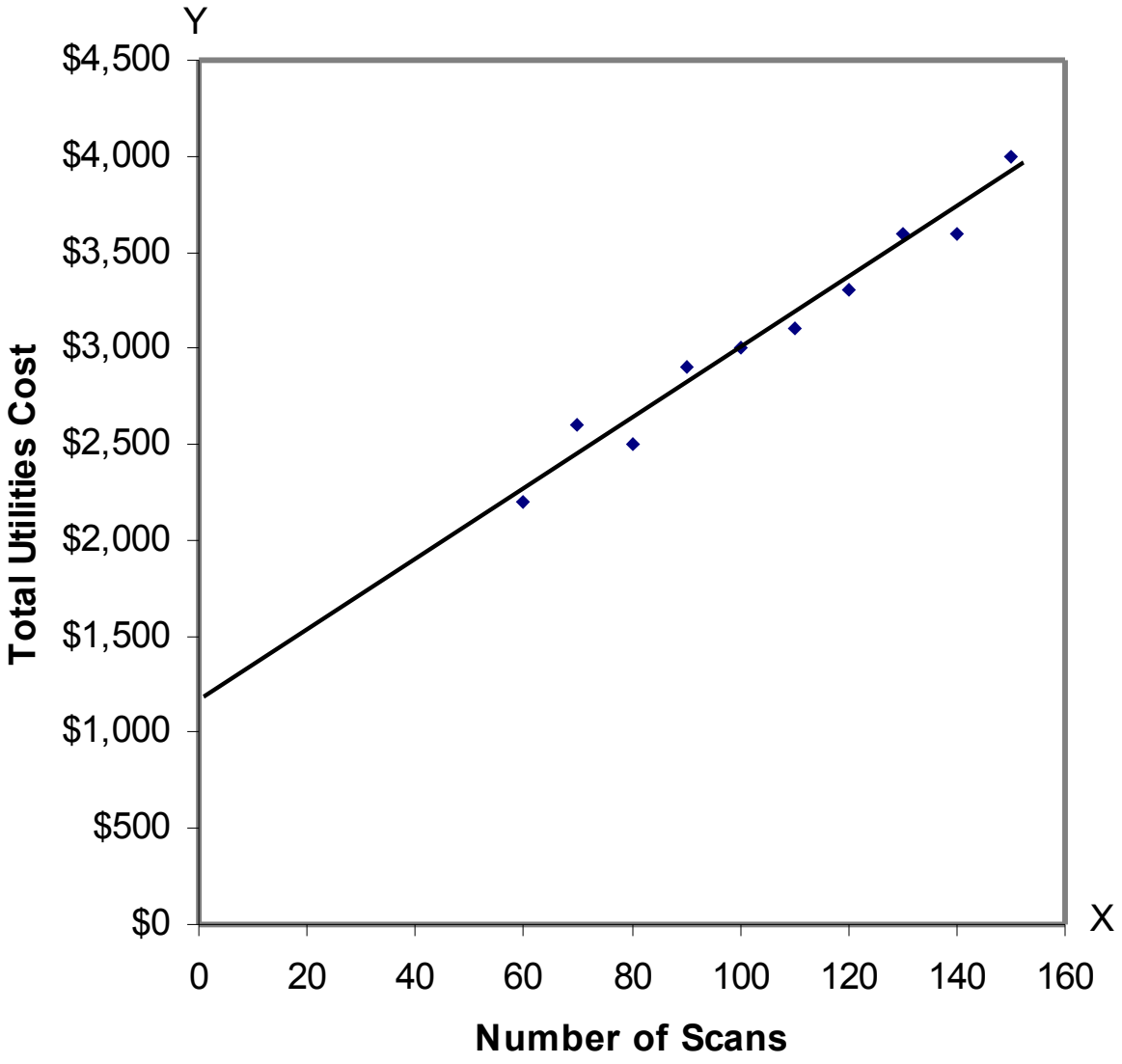
Total cost at 100 scans (a point that falls on the line). .	$3,000
Less the fixed cost element.....	1,200
Variable cost element (total).....	$1,800

$1,800 ÷ 100 scans = $18 per scan

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

Problem 5-14 (continued)

The completed scattergraph:



Problem 5-15 (30 minutes)

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

	Level of Activity	
	50,000 DLHs	*75,000 DLHs*
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 DLHs = ¥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 DLHs × ¥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 5-15 (continued)

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

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

Problem 5-16 (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 5-16 (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 5-17 (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 5-17 (continued)

3.

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

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

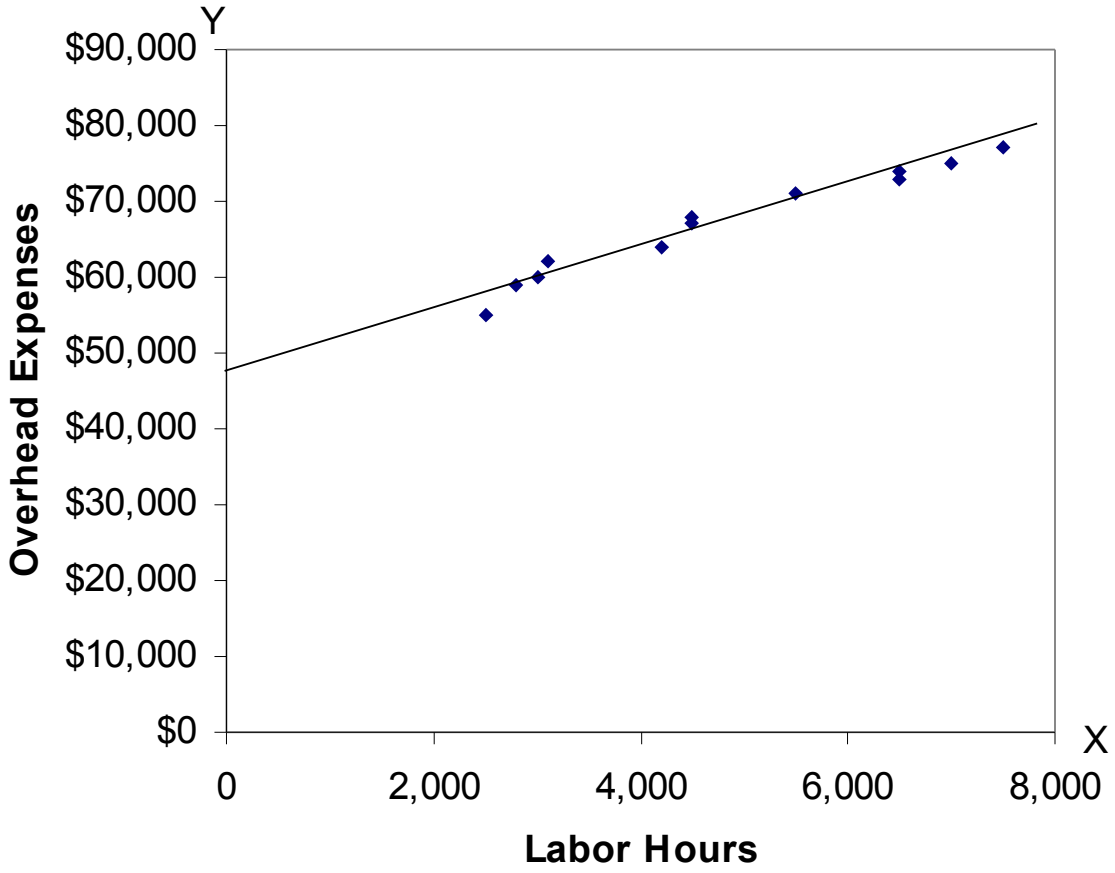
4. Total overhead cost at an activity level of 75,000 machine-hours:

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

Case 5-18 (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, beverages, and labor are all apparently variable with respect to the number of guests. However, the situation with respect to 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 5-18 (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 5-18 (continued)

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

- In this situation, the quick-and-dirty method based on the scattergraph is probably better than the high-low method 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:

Sales (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 5-18 (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 5-19 (45 minutes)

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

Case 5-19 (continued)

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

Number of Paid Days

Case 5-19 (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.

Research and Application 5-20

1. Blue Nile succeeds first and foremost because of its operational excellence customer value proposition. Page 3 of the 10-K says “we have developed an efficient online cost structure … that eliminates traditional layers of diamond wholesalers and brokers, which allows us to generally purchase most of our product offerings at lower prices by avoiding markups imposed by those intermediaries. Our supply solution generally enables us to purchase only those diamonds that our customers have ordered. As a result, we are able to minimize the costs associated with carrying diamond inventory.” On page 4 of the 10-K, Blue Nile’s growth strategy hinges largely on increasing what it calls supply chain efficiencies and operational efficiencies. Blue Nile also emphasizes jewelry customization and customer service, but these attributes do not differentiate Blue Nile from its competitors.

2. Blue Nile faces numerous business risks as described in pages 8-19 of the 10-K. Students may mention other risks beyond those specifically mentioned in the 10-K. Here are four risks faced by Blue Nile with suggested control activities:

   - Risk: Customer may not purchase an expensive item such as a diamond over the Internet because of concerns about product quality (given that customers cannot see the product in person prior to purchasing it).
     Control activities: Sell only independently certified diamonds and market this fact heavily. Also, design a web site that enables customers to easily learn more about the specific products that they are interested in purchasing.
   - Risk: Customers may avoid Internet purchases because of fears that security breaches will enable criminals to have access to their confidential information.
     Control activities: Invest in state-of-the-art encryption technology and other safeguards.

Research and Application 5-20 (continued)

- Risk: Because Blue Nile sells luxury products that are often purchased on a discretionary basis, sales may decline significantly in an economic downturn as people have access to less disposable income.
  Control activities: Expand product offerings and expand the number of geographic markets served.
- Risk: The financial reporting process may fail to function properly (e.g., it may not comply with the Sarbanes-Oxley Act of 2002) as the business grows.
  Control activities: Implement additional financial accounting systems and internal control over those systems.

Blue Nile faces various risks that are not easily reduced through control activities. Three such examples include:

- If Blue Nile is required by law to charge sales tax on purchases it will reduce Blue Nile's price advantage over bricks-and-mortar retailers (see page 17 of the 10-K).
- Restrictions on the supply of diamonds would harm Blue Nile's financial results (see page 9 of the 10-K).
- Other Internet retailers, such as Amazon.com, could offer the same efficiencies and low price as Blue Nile, while leveraging their stronger brand recognition to attract Blue Nile's customers (see page 10 of the 10-K).

3. Blue Nile is a merchandiser. The first sentence of the overview on page 3 of the 10-K says "Blue Nile Inc. is a leading online retailer of high quality diamonds and fine jewelry." While Blue Niles does some assembly work to support its "Build Your Own" feature, the company essentially buys jewelry directly from suppliers and resells it to customers. In fact, Blue Nile never takes possession of some of the diamonds it sells. Page 4 of the 10-K says "our diamond supplier relationships allow us to display suppliers' diamond inventories on the Blue Nile web site for sale to consumers without holding the diamonds in our inventory until the products are ordered by customers." This sentence suggests that items are shipped directly from the supplier to the consumer.

Research and Application 5-20 (continued)

4. There is no need to calculate any numbers to ascertain that cost of sales is almost entirely a variable cost. Page 25 of the 10-K says "our cost of sales consists of the cost of diamonds and jewelry products sold to customers, inbound and outbound shipping costs, insurance on shipments and the costs incurred to set diamonds into ring, earring and pendant settings, including labor and related facilities costs." The overwhelming majority of these costs are variable costs. Assuming the workers that set diamonds into ring, earring, and pendant settings are not paid on a piece rate, the labor cost would be step-variable in nature. The facilities costs are likely to be committed fixed in nature; however, the overwhelming majority of the cost of sales is variable.

   Similarly, there is no need to calculate any numbers to ascertain that selling, general and administrative expense is a mixed cost. Page 25 of the 10-K says "our selling, general and administrative expenses consist primarily of payroll and related benefit costs for our employees, marketing costs, credit card fees and costs associated with being a publicly traded company. These expenses also include certain facilities, fulfillment, customer service, technology and depreciation expenses, as well as professional fees and other general corporate expenses." At the bottom of page 25, the 10-K says "the increase in selling, general and administrative expenses in 2004 was due primarily to…higher credit card processing fees based on increased volume." This indicates that credit card processing fees is a variable cost. At the top of page 26 of the 10-K it says "the decrease in selling, general and administrative expenses as a percentage of sales in 2004 resulted primarily from our ability to leverage our fixed cost base." This explicitly recognizes that selling, general and administrative expense includes a large portion of fixed costs.

   Examples of the various costs include:
   - Variable costs: cost of sales, credit card processing fees.
   - Step-variable costs: diamond setting labor, fulfillment labor.
   - Discretionary fixed costs: marketing costs, employee training costs.
   - Committed fixed costs: general corporate expenses, facilities costs.

Research and Application 5-20 (continued)

5. The data needed to complete the table as shown below is found on page 49 of the 10-K:

	2004				*2005*	
	Quarter 1	*Quarter 2*	*Quarter 3*	*Quarter 4*	*Quarter 1*	*Quarter 2*
Net sales.....	$35,784	$35,022	$33,888	$64,548	$44,116	$43,826
Cost of sales.....	27,572	27,095	26,519	50,404	34,429	33,836
Gross profit.....	8,212	7,927	7,369	14,144	9,687	9,990
Selling, general and administrative expense.....	5,308	5,111	5,033	7,343	6,123	6,184
Operating income.....	$ 2,904	$ 2,816	$ 2,336	$ 6,801	$ 3,564	$ 3,806

	Net sales	*Selling, General, and Administrative*
High Quarter (2004 Q4)….	$64,548	$7,343
Low Quarter (2004 Q3)…..	$33,888	$5,033
Change.....	$30,660	$2,310

Variable cost = $2,310/$30,660 = 0.075342 per dollar of revenue

Fixed cost estimate (using the low level of activity):

$5,033 − ($33,888 × 0.075342) = $2,480 (rounded up)

The linear equation is: Y = $2,480 + 0.075342X, where X is revenue.

Research and Application 5-20 (continued)

6. The contribution format income statement using the high-low method for the third quarter of 2005 would be as follows:

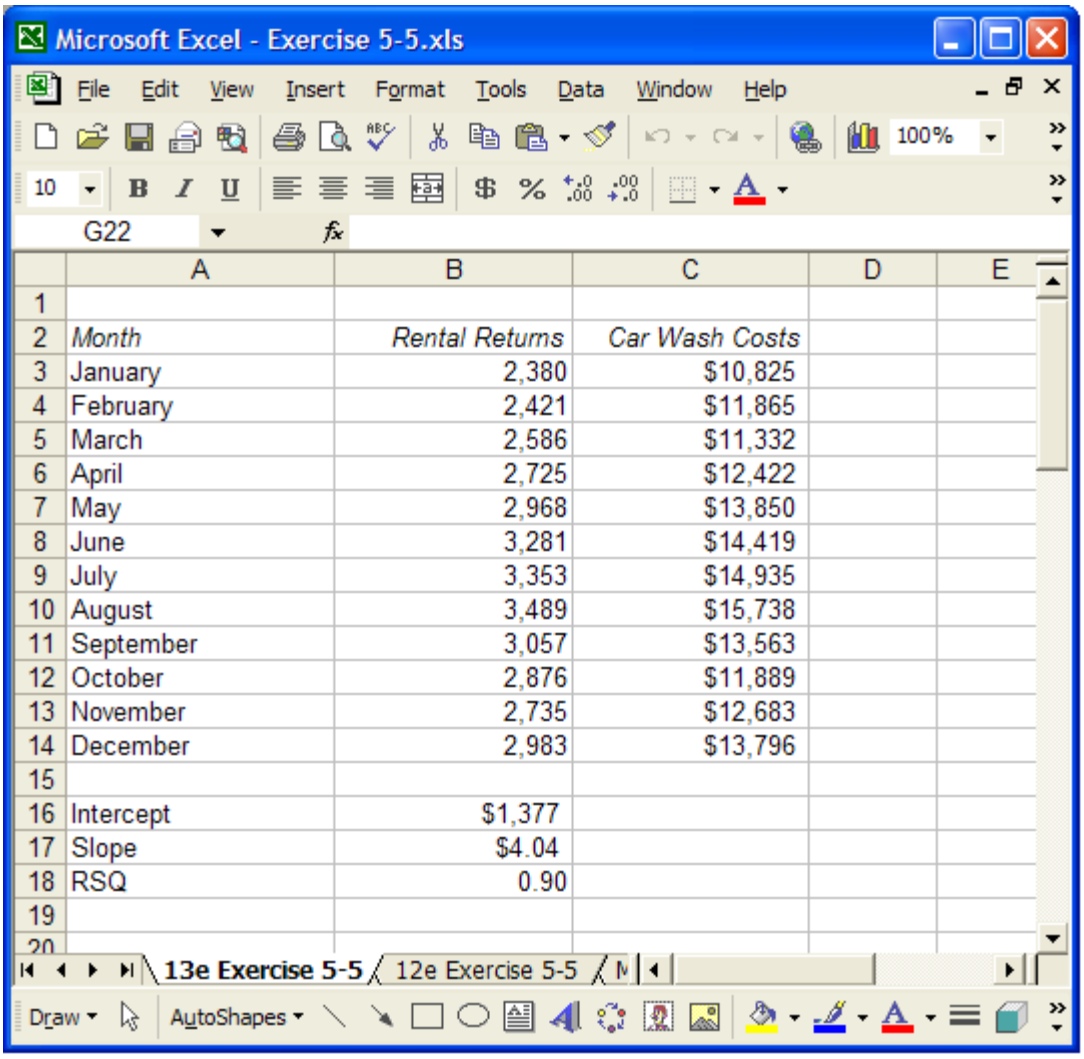
	2005 Third Quarter	
Net sales		$45,500
Cost of sales	$35,128	
Variable selling, general and administrative	3,428	38,556
Contribution margin		6,944
Fixed selling, general and administrative		2,480
Net operating income		$ 4,464

7. Blue Nile's cost structure is heavily weighted towards variable costs. Less than 10% of Blue Nile's costs are fixed. Blue Nile's cost of sales as a percentage of sales is higher than bricks and mortar retailers. Page 22 of the 10-K says "As an online retailer, we do not incur most of the operating costs associated with physical retail stores, including the costs of maintaining significant inventory and related overhead. As a result, while our gross profit margins are lower than those typically maintained by traditional diamond and fine jewelry retailers, we are able to realize relatively higher operating income as a percentage of net sales. In 2004, we had a 22.2% gross profit margin, as compared to gross profit margins of up to 50% by some traditional retailers. We believe our lower gross profit margins result from lower retail prices that we offer to our customers."

Appendix 5A
Least-Squares Regression Computations

Exercise 5A-1 (45 minutes)

The least-squares regression estimates of fixed and variable costs can be computed using any of a variety of statistical and mathematical software packages or even by hand. The solution below uses Microsoft® Excel as illustrated in the text.



	A	B	C	D	E
1					
2	*Month*	*Rental Returns*	*Car Wash Costs*		
3	January	2,380	$10,825		
4	February	2,421	$11,865		
5	March	2,586	$11,332		
6	April	2,725	$12,422		
7	May	2,968	$13,850		
8	June	3,281	$14,419		
9	July	3,353	$14,935		
10	August	3,489	$15,738		
11	September	3,057	$13,563		
12	October	2,876	$11,889		
13	November	2,735	$12,683		
14	December	2,983	$13,796		
15					
16	Intercept	$1,377			
17	Slope	$4.04			
18	RSQ	0.90			
19					
20					

Exercise 5A-1 (continued)

The intercept provides the estimate of the fixed cost element, $1,377 per month, and the slope provides the estimate of the variable cost element, $4.04 per rental return. Expressed as an equation, the relation between car wash costs and rental returns is

$$Y = \$1,377 + \$4.04X$$

where X is the number of rental returns.

Note that the R^2 is 0.90, which is quite high, and indicates a strong linear relationship between car wash costs and rental returns.

Exercise 5A-1 (continued)

While not a requirement of the exercise, it is always a good idea to plot the data on a scattergraph. The scattergraph can help spot nonlinearities or other problems with the data. In this case, the regression line (shown below) is a reasonably good approximation to the relationship between car wash costs and rental returns.

Exercise 5A-2 (30 minutes)

1.

Week	*Units (X)*	*Total Etching Cost (Y)*
1	4	SFr18
2	3	SFr17
3	8	SFr25
4	6	SFr20
5	7	SFr24
6	2	SFr16

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).....	SFr12.32
Slope (variable cost per unit).....	SFr1.54
R^2.....	0.94

Therefore, the cost formula is SFr12.32 per month plus SFr1.54 per unit etched or

Y = SFr12.32 + SFr1.54

Note that the R^2 is 0.94, which means that 94% 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 = SFr12.32 + SFr1.54X

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

Variable cost: 5 units × SFr1.54 per unit....	SFr 7.70
Fixed cost.....	12.32
Total expected cost.....	SFr20.02

Exercise 5A-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.....	0.92

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

$$Y = \$911 + \$218X$$

Note that the R^2 is 0.92, which means that 92% 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.

Problem 5A-4 (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.....	0.96

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

Note that the R^2 is 0.96, which means that 96% 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

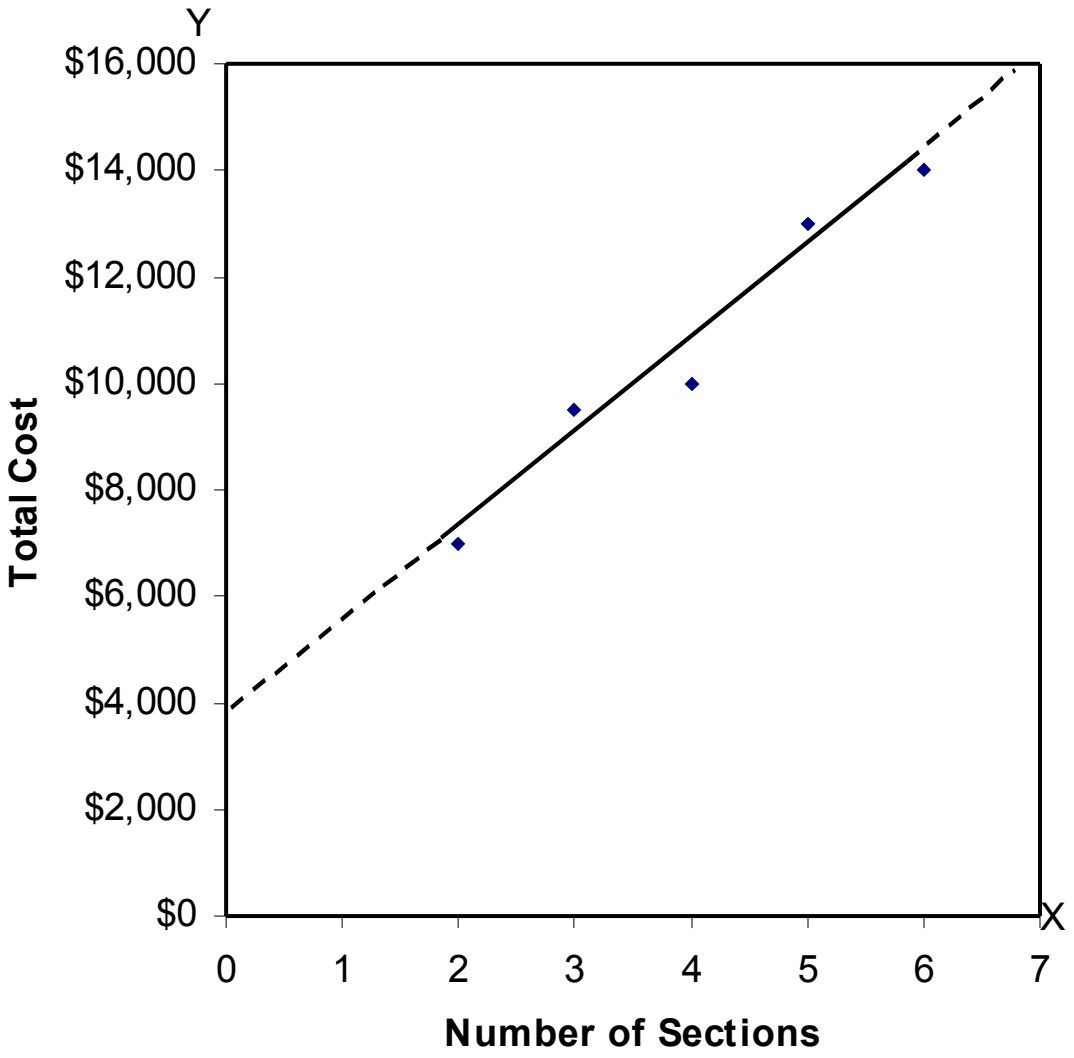
3. Expected total cost would be:

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 5A-4 (continued)

4.



Problem 5A-5 (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 5A-5 (continued)

2.

Milden Company
Budgeted Income Statement
For the First Quarter, Year 3

Sales (12,000 units × $100 per unit).....		$1,200,000
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
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 5A-6 (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 5-14, 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.

Case 5A-7 (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:

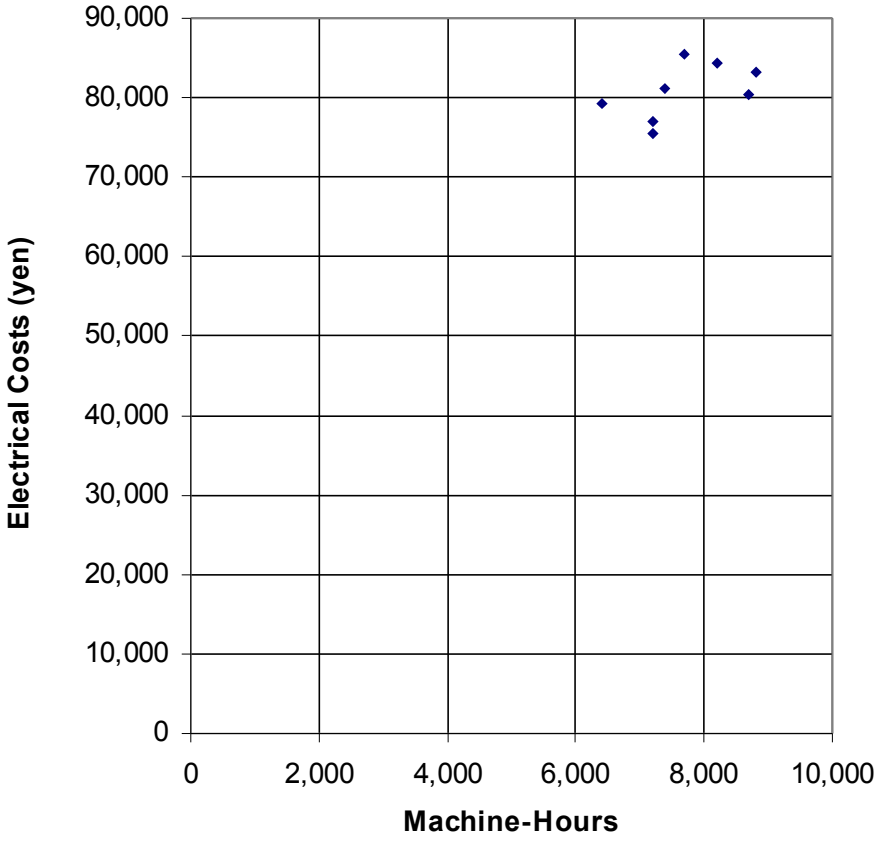
Predetermined overhead rate (a).....	¥9.06 per DLH
Direct labor-hours for the job (b).....	350 DLHs
Electrical cost applied to the job (a) × (b).....	¥3,171

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

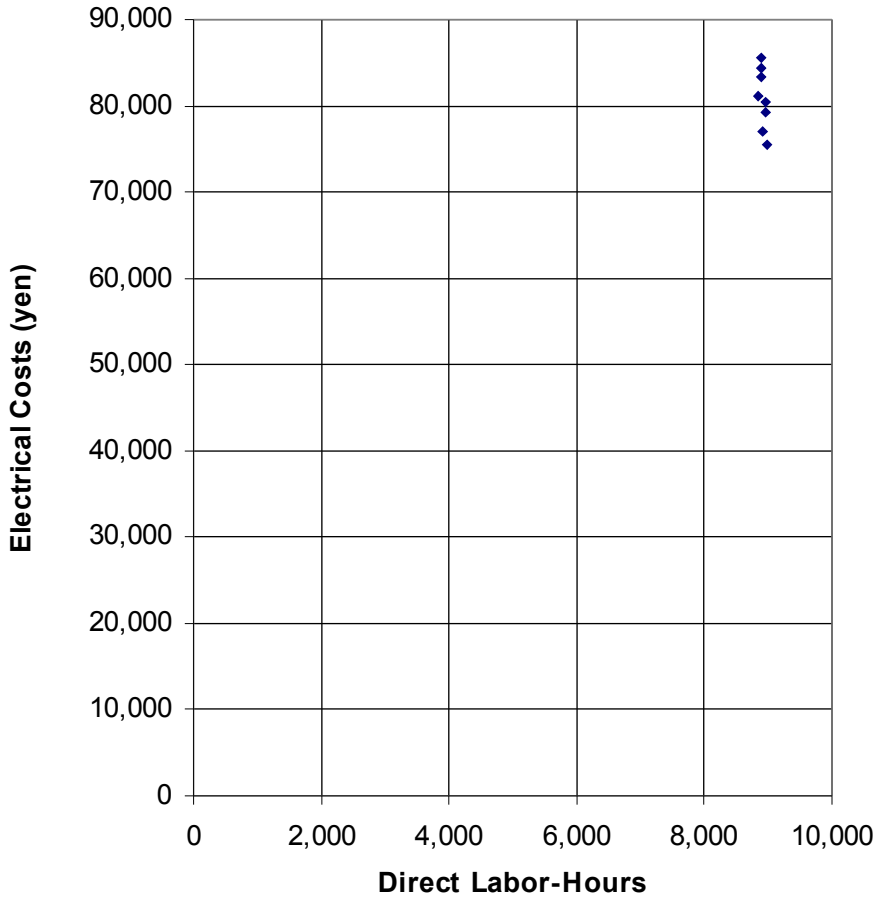
Case 5A-7 (continued)

3. Scattergraph for electrical costs and machine-hours:



Case 5A-7 (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 choose between machine-hours and direct labor-hours as an

Case 5A-7 (continued)

allocation base, machine-hours seems to be the better choice. Even so, it looks like little of the overhead cost is 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 5A-7 (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.)

Research and Application 5A-8

1. Using least-squares regression, the estimates are as follows:

   SLOPE (variable cost) = 0.075206
   INTERCEPT (fixed cost) = $2,627 (rounded up)
   R^2 (goodness of fit) = 0.96

   The cost formula is: Y = $2,627 + 0.075206X

   These estimates differ from the high-low method because least squares regression uses all of the data rather than just the data pertaining to the high and low quarters of activity.

2. The contribution format income statement using least-squares regression for the third quarter of 2005 would be as follows:

	2005 Third Quarter	
Net sales		$45,500
Cost of sales	$35,128	
Variable selling, general and administrative	3,422	38,550
Contribution margin		6,950
Fixed selling, general and administrative		2,627
Operating income		$ 4,323