Lecture 2: Cost Behavior and Activity-based Costing

IE618 Eng Cost & Production Economics

Spring 2014

Dr. Reggie J. Caudill

Professor of Mechanical and Industrial Engineering

caudill@njit.edu

973-596-3330

203 MEC

http://web.njit.edu/~caudill/

Basics of Cost Behavior

- **Cost Behavior**
  - The term used to describe whether a cost changes when the level of output changes.
  - Fixed costs do not change as output changes
  - Variable costs increase in total with an increase in output and decrease in total with a decrease in output.
- **Cost Objects**
  - An item for which managers want cost information
  - For manufacturing or merchandising firms, it is usually the tangible product
  - For service firms, it is usually the service provided

Objective 1

Basics of Cost Behavior

Fixed Costs

***Fixed costs* are *costs* that *in total* are constant within the relevant range as the level of the activity driver varies.**

JCM Audio Systems, Inc. produces speakers for home audio systems. One department produces voice coils. There are two production lines that can each make up to 100,000 voice coils per year. The production-line manager is paid $60,000 per year. For production up to 100,000 units only one manager is needed; above that (to 200,000 units) two are needed.

Objective 1

Basics of Cost Behavior

Fixed Costs

Supervision	*Computers Processed*	*Unit Cost*
$60,000	**40,000**	**$1.50**
60,000	**80,000**	**$0.75**
60,000	**100,000**	**$0.60**
120,000	120,000	$1.00
120,000	160,000	$0.75
120,000	200,000	$0.60

The total cost of supervision remains the same within the relevant range, but the unit cost decreases as production increases.

Objective 1

Basics of Cost Behavior

Fixed Costs

Supervision	*Computers Processed*	*Unit Cost*
$60,000	40,000	$1.50
60,000	80,000	$0.75
60,000	100,000	$0.60
120,000	**120,000**	**$1.00**
120,000	**160,000**	**$0.75**
120,000	**200,000**	**$0.60**

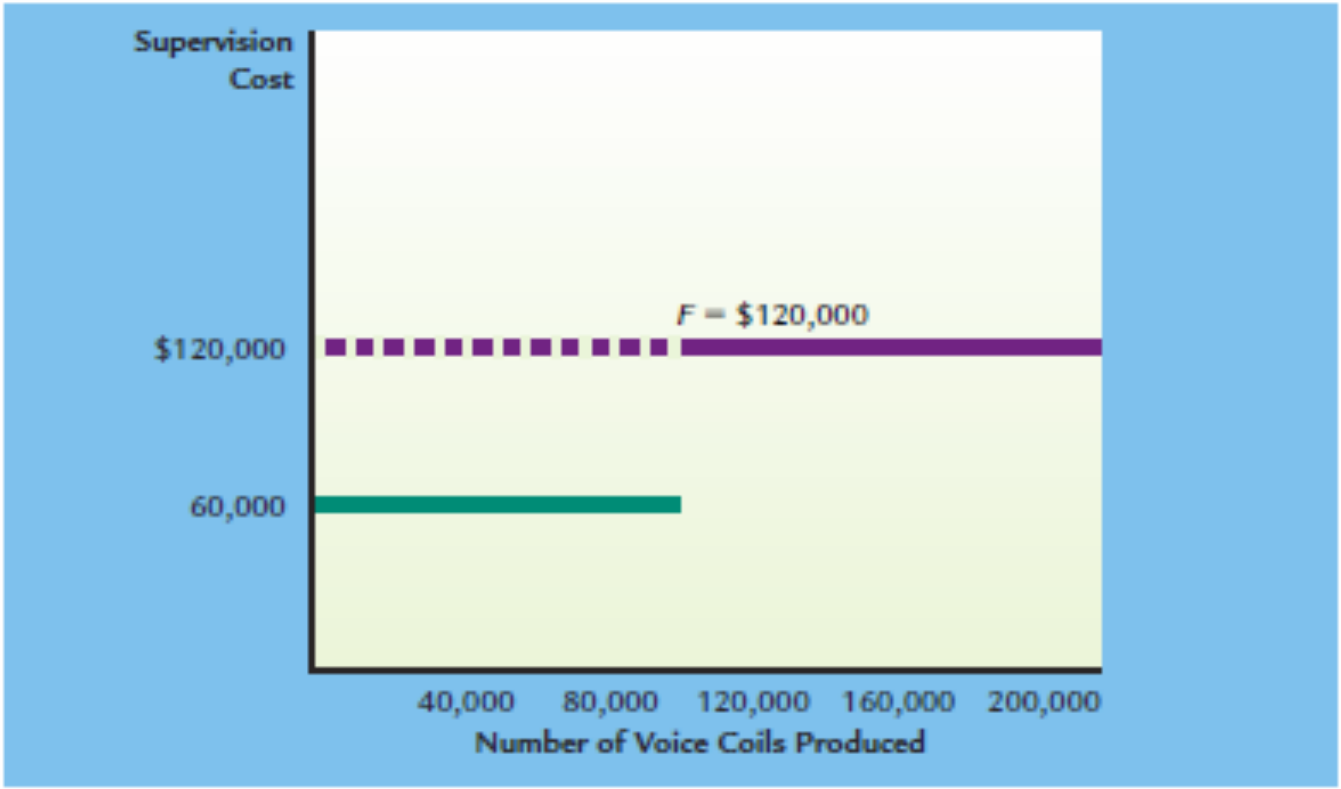
The total cost of supervision remains the same within the relevant range, but the unit cost decreases as production increases.

Objective 1

Basics of Cost Behavior

EXHIBIT 3.1

Fixed Cost Behavior



Objective 1

Basics of Cost Behavior

Variable Costs

Variable costs **are costs that in total vary in direct proportion to changes in an activity driver.**

The cost of direct materials for each voice coil is $3 The total cost of direct materials for each level of production varies, but the unit cost stays the same.

Basics of Cost Behavior

Variable Costs

JDM Audio Systems, Inc.

Total Cost of Disk Drives	*Number of Computers Produced*	*Unit Cost of Disk Drives*
$120,000	40,000	$3
240,000	80,000	3
360,000	120,000	3
480,000	160,000	3
600,000	200,000	3

Objective 1

Basics of Cost Behavior

Variable Costs

JDM Audio Systems, Inc.

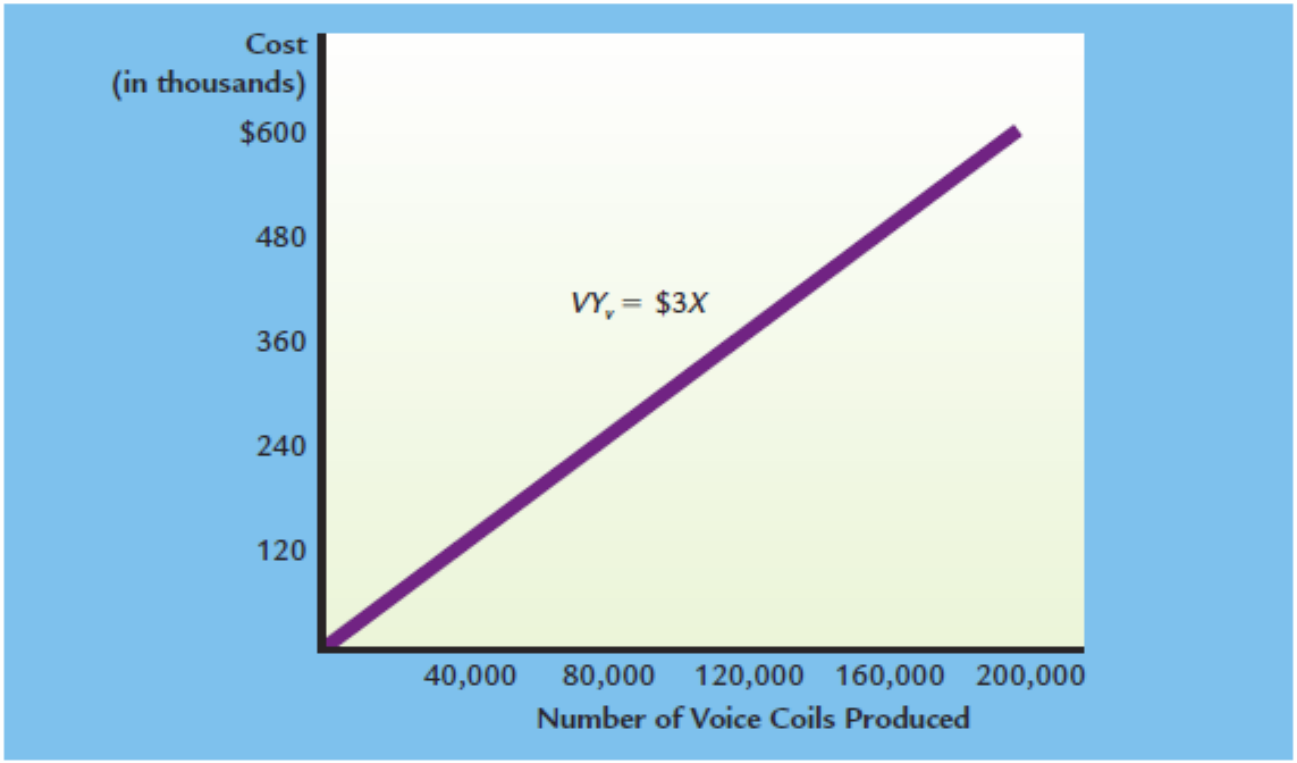
Total Cost of Disk Drives	*Number of Computers Produced*	*Unit Cost of Disk Drives*
$120,000	40,000	**$3**
240,000	80,000	**3**
360,000	120,000	**3**
480,000	160,000	**3**
600,000	200,000	**3**

Objective 1

Basics of Cost Behavior

EXHIBIT 3.2

Variable Cost Behavior

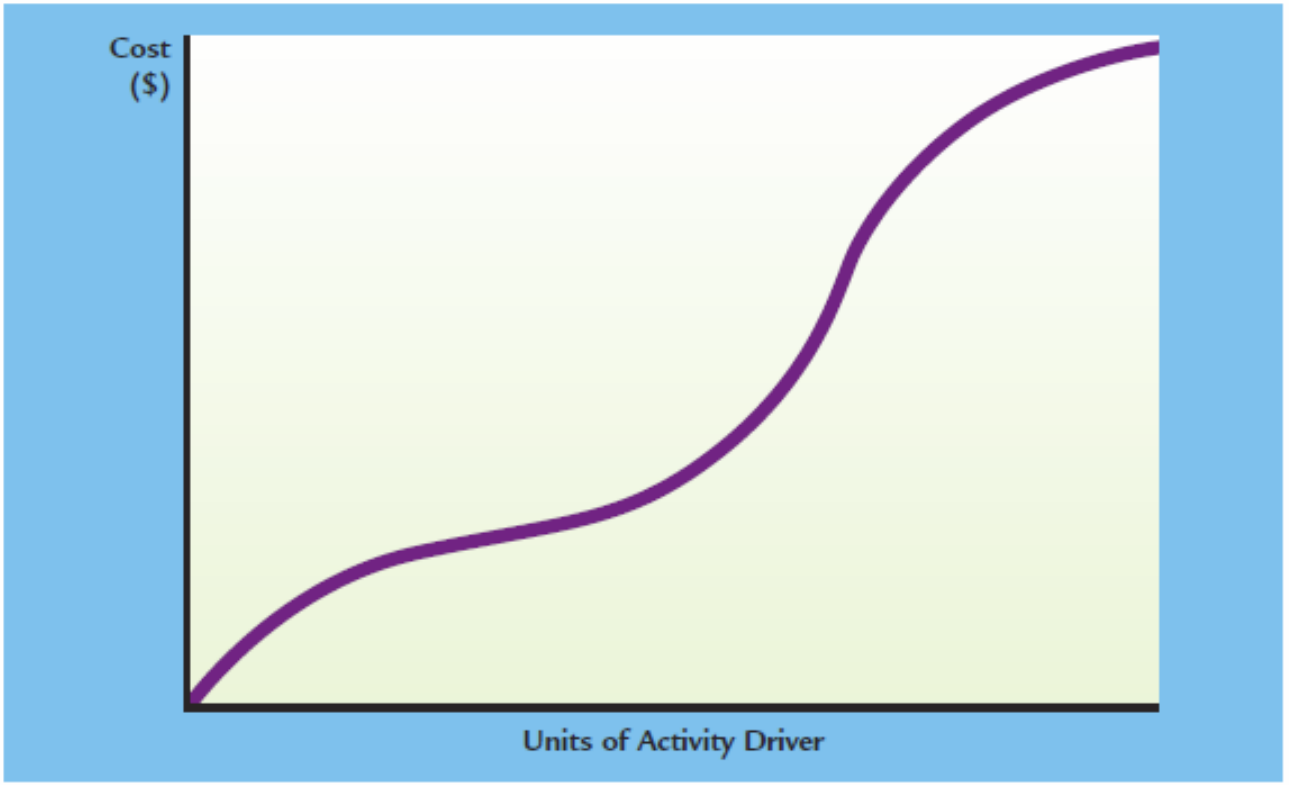


Objective 1

Basics of Cost Behavior

EXHIBIT 3.3

Nonlinearity of Variable Costs

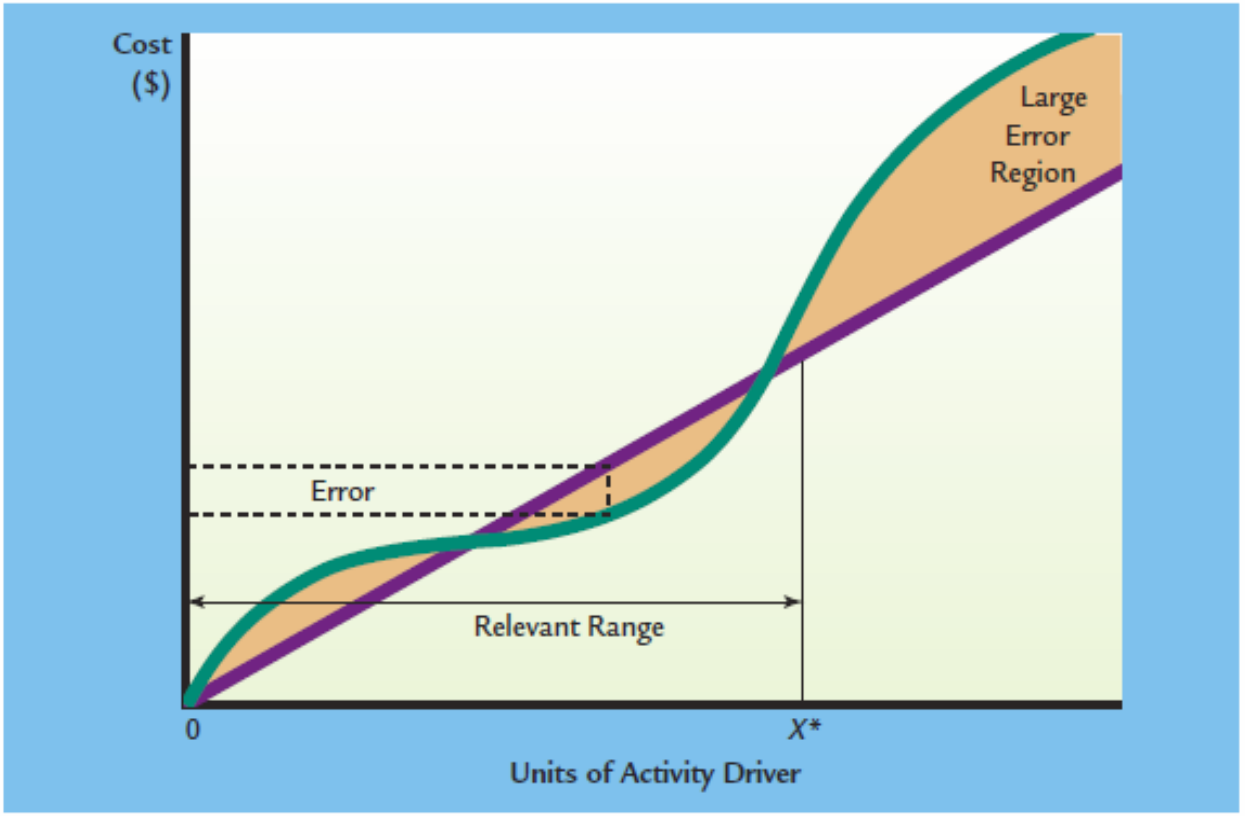


Objective 1

Basics of Cost Behavior

EXHIBIT 3.4

Relevant Range for Variable Costs



Objective 1

Basics of Cost Behavior

Mixed Costs

Mixed costs **are costs that has both a fixed and a variable component.**

Y = Fixed cost + Total variable cost

$Y = F + VX$

where

Y = Total cost (Usually a mixed cost)

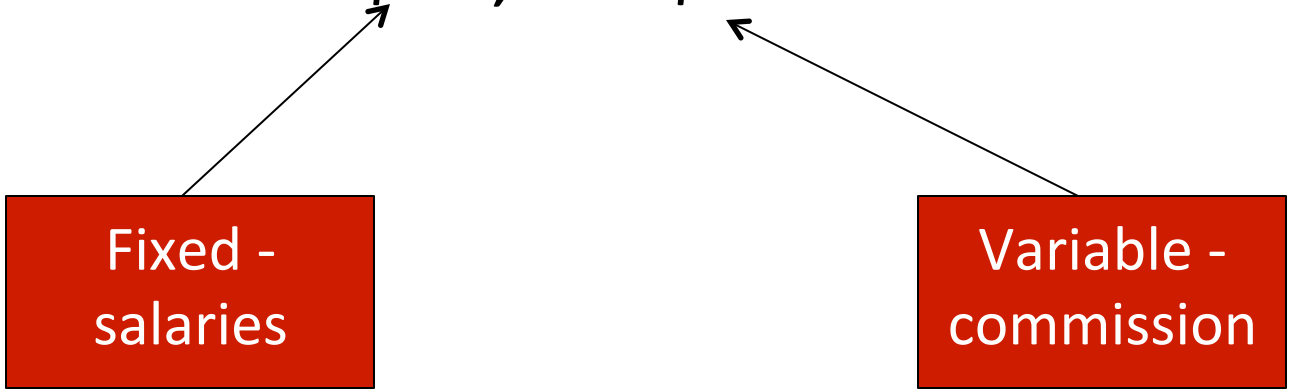
Objective 1

Basics of Cost Behavior

Mixed Costs

JCM's sales costs are mixed. There are 10 sales representatives who each earn $30,000 plus receive a commission of $5 per speaker sold. This function can be represented by the following equation:

$$Y = \$300{,}000 + \$5X$$



Objective 1

Basics of Cost Behavior

Mixed Costs

JCM Audio Systems, Inc.

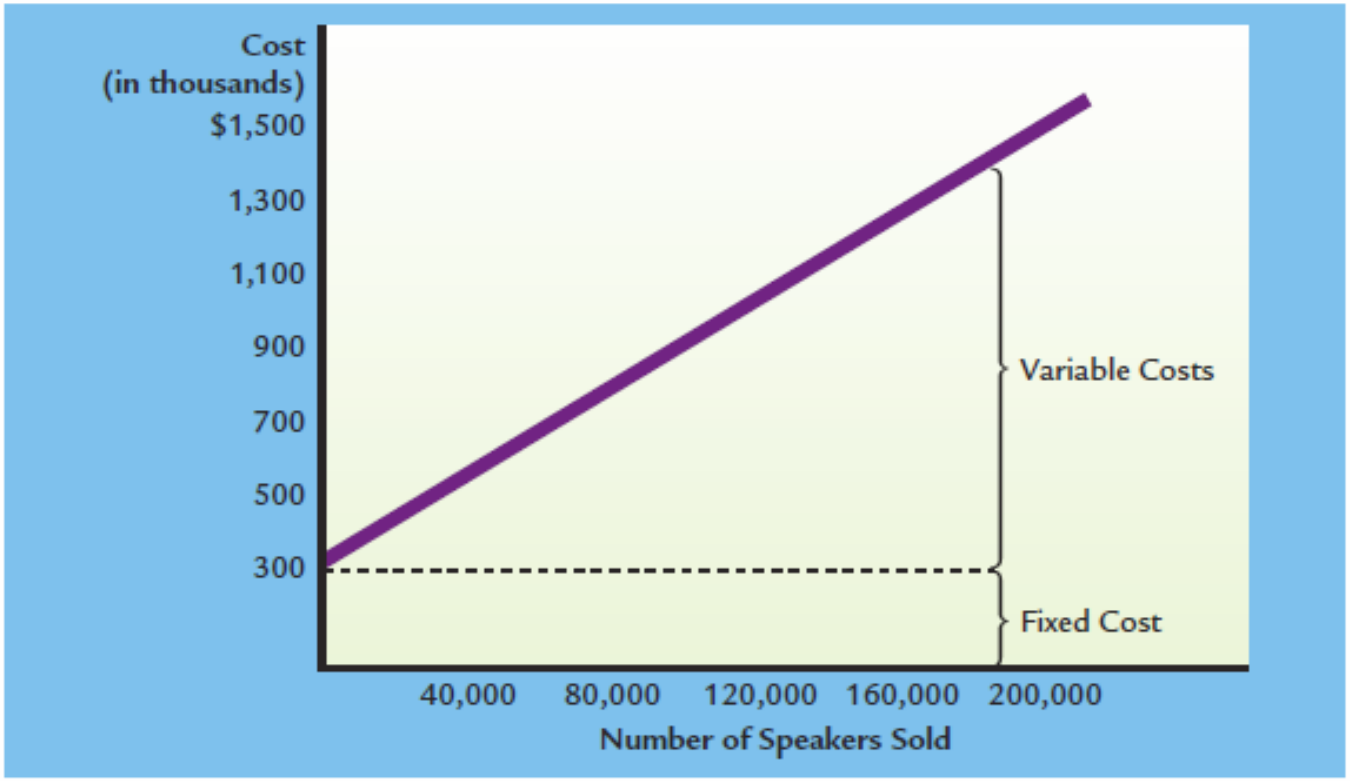
Fixed Cost of Selling	*Variable Cost of Selling*	*Total Cost*	*Speakers Sold*	*Selling Cost Per Unit*
$300,000	$200,000	$ 500,000	40,000	$12.50
300,000	400,000	700,000	80,000	8.75
300,000	600,000	900,000	120,000	7.50
300,000	800,000	1,100,000	160,000	6.88
300,000	1,000,000	1,300,000	200,000	6.50

Objective 1

Basics of Cost Behavior

EXHIBIT 3.5

Mixed Cost Behavior



Objective 1

Resources, Activities, and Cost Behavior

- **Resources**
  - Economic elements that enable one to perform activities.
  - When a firm acquires the resources needed to perform an activity, it obtains **activity capacity.**
  - **Practical capacity** is the activity level where the activity is performed efficiently

Objective 2

Resources, Activities, and Cost Behavior

- **Flexible Resources**
  - Supplied as needed and used.
  - Quantity of resource supplied equals quantity demanded.
  - No unused capacity.
- **Committed Resources**
  - Supplied in advance of usage.
  - A given quantity is obtained, whether or not that full amount is used.
  - Unused capacity is therefore possible.

Objective 2

Resources, Activities, and Cost Behavior

Step-Cost Behavior

A step cost function displays a constant level of cost for a range of output and then jumps to a higher level of cost at some point.

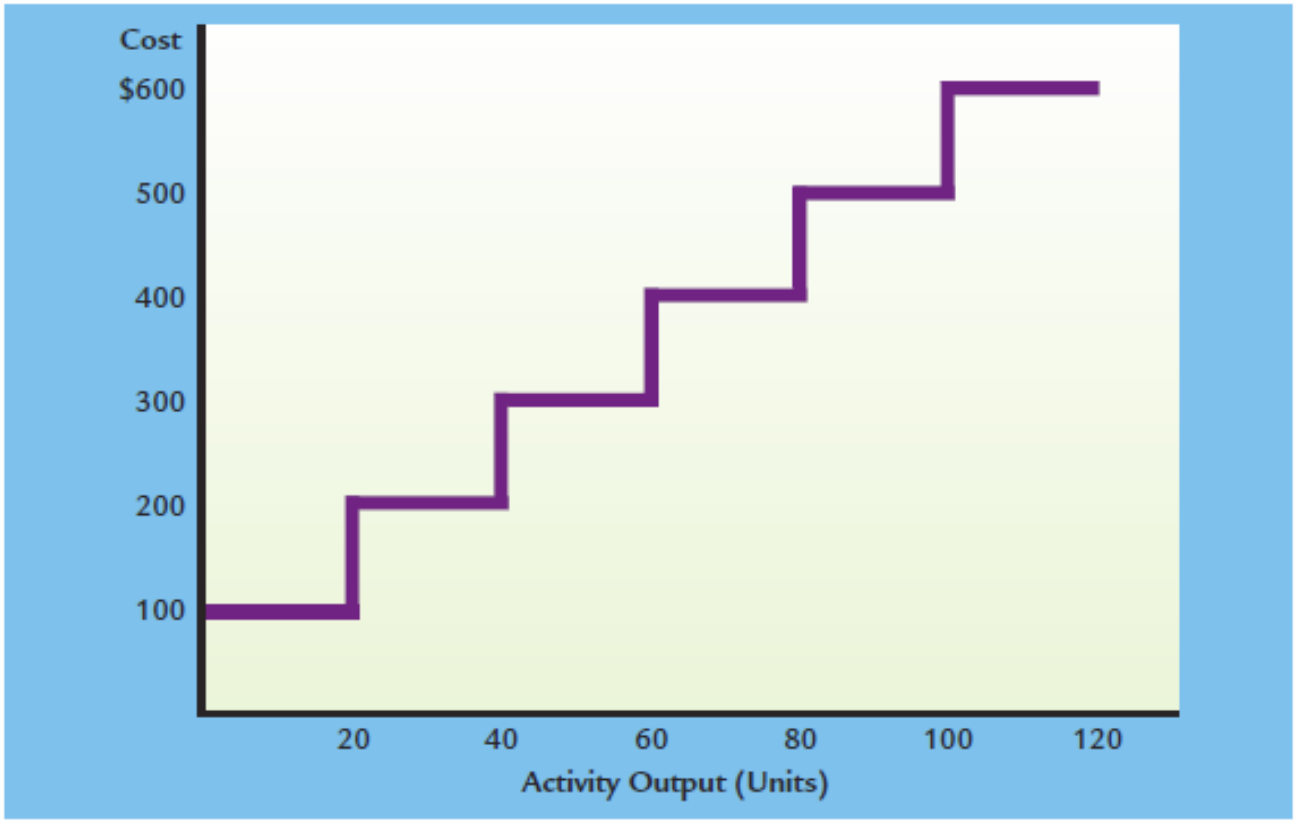
- Step-variable costs
  - Must be purchased in "chunks."
- Step-fixed costs
  - Many fixed costs are actually step-fixed costs.
  - Exceed the relevant range, and the costs increase "one step."

Objective 2

Resources, Activities, and Cost Behavior

EXHIBIT 3.6

Step-Cost Function

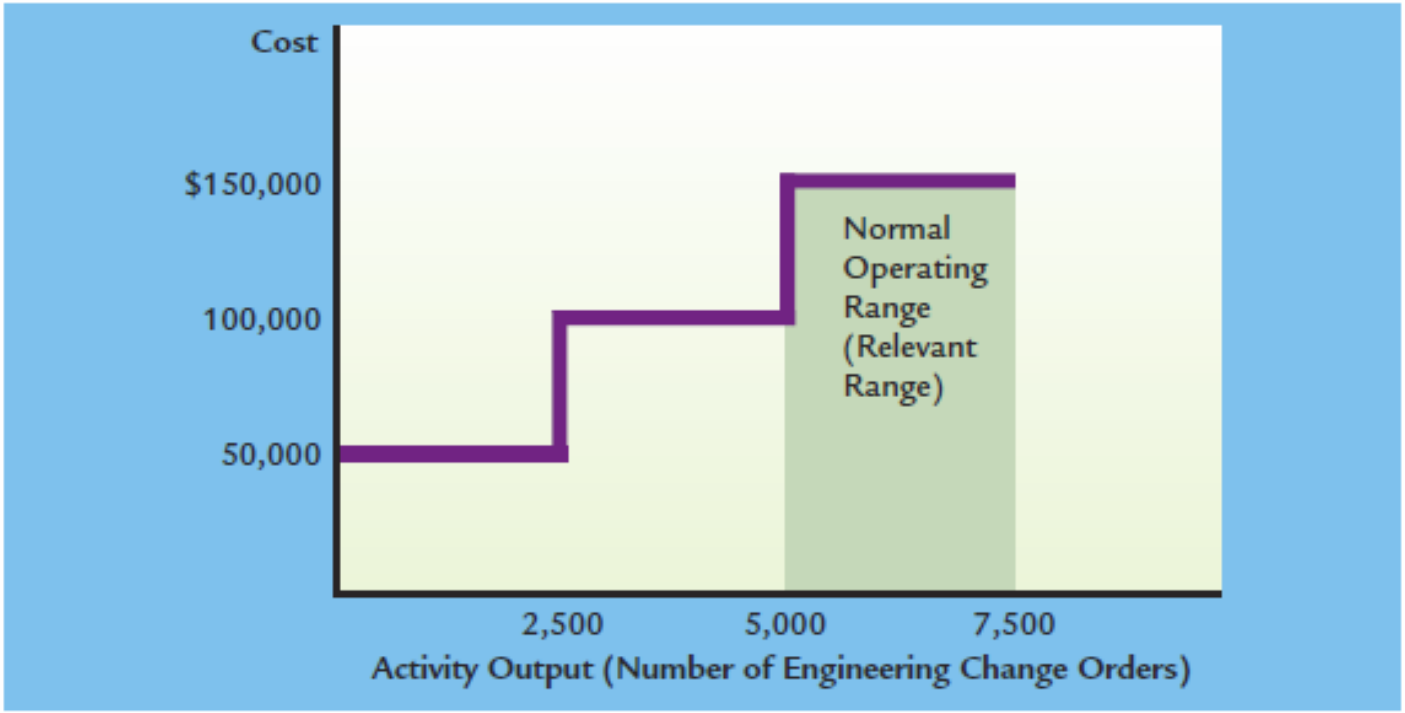


Objective 2

Resources, Activities, and Cost Behavior

EXHIBIT 3.7

Step-Fixed Costs



Objective 2

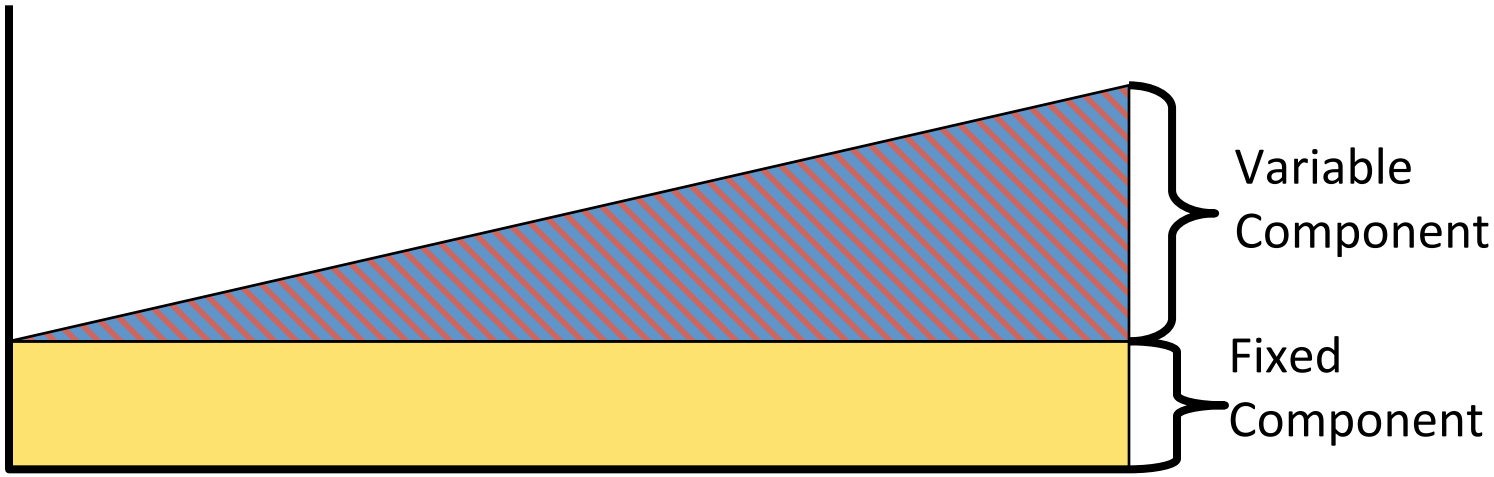
Resources, Activities, and Cost Behavior

- **Activities and Mixed Cost Behavior**
  - Many activities have characteristics of both flexible and committed resources.
    - For example, a power department acquires buildings and equipment in advance of actual usage an in excess of immediate demands.
    - However, it also acquires fuel to produce power on an as-needed basis.
  - Need for cost separation
    - Sometimes it is easy to spot the variable and fixed portion of a cost.
    - Other times it is not: thus the need for a method to separate costs into their fixed and variable components

Objective 2

Methods of Determining Cost Behavior

- The industrial engineering method
- The account analysis method



Objective 3

Quantitative Methods for Separating Fixed Cost

$$Y = F + VX$$

where:

Y = Total cost (the dependent variable)

F = Fixed cost (the intercept parameter)

V = Variable cost per unit (the slope parameter)

X = Measure of output (the independent variable)

Objective 4

Quantitative Methods for Separating Fixed Cost

The High-Low Method

Take two points (the high and the low by volume of activity) and determine the slope and intercept.

- Advantages
  - It is objective.
  - It is simple.
- Disadvantages
  - The high and low points may be "outliers."
  - The high and low points may not be representative of the points in general.

Objective 4

Quantitative Methods for Separating Fixed Cost

Scattergraphs

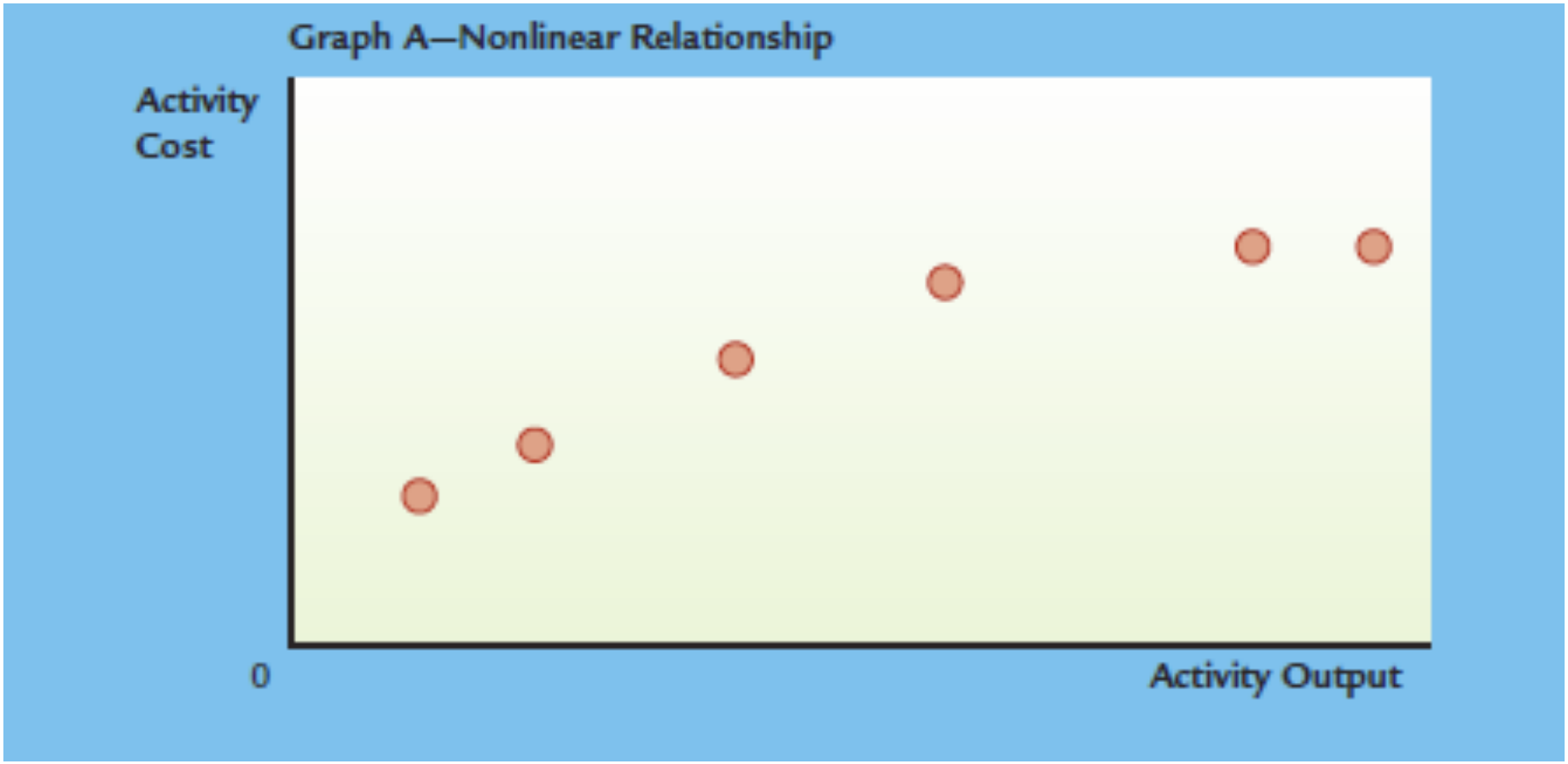
Use a scattergraph to visually assess the relationship between cost and output.

- Advantages
  - Allows for visual inspection of the data.
- Disadvantages
  - It is subjective.

Next let's look at some scattergraphs.

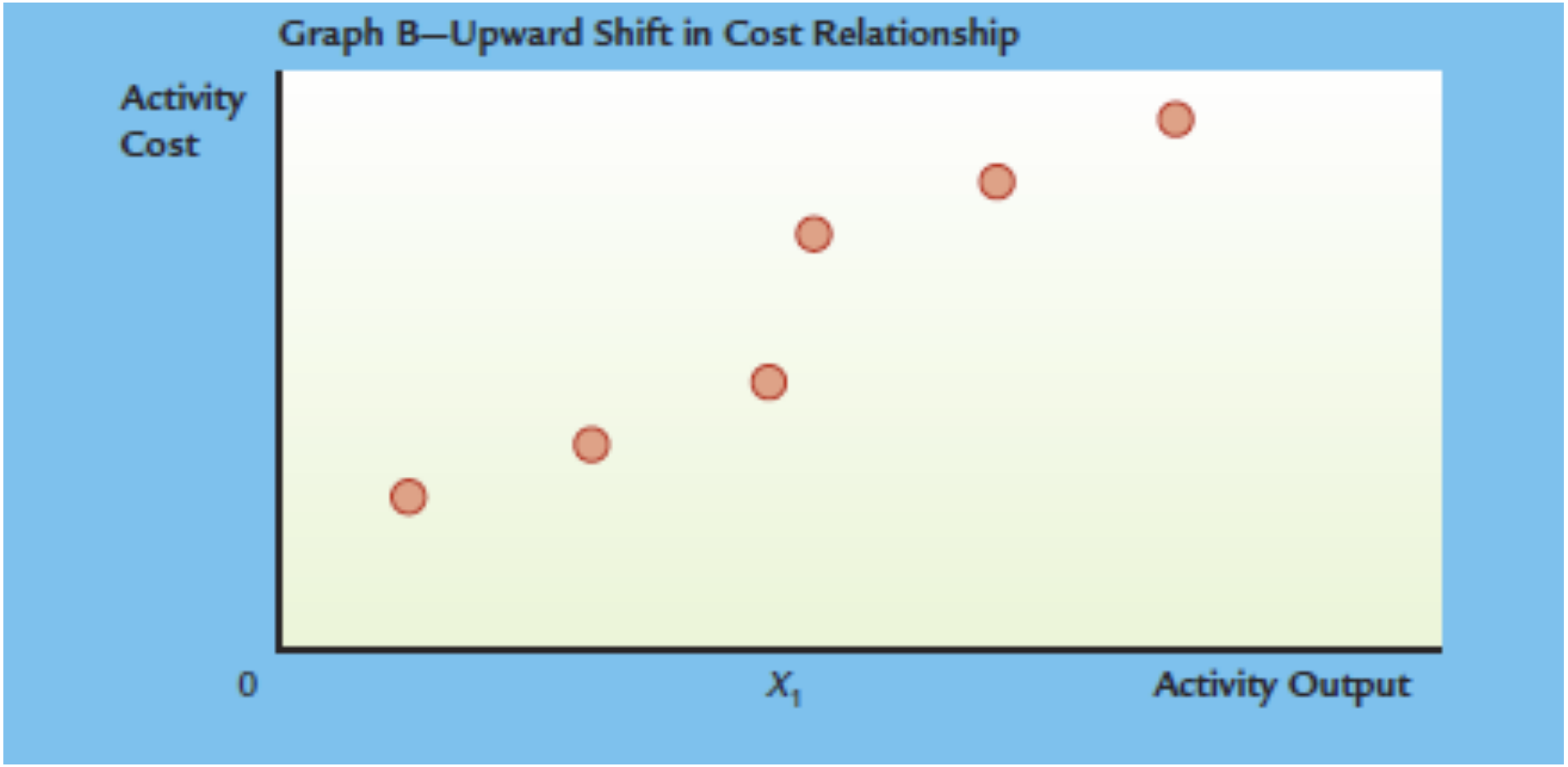
Objective 4

Scattergraph of a Nonlinear Relationship



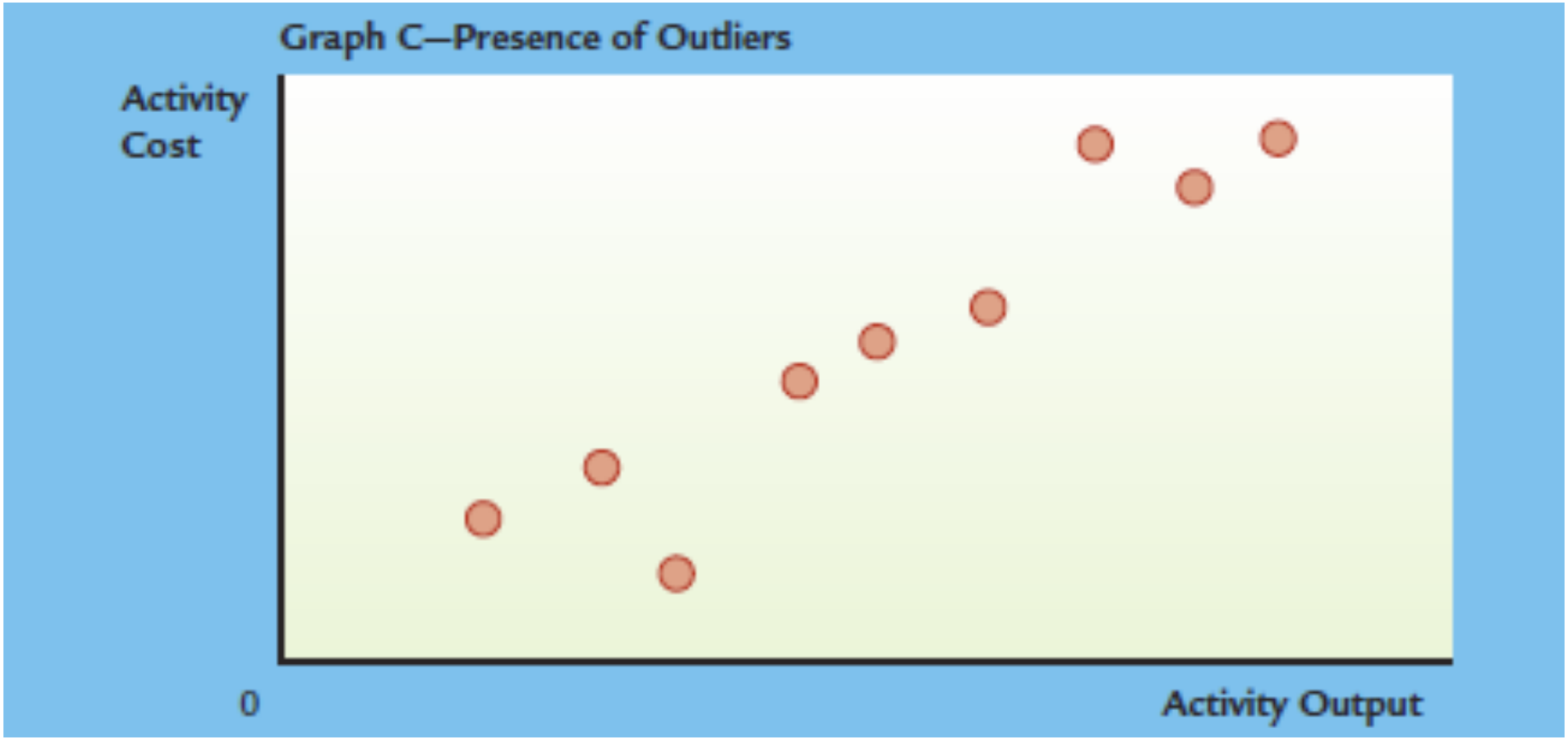
Objective 4

Scattergraph of an Upward Shift



Objective 4

Scattergraph with Outliers



Objective 4

3.3 High-Low Method

Month	Materials Handling Cost	Number of Moves	
January	$2,000	100	Low Activity
February	3,090	125	
March	2,780	175	
April	1,990	200	
May	7,500	500	High Activity
June	5,300	300	
July	4,300	250	
August	6,300	400	
September	5,600	475	
October	6,240	425	

Step 1: Solve for unit variable cost (*V*)

V = Change in cost ÷ Change in activity

3.3 High-Low Method

Month	Materials Handling Cost	Number of Moves	
January	$2,000	100	Low Activity
February	3,090	125	
March	2,780	175	
April	1,990	200	
May	7,500	500	High Activity
June	5,300	300	
July	4,300	250	
August	6,300	400	
September	5,600	475	
October	6,240	425	

$$\text{Step1: } V = \frac{\$7{,}500 - \$2{,}000}{500 - 100} = \$13.75$$

3.3 High-Low Method

Step 1: Solve for unit variable cost (*V*)
V = Change in cost ÷ Change in activity

$$V = \frac{\$7{,}500 - \$2{,}000}{500 - 100} = \$13.75$$

Step 2: Using either the high activity or low activity, solve for the total fixed costs *F*

Low Activity cost

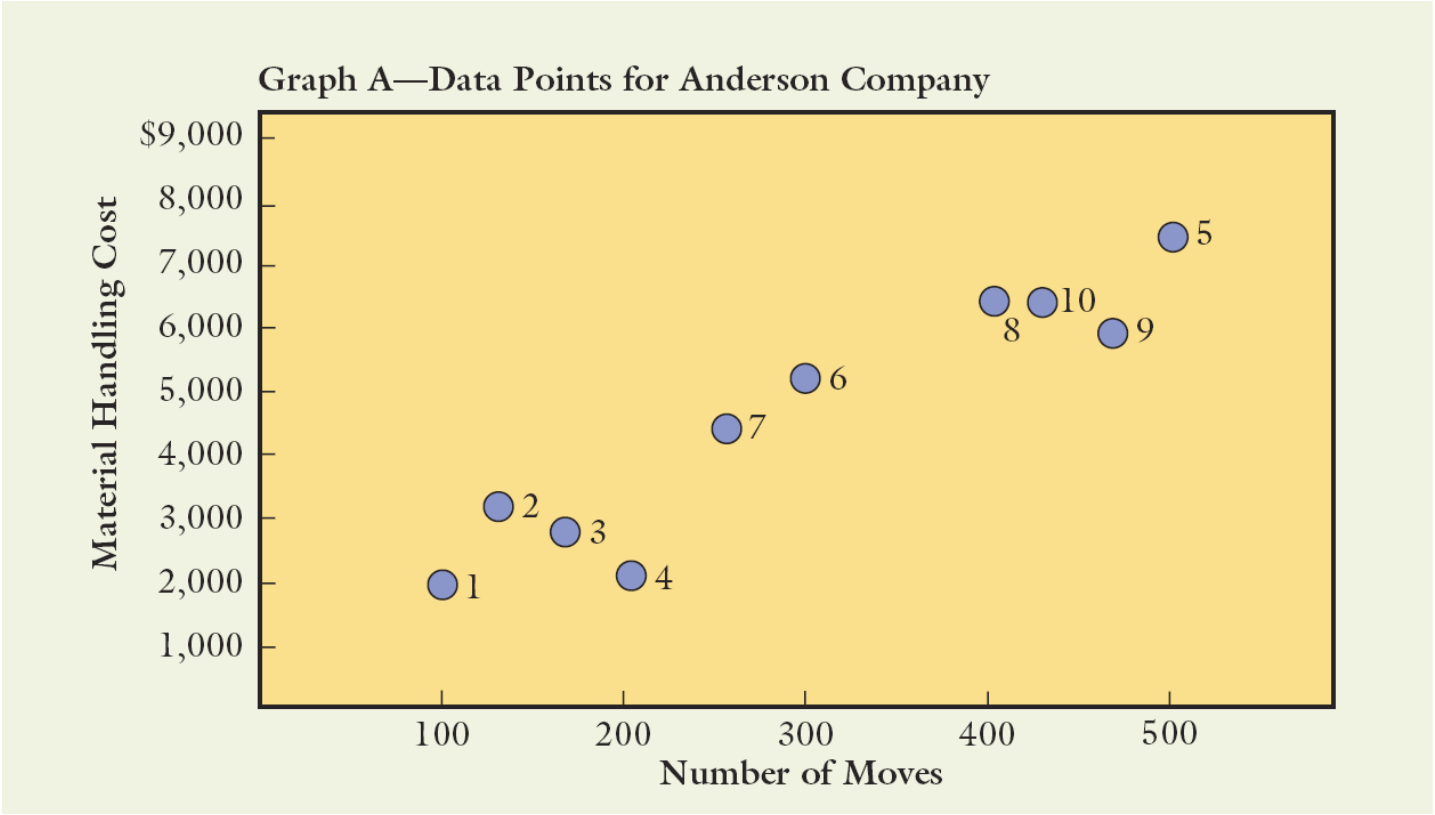
$$Y = F + V(X)$$
$$\$2{,}000 = F + \$13.75(100)$$
$$\$625 = F$$

High Activity cost

$$Y = F + V(X)$$
$$\$7{,}500 = F + \$13.75(500)$$
$$\$625 = F$$

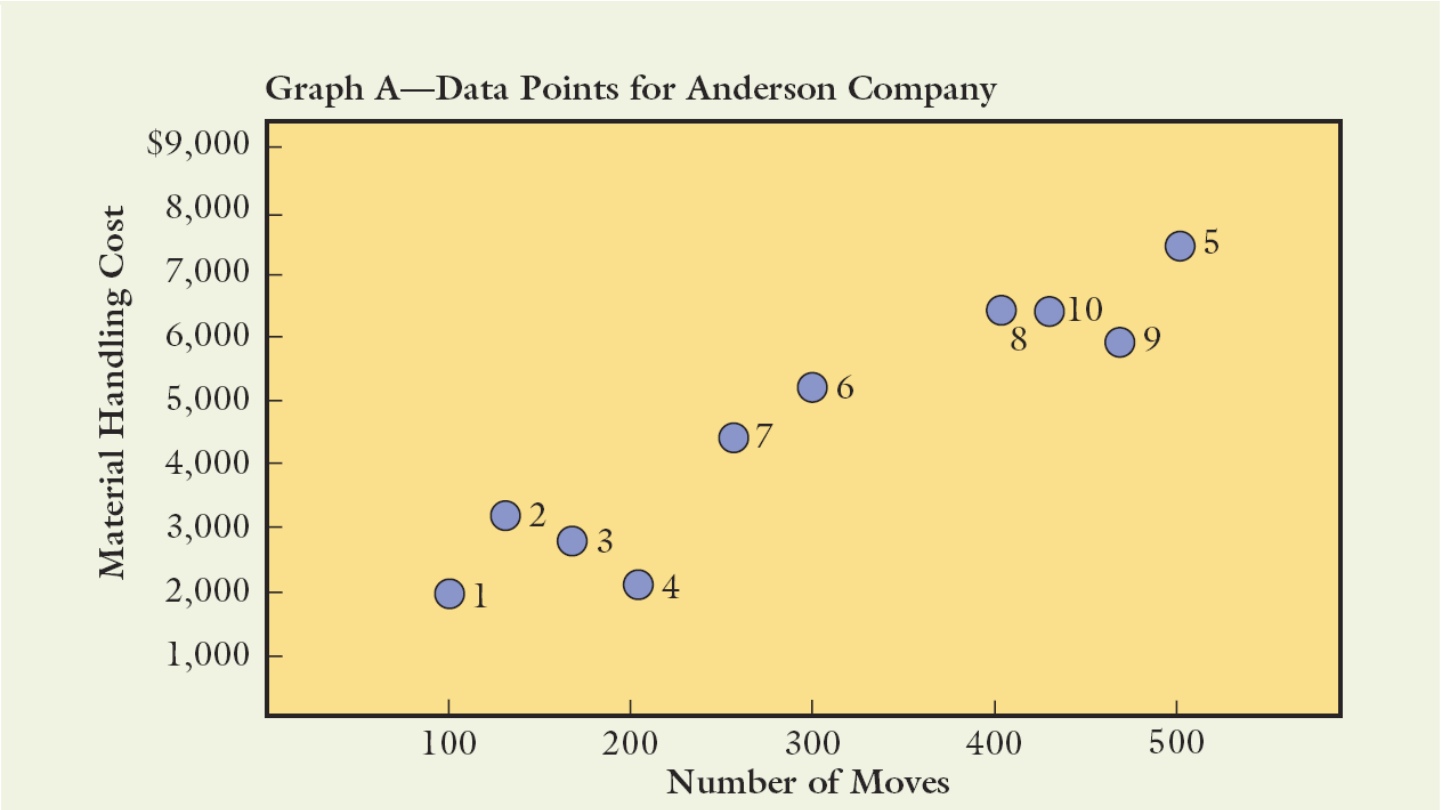
3.3 Scatterplot Method

Step 1: Plot the data points on a scattergraph



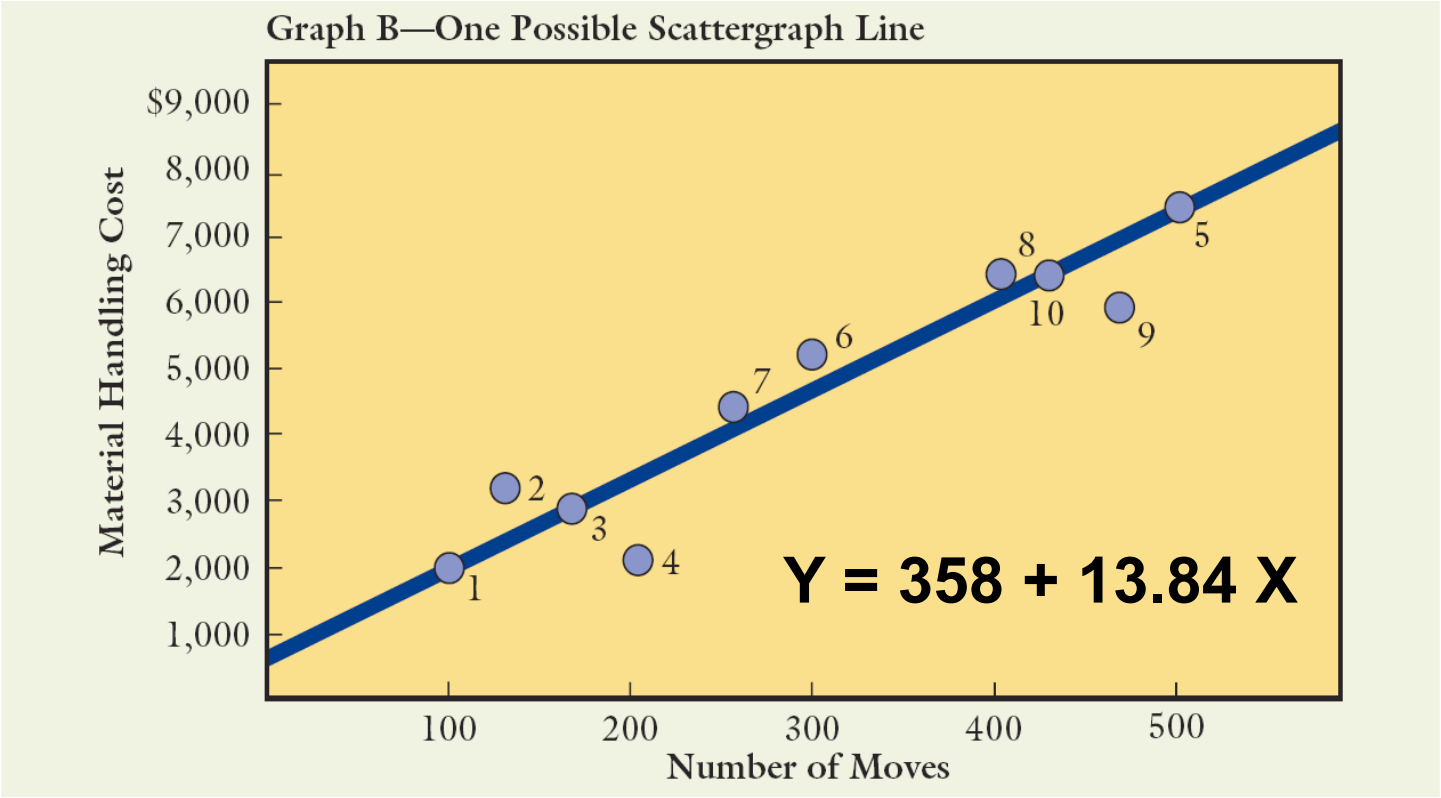
3.3 Scatterplot Method

Step 2: Choose the two data points most representative of the data to describe the cost behavior line…ex: 3 &10



3.3 Scatterplot Method

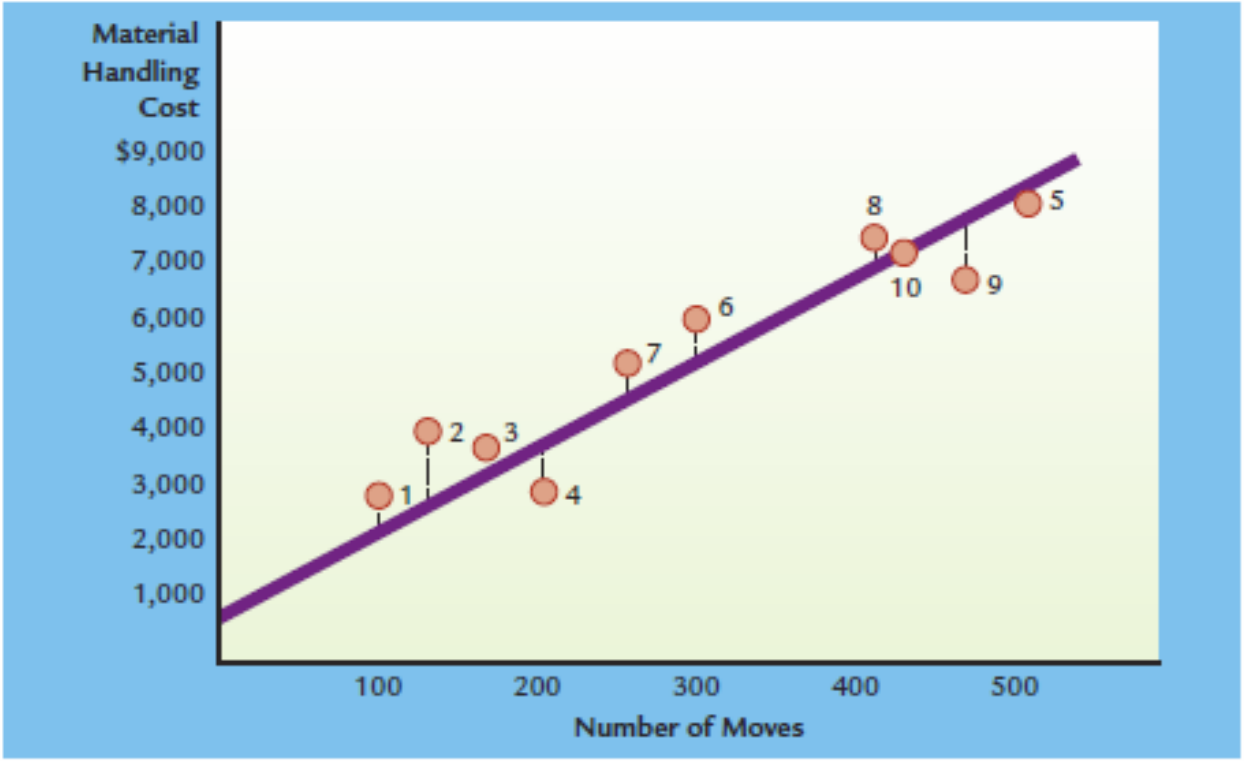
Step 2: Choose the two data points most representative of the data to describe the cost behavior line…ex: 3 &10



The Method of Least Squares- Deviations of Data from a Line

EXHIBIT 3.10

Deviations of Data from a Line



Objective 4

Method of Least Squares

Y = 358 + 13.84 X

Actual Cost	Predicted Cost	Deviation	Deviation Squared
2,000	1,742	258	66,564
3,090	2,088	1,002	1,004,004
2,780	2,780	-	-
1,990	3,126	(1,136)	1,290,496
7,500	7,278	222	49,284
5,300	4,510	790	624,100
4,300	3,818	482	232,324
6,300	5,894	406	164,836
5,600	6,932	(1,332)	1,774,224
6,240	6,240	-	-
		Total measure of closeness	5,205,832

Regression Programs

- The *best-fitting line* is the line with the smallest sum of squared deviations
- Regression analysis determines the linear function with the minimum sum of squared deviations
- Utilize spreadsheet packages such as Microsoft Excel to perform the computation

The Method of Least Squares- Using Excel to do Regression

Enter the data into the spreadsheet:

Spreadsheet Data for Anderson Company.xls

	A	B	C	D	E	F	G	H	I
1	Month	Cost	# Moves						
2	January	$2,000	100						
3	February	3,090	125						
4	March	2,780	175						
5	April	1,990	200						
6	May	7,500	500						
7	June	5,300	300						
8	July	4,300	250						
9	August	6,300	400						
10	September	5,600	475						
11	October	6,240	425						
12									
13									
14									
15									
16									
17									
18									
19									
20									

Sheet1 Sheet2 Sheet3

Objective 4

The Method of Least Squares- Using Excel to do Regression

- Once the data is entered:
  - Choose the "Tools" menu
  - Choose the "Data Analysis" option
    - If this is not available you may have to manage add-ins.
  - Scroll down to "Regression"
  - Click on "Input Y Range" and highlight the cost cells
  - Click on "Input X Range" and highlight the driver cells
  - Choose your preferred location for output.
  - Click ok.

Objective 4

The Method of Least Squares- Using Excel to do Regression

Here is the output Excel creates:

Regression Output for Anderson Company.xls

	A	B	C	D	E	F
1	**SUMMARY OUTPUT**					
2	*Regression Statistics*					
3	Multiple R	0.928949080				
4	R Square	0.862946394				
5	Adjusted R Square	0.845814693				
6						
7	Square					
8	Standard Error	770.4987038				
9	Observations	10				
10						
11	**ANOVA**					
12		*df*	*SS*	*MS*	*F*	*Significance F*
13	Regression	1	29903853.98	29903853.98	50.37132077	0.000102268
14	Residual	8	4749346.021	593668.2526		
15	Total	9	34653200			
16						
17						
18		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	
19	Intercept	854.4993582	569.7810263	1.499697811	0.172079925	
20	*X* Variable 1	12.3915276	1.745955536	7.097275588	0.000102268	
21						

Sheet1 Sheet2 Sheet3

Objective 4

The Method of Least Squares- Using Excel to do Regression

- Interpreting the results:
  - Under "coefficients" in the bottom left of the output find the intercept and the slope
  - Write the equation:
    - Y = 12.39X + 854.50
  - Use the equation to make a point estimate:
    - At a point of 350 moves the total cost is predicted to be:
      - Y = 12.39(350) + 854.50
      - Y = $4336.50

Objective 4

Reliability of Cost Formulas

- Hypothesis test of cost parameters
  - The t Stat tests the hypothesis that the parameters are different that zero.
  - The P-value is the level of significance achieved.
    - Generally we are comfortable with a value of 0.05 or less.

Objective 5

Reliability of Cost Formulas

- Goodness of fit
  - The coefficient of determination, or R^2, shows the percentage of variability in the dependent variable explained by the independent variable(s).
    - The adjusted R^2 takes into account how many independent variables we have used; therefore we usually prefer it to the unadjusted R^2.
  - The coefficient of correlation, or R, is the square root of the coefficient of determination.
    - It ranges from positive to negative one.
    - The higher the magnitude, the greater the correlation.

Objective 5

Reliability of Cost Formulas

- Confidence Intervals

$$\mathbf{Y_f \pm tS_e}$$

  - This is the formula for calculating a confidence interval.
  - Y_f is the predicted cost for a given level of activity.
  - t is the t distribution (get this from the table in your book)
  - S_e is the standard error shown in your regression output.

Objective 5

Multiple Regression

$$Y = F + V_1X_1 + V_2X_2 \; etc.$$

- More than one independent variable can be used to explain the dependent variable.
  - Our single independent variable, number of moves, explained 85% of the variance in our dependent variable, materials handling.
  - Adding another independent variable might increase the explanatory power of our model.
  - Performing the regression is very similar.
    - Input the data – make sure the two independent variables are side by side.
    - Follow the same directions, but select both independent variable columns for the "input x range."

Objective 6

Multiple Regression

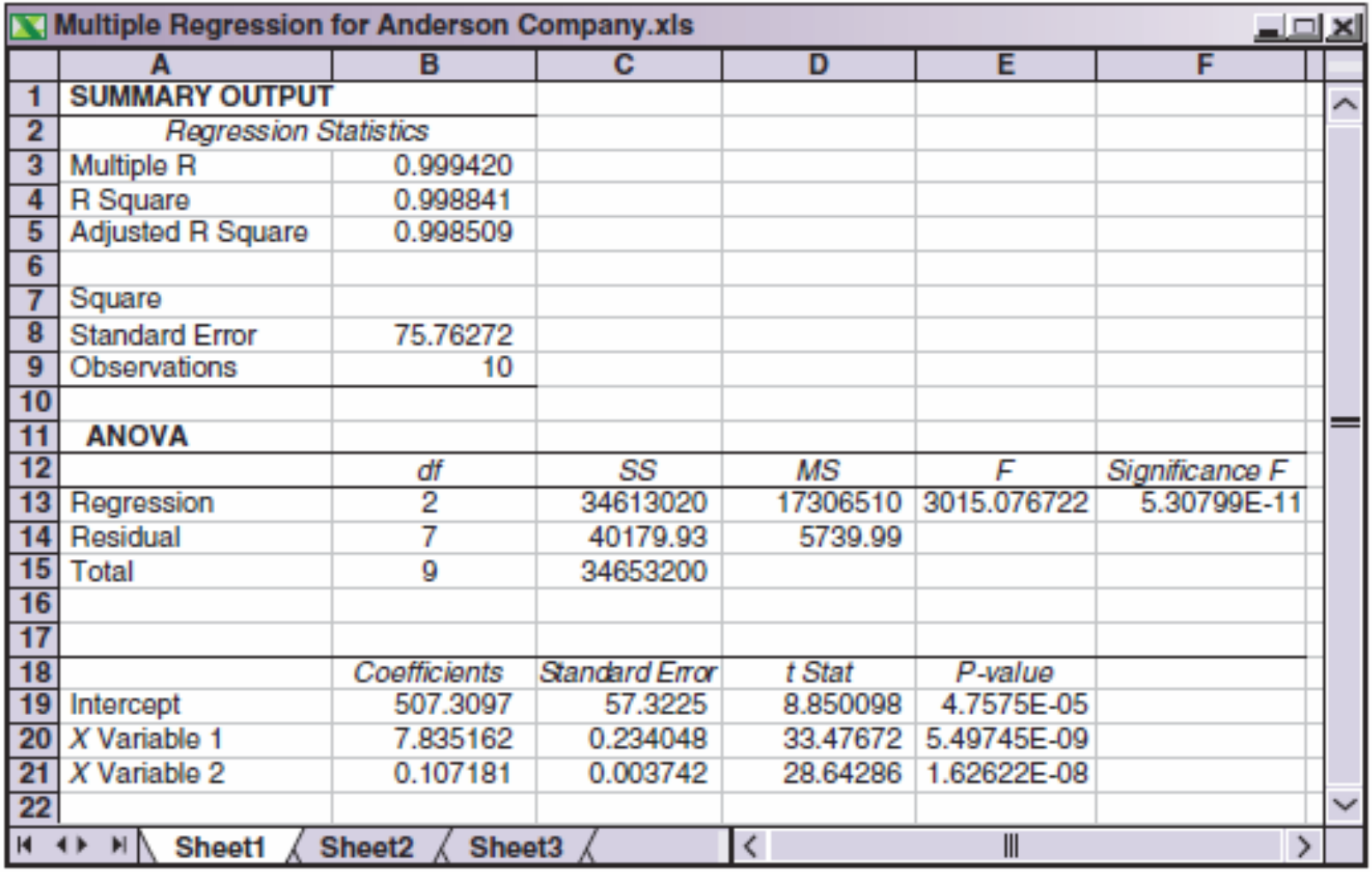
Spreadsheet Data for Anderson Company

Month	Materials Handling Cost	Number of Moves	Pounds Moved
January	$2,000	100	6,000
February	3,090	125	15,000
March	2,780	175	7,800
April	1,990	200	600
May	7,500	500	29,000
June	5,300	300	23,000
July	4,300	250	17,000
August	6,300	400	25,000
September	5,600	475	12,000
October	6,240	425	22,400

X_1

X_2

Multiple Regression



Multiple Regression for Anderson Company.xls

	A	B	C	D	E	F
1	**SUMMARY OUTPUT**					
2	*Regression Statistics*					
3	Multiple R	0.999420				
4	R Square	0.998841				
5	Adjusted R Square	0.998509				
6						
7	Square					
8	Standard Error	75.76272				
9	Observations	10				
10						
11	**ANOVA**					
12		*df*	*SS*	*MS*	*F*	*Significance F*
13	Regression	2	34613020	17306510	3015.076722	5.30799E-11
14	Residual	7	40179.93	5739.99		
15	Total	9	34653200			
16						
17						
18		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	
19	Intercept	507.3097	57.3225	8.850098	4.7575E-05	
20	*X* Variable 1	7.835162	0.234048	33.47672	5.49745E-09	
21	*X* Variable 2	0.107181	0.003742	28.64286	1.62622E-08	
22						

Sheet1 Sheet2 Sheet3

Objective 6

Multiple Regression

- Interpreting the results:
  - Under "coefficients" in the bottom left of the output find the intercept and the slope
  - Write the equation:

$$Y = 7.84X_1 + 0.11X_2 + 507.31$$

- Examine reliability of the new model:
  - Adjusted R^2 is 99% - a significant improvement.
  - The p-values are all very good as well.
  - Note that the t statistic drops to 7 degrees of freedom because another independent variable is used.

Objective 6

Multiple Regression

Based on the multiple regression analysis, the cost formula is written as:

$$Y = \$507 + \$7.84X_1 + \$0.11X_2$$

In November the company expects to make 350 moves with a weight of 17,000 pounds. The predicted cost of material handling is:

$$Y = \$507 + \$7.84(350) + \$0.11(17{,}000)$$

$$= \$507 + \$2{,}744 + \$1{,}870$$

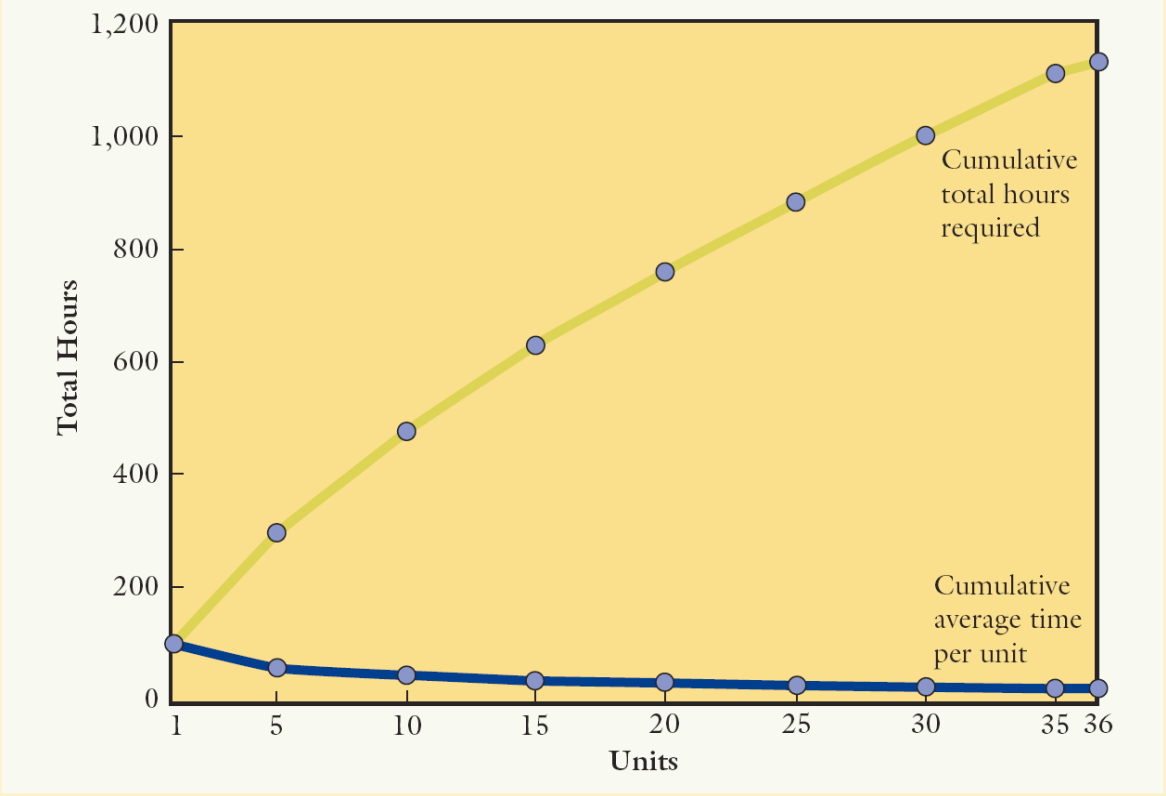
$$= \mathbf{\$5{,}121}$$

The Learning Curve and Nonlinear Cost Behavior

- The learning curve shows how labor hours per unit decreases as units produced increases.
- The experience curve relates cost to increased efficiency – the more you perform a task the lower the cost is of doing it.
- The cumulative average-time learning curve model states that the cumulative average time per unit decreases by a constant percentage.
- The learning rate is expressed as a percent.
- The incremental unit-time learning curve model decreases by a constant percentage each time the cumulative quantity of units produced doubles.

Objective 7

Graph of Cumulative Total Hours Required and the Cumulative Average Time per Unit



Y = Cum. Ave. Time per unit

X = Cum. No. of units

p = Time in hrs. to produce first unit

q = Rate of learning

$$q = \frac{\ln(\%\,\text{learning})}{\ln 2}$$

$$Y = p\,X^{q}$$

$$T_N = T_1 \times N^{q}$$

Cumulative Average Time Learning Curve with 80% Learning Rate

Cumulative Number of Units (1)	Cumulative Average Time per Unit in Hours (2)		Cumulative Total Time: Labor Hours (3) = (1) × (2)	Individual Units Time for *n*th Unit-Labor Hours (4)
1	100		100	100
2	80	(80% × 100)	160	60
3	70.21		210.63	50.63
4	64	(80% × 80)	256	45.37
5	59.57		297.85	41.85
6	56.17		337.02	39.17
7	53.45		374.15	37.13
8	51.20	(80% × 64)	409.60	35.45
16	40.96		655.36	28.06
32	32.77		1,048.64	

q = ln (0.80)/ln (2.0) = -0.3219 so T4=100 x 4^-0.3219 = 64

Managerial Judgement

- Managerial judgment is the most widely used method in practice.
  - Managers may just use their experiences and observations to determine fixed and variable costs.
  - Managers may identify mixed costs and use experience to determine what part is fixed – thus denoting the rest as variable.
  - This is a simple method and when the manager has a good understanding of the processes can yield good results.
  - However poor judgment yields poor results.

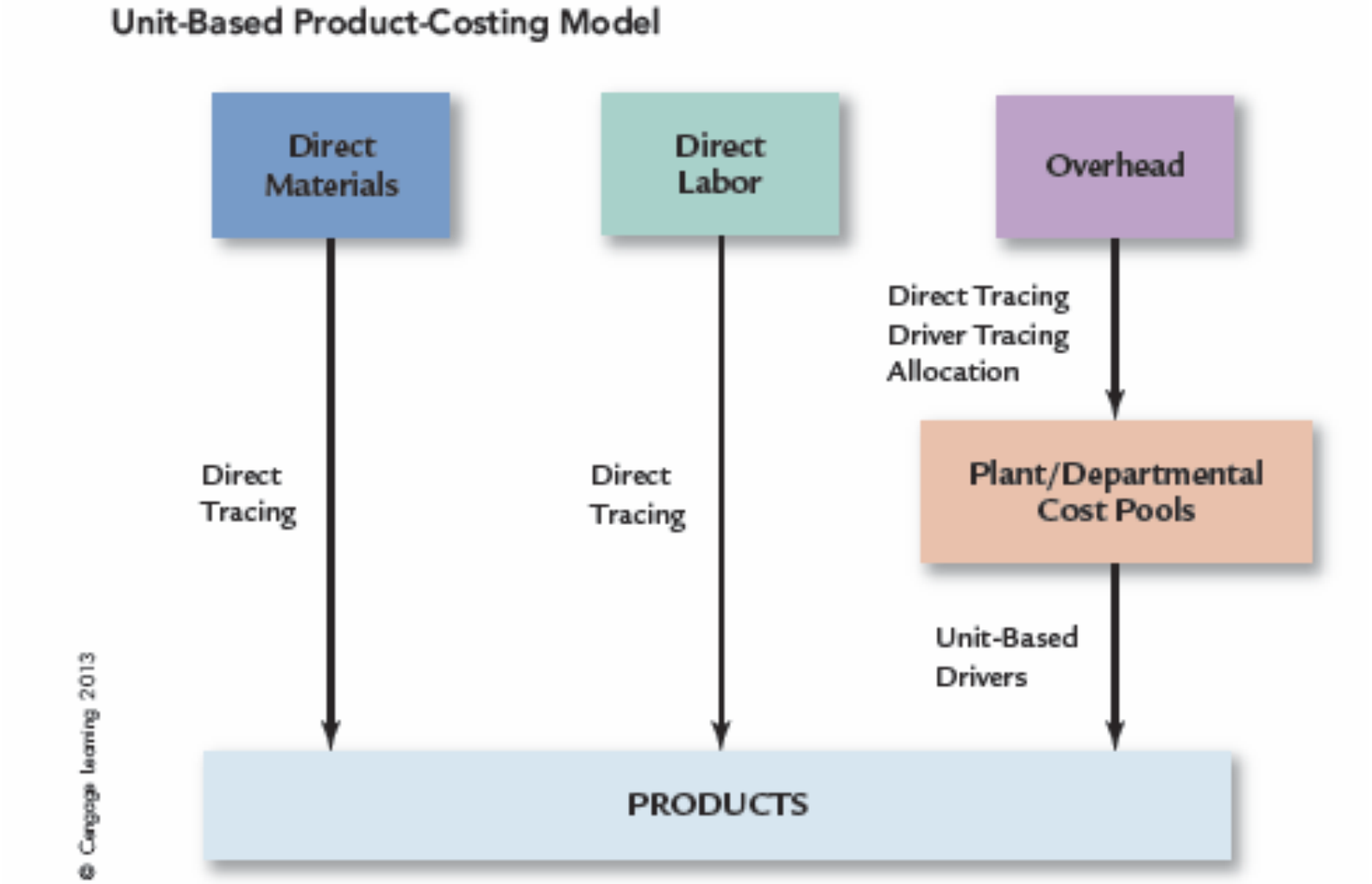
Objective 8

Activity-Based Costing

Chapter 4 Objectives

1. Describe the basics of plantwide and departmental overhead costing.
2. Explain why plantwide and departmental overhead costing may not be accurate.
3. Provide a detailed description of activity-based product costing.
4. Explain how ABC can be simplified.

Unit-Level Product Costing



Objective 1

Unit-Level Product Costing

Overhead costs are assigned to products using ***predetermined overhead rates***.

$$\text{Predetermined overhead rate} = \frac{\textbf{Budgeted annual overhead}}{\textbf{Budgeted annual driver level}}$$

Applied overhead = **Overhead rate × Actual driver usage**

Objective 1

Unit-Level Product Costing

Overhead Variances

The difference between actual overhead and applied overhead is an **overhead variance**.

If actual overhead > applied overhead:
underapplied overhead

If actual overhead < applied overhead:
overapplied overhead

Disposal of variance:
If immaterial, assign to cost of goods sold.
If material, allocate between work-in-process inventory, finished goods inventory, and cost of goods sold.

Objective 1

Unit-Level Product Costing

Overhead Application: Departmental Rates

- Departmental Rates
- Costs assigned to individual production department overhead cost pools.
- Unit level drivers for each department are identified.
  - Pre-determined rates are calculated for each department.
  - Overhead is *applied* to each product for each department that product passes through.

Objective 1

Unit-Level Product Costing

Unit level drivers: Factors that measure the demands placed on unit-level activities by products

Unit level activities: Activities performed each and every time a unit of a product is produced.

Five most commonly used unit level drivers:

1. Units produced
2. Direct labor hours
3. Direct labor dollars
4. Machine hours
5. Direct material dollars

Objective 1

Overhead Application: Plantwide Rates

Suncal, Inc.

Budgeted overhead	$360,000
Expected activity (in direct labor hours)	120,000
Predetermined overhead rate	**$ 3.00**

	Pocket calculator	Currency translator
Actual activity (in direct labor hours)	40,000	60,000
Predetermined overhead rate	$3.00	$3.00
Overhead applied to production	$120,000	$180,000
Units produced	80,000	90,000
Overhead per unit	$1.50	$2.00

Overhead Application: Plantwide Rates

Recall, the budgeted overhead was $360,000. Rarely are the actual overhead and activity driver rates as budgeted. Consider, when the actual overhead is $320,000.

	Pocket calculator	Currency translator	Total
Actual activity (in direct labor hours)	40,000	60,000	
Predetermined overhead rate	$3.00	$3.00	
Overhead applied to production	$120,000	$180,000	$300,000
Units produced	80,000	90,000	
Overhead per unit	$1.50	$2.00	
Actual overhead			320,000
Underapplied overhead			$20,000

Overhead Application: Departmental Rates

	Production Departments		
	Fabrication	Assembly	Total
Overhead	$ 280,000	$ 80,000	$ 360,000
Direct labor hours:			
Pocket calculator	10,000	30,000	40,000
Currency translator	10,000	50,000	60,000
Total DL hours	20,000	80,000	100,000
Machine hours:			
Pocket calculator	5,000	1,000	6,000
Currency translator	15,000	2,000	17,000
Total machine hours	20,000	3,000	23,000
Application rate	$ 14.00 per machine hour	$ 1.00 per direct labor hour	

Overhead Application: Departmental Rates

	Pocket calculator	Currency translator
Fabrication:		
5,000 hr × $14.00	$70,000	
15,000 hr × $14.00		$210,000
Assembly:		
30,000 hr × $1.00	30,000	
50,000 hr × $1.00		50,000
	$100,000	$260,000
Units produced	80,000	90,000
Overhead per unit	$1.25	$2.89

Limitations of Plantwide and Departmental Rates

- **Non-Unit-Related Overhead Costs**
  - Plantwide and department rates assume that a product's consumption of overhead is directly related to units produced.
  - Some costs, however, such as setups cost a certain amount no matter how many products are produced.
  - Other costs, such as engineering hours, may depend on something entirely different, such as work orders, not units.

Objective 2

Limitations of Plantwide and Departmental Rates

	Scented Cards	Regular Cards	Total
Units produced per year	20,000	200,000	—
Prime costs	$160,000	$1,500,000	$1,660,000
Direct labor hours	20,000	160,000	180,000
Number of setups	60	40	100
Machine hours	10,000	80,000	90,000
Inspection hours	2,000	16,000	18,000
Number of moves	180	120	300

	Departmental Data		
	Cutting Dept.	Printing Dept.	Total
Direct labor hours:			
Scented cards	10,000	10,000	20,000
Regular cards	150,000	10,000	160,000
Total	160,000	20,000	180,000
Machine hours:			
Scented cards	2,000	8,000	10,000
Regular cards	8,000	72,000	80,000
Total	10,000	80,000	90,000
Overhead costs:			
Setting up equipment	$120,000	$120,000	$240,000
Moving materials	60,000	60,000	120,000
Machining	20,000	180,000	200,000
Inspecting products	16,000	144,000	160,000
Total	$216,000	$504,000	$720,000

Unit Cost Based on Plantwide and Departmental Rates

	Scented	Regular
PLANT-WIDE RATE		
Prime costs	$ 160,000	$ 1,500,000
Overhead costs:		
$4.00 × 20,000	80,000	
$4.00 × 160,000		640,000
Total manufacturing costs	$ 240,000	$ 2,140,000
Units of production	20,000	200,000
Unit cost	$ 12.00	$ 10.70

This schedule uses the data from previous slide to determine unit cost using a single plant-wide overhead rate based on direct labor hours: $720k/180,000= $4/DLH.

4.2 Unit Cost Based on Plantwide and Departmental Rates

	Scented	Regular
PLANT-WIDE RATE		
Prime costs	$ 160,000	$ 1,500,000
Overhead costs:		
$4.00 × 20,000	80,000	
$4.00 × 160,000		640,000
Total manufacturing costs	$ 240,000	$ 2,140,000
Units of production	20,000	200,000
Unit cost	$ 12.00	$ 10.70
DEPARTMENTAL RATES		
Prime costs	$ 160,000	$ 1,500,000
Overhead costs:		
Cutting Department:		
$1.35 × 10,000	13,500	
$1.35 × 150,000		202,500
Printing deparment:		
$6.30 × 8,000	50,400	
$6.30 × 72,000		453,600
Total manufacturing costs	$ 223,900	$ 2,156,100
Units of production	20,000	200,000
Unit cost	$ 11.20	$ 10.78

This schedule uses the data from previous slides to determine unit cost using a single plantwide overhead rate based on direct labor hours: $720k/180,000= $4/DLH.

This schedule uses the data from previous slides to determine unit cost using department overhead rates based on labor (cutting) and machine (printing) hours.

Limitations of Plantwide and Departmental Rates

	Scented Cards	Regular Cards	Total
Units produced per year	20,000	200,000	—
Prime costs	$160,000	$1,500,000	$1,660,000
Direct labor hours	20,000	160,000	180,000
Number of setups	60	40	100
Machine hours	10,000	80,000	90,000
Inspection hours	2,000	16,000	18,000
Number of moves	180	120	300

	Departmental Data		
	Cutting Dept.	Printing Dept.	Total
Direct labor hours:			
Scented cards	10,000	10,000	20,000
Regular cards	150,000	10,000	160,000
Total	160,000	20,000	180,000
Machine hours:			
Scented cards	2,000	8,000	10,000
Regular cards	8,000	72,000	80,000
Total	10,000	80,000	90,000
Overhead costs:			
Setting up equipment	$120,000	$120,000	$240,000
Moving materials	60,000	60,000	120,000
Machining	20,000	180,000	200,000
Inspecting products	16,000	144,000	160,000
Total	$216,000	$504,000	$720,000

4.2 Limitations of Plantwide and Departmental Rates

	Scented	Regular
ACTIVITY RATES		
Prime costs	$ 160,000	$ 1,500,000
Overhead costs:		
Setting up:		
$2,400 × 60	144,000	
$2,400 × 40		96,000
Machining:		
$2.22 × 10,000	22,200	
$2.22 × 80,000		177,600
Inspecting:		
$8.89 × 2,000	17,780	
$8.89 × 16,000		142,240
Moving materials:		
$400 × 180	72,000	
$400 × 120		48,000
Total manufacturing costs	$ 415,980	$ 1,963,840
Units of production	20,000	200,000
Unit cost	$ 20.80	$ 9.82

4 Activities:

Setup
- Cost $240,000
- Qty 100

Machining
- Cost $200,000
- Qty 90,000

Inspecting
- Cost $160,000
- Qty 18,000

Moving materials
- Cost $120,000
- Qty 300

Limitations of Plantwide and Departmental Rates

- **Product Diversity**
  - Even if there are significant non-unit driven overhead costs, it will not cause distorted costing if the products all consume overhead in the same proportion as unit-level driven overhead costs.
  - **Product diversity** simply means that products consume overhead activities in different proportions.
    - This can be caused by differences in product size, complexity, setup time, batch size, etc.
  - The proportion of each activity consumed by a product is called the **consumption ratio.**

Objective 2

Limitations of Plantwide and Departmental Rates

- **Problems with Costing Accuracy**
  - At the toy manufacturer discussed in the text race cars use 40,000 hours of labor and robots use 10,000. If a plantwide rate is used, race cars will receive four times the amount of overhead assigned to robots!
  - But look at the activities:
    - Race cars use three times as many setups as robots.
    - Race cars use about 2 ⅓ times as many inspection hours as robots.
    - Race cars use about 1 ½ times as many moves as robots.
  - Is it fair to assign four times as much overhead to race cars as to robots?

Objective 2

Limitations of Plantwide and Departmental Rates

- **Activity Rates: A Better Approach**
  - Instead of using a single pool or department pools based on units, expand the number of pools and rates and base them on activities.
  - The rates are based on causal factors that measure consumption – both unit and non-unit based.
  - Thus in our toy manufacturer we can use four pools related to our four activities: machining, setups, moving materials, and inspections.

Objective 2

Limitations of Plantwide and Departmental Rates : ANOTHER EX.

Comparison of methods

- Two producing departments: molding and assembly.
- Two products: race cars and robots.
- Five times more race cars than robots are produced making race cars a high-volume product and robots a low-volume product.
- The molds for robots are larger and more varied than those for race cars.
- Four types of overhead activities are performed: setups, machining, inspection, and moving batches.

Objective 2

Limitations of Plantwide and Departmental Rates : ANOTHER EX.

Comparison of methods

I. *Activity Usage Measures (expected and actual)*

	Robots	Race Cars	Total
Units produced	50,000	250,000	—
Prime costs	$200,000	$750,000	$950,000
Direct labor hours	10,000	40,000	50,000
Machine hours	20,000	10,000	30,000
Number of setups	25	75	100
Inspection hours	1,200	2,800	4,000
Number of moves	140	210	350

Objective 2

Limitations of Plantwide and Departmental Rates : ANOTHER EX.

Comparison of methods

II. *Departmental Data (expected and actual)*

	Molding	Assembly	Total
Direct labor hours:			
Robots	5,000	5,000	10,000
Race cars	5,000	35,000	40,000
Total	10,000	40,000	50,000
Machine hours:			
Robots	17,000	3,000	20,000
Race cars	3,000	7,000	10,000
Total	20,000	10,000	30,000
Overhead costs:			
Machining	$120,000	$ 30,000	$150,000
Moving materials	40,000	30,000	70,000
Setting up	70,000	10,000	80,000
Inspecting products	20,000	30,000	50,000
Total	$250,000	$100,000	$350,000

Objective 2

Limitations of Plantwide and Departmental Rates : ANOTHER EX.

EXHIBIT 4.4

Comparison of Unit Costs

	Total Unit Cost			Unit Overhead Cost		
	Robots	Race Cars		Robots	Race Cars	
Activity-based cost	$7.26	$3.75	Cornerstone 4.5	$3.26	$0.75	Cornerstone 4.5
Unit-based cost:						
Plantwide rate	5.40	4.12	Exhibit 4.3	1.40	1.12	Cornerstone 4.1
Departmental rates	8.50	3.50	Exhibit 4.3	4.50	0.50	Cornerstone 4.3

Objective 2

Activity-Based Costing System

Design Steps for an ABC System

- **Identify, define, and classify activities and key attributes.**
  - A simple list of activities identified is called an **activity inventory**.
  - **Activity attributes** are nonfinancial and financial information items that describe individual activities.
  - An **activity dictionary** lists the activities in an organization along with desired attributes.
  - A **primary activity** is one that is consumed by the final cost object.

Objective 3

Activity-Based Costing System

Design Steps for an ABC System

- **Assign the cost of resources to activities.**
  - The cost of an activity is simply the cost of the resources consumed by that activity.
  - If a resource is exclusive to an activity, assign 100% of the cost to the activity
  - If the resource is split between more than one activity, determine a **resource driver**.
- **Assign the cost of secondary activities to primary activities.**
  - Treat the secondary activity like a resource from the previous step.

Objective 3

Activity-Based Costing System

Design Steps for an ABC System

- **Identify cost objects and specify the amount of each activity consumed by them.**
  - Assign costs consumed by more than one activity in proportion to their usage of the activity as measured by the **activity driver.**
    - **Transaction drivers** measure the number of times an activity is performed.
    - **Duration drivers** measure the demands in terms of the amount of time it takes to perform an activity.

Objective 3

Activity-Based Costing System

Design Steps for an ABC System

- **Calculate primary activity rates.**
  - Primary activity rates are computed by dividing budgeted activity costs by practical activity capacity.
  - Practical activity capacity is the activity output that can be produced when the activity is performed efficiently.
- **Assign activity costs to cost objects.**
  - Multiply the activity rate by the actual number of activity drivers consumed.

Objective 3

Activity-Based Costing System

Classifying Activities

Classifying activities into categories aids in product costing because the cost behavior differs by level. The four levels are:

- **Unit-level**
- **Batch-level**
- **Product-level**
- **Facility-level**

Objective 3

Reducing the Size and Complexity of an ABC System

Before-the-Fact Simplification: TDABC

- Before the fact simplification method that simplifies Stage 1 by eliminating the need for detailed interviewing and surveying to determine resource drivers:
  - Calculate total operating cost of a department or process.
  - Divide by practical capacity to determine a **capacity cost rate**.
  - Multiply this by time to perform one unit of activity and total activity output to determine your total **activity cost.**

Objective 4

Reducing the Size and Complexity of an ABC System

After-the-Fact Simplification

- **Approximately Relevant ABC Systems**
  - Calculate the cost of your activities.
- Combine the less expensive activity costs into the more expensive activity costs making fewer categories.
- **Equally Accurate Reduced ABC Systems**
- Use expected consumption ratios to reduce the number of drivers.

Objective 4

End of Chapter 4