

Chapter 1

Introduction to Quantitative Analysis

To accompany
Quantitative Analysis for Management, Eleventh Edition,
by Render, Stair, and Hanna
Power Point slides created by Brian Peterson

Learning Objectives

After completing this chapter, students will be able to:

- 1. Describe the quantitative analysis approach**
- 2. Understand the application of quantitative analysis in a real situation**
- 3. Describe the use of modeling in quantitative analysis**
- 4. Use computers and spreadsheet models to perform quantitative analysis**
- 5. Discuss possible problems in using quantitative analysis**
- 6. Perform a break-even analysis**

Chapter Outline

- 1.1 Introduction**
- 1.2 What Is Quantitative Analysis?**
- 1.3 The Quantitative Analysis Approach**
- 1.4 How to Develop a Quantitative Analysis Model**
- 1.5 The Role of Computers and Spreadsheet Models in the Quantitative Analysis Approach**
- 1.6 Possible Problems in the Quantitative Analysis Approach**
- 1.7 Implementation — Not Just the Final Step**

Introduction

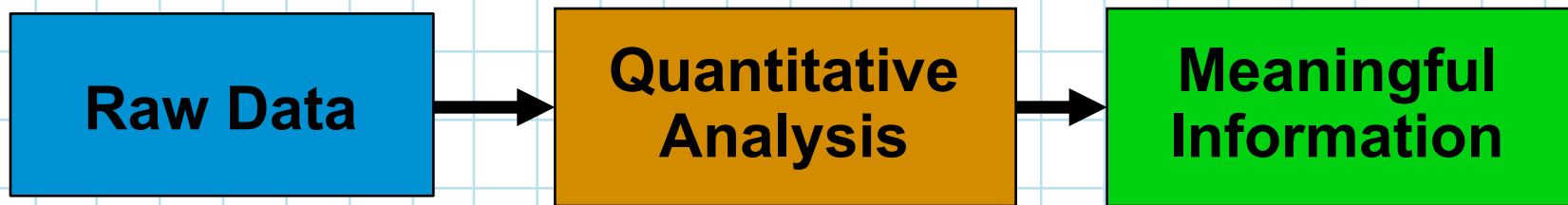
- **Mathematical tools have been used for thousands of years.**
- **Quantitative analysis can be applied to a wide variety of problems.**
 - **It's not enough to just know the mathematics of a technique.**
 - **One must understand the specific applicability of the technique, its limitations, and its assumptions.**

Examples of Quantitative Analyses

- **In the mid 1990s, Taco Bell saved over \$150 million using forecasting and scheduling quantitative analysis models.**
- **NBC television increased revenues by over \$200 million between 1996 and 2000 by using quantitative analysis to develop better sales plans.**
- **Continental Airlines saved over \$40 million in 2001 using quantitative analysis models to quickly recover from weather delays and other disruptions.**

What is Quantitative Analysis?

Quantitative analysis is a scientific approach to managerial decision making in which raw data are processed and manipulated to produce meaningful information.



What is Quantitative Analysis?

- ***Quantitative factors*** are data that can be accurately calculated. Examples include:
 - Different investment alternatives
 - Interest rates
 - Inventory levels
 - Demand
 - Labor cost
- ***Qualitative factors*** are more difficult to quantify but affect the decision process. Examples include:
 - The weather
 - State and federal legislation
 - Technological breakthroughs.

The Quantitative Analysis Approach

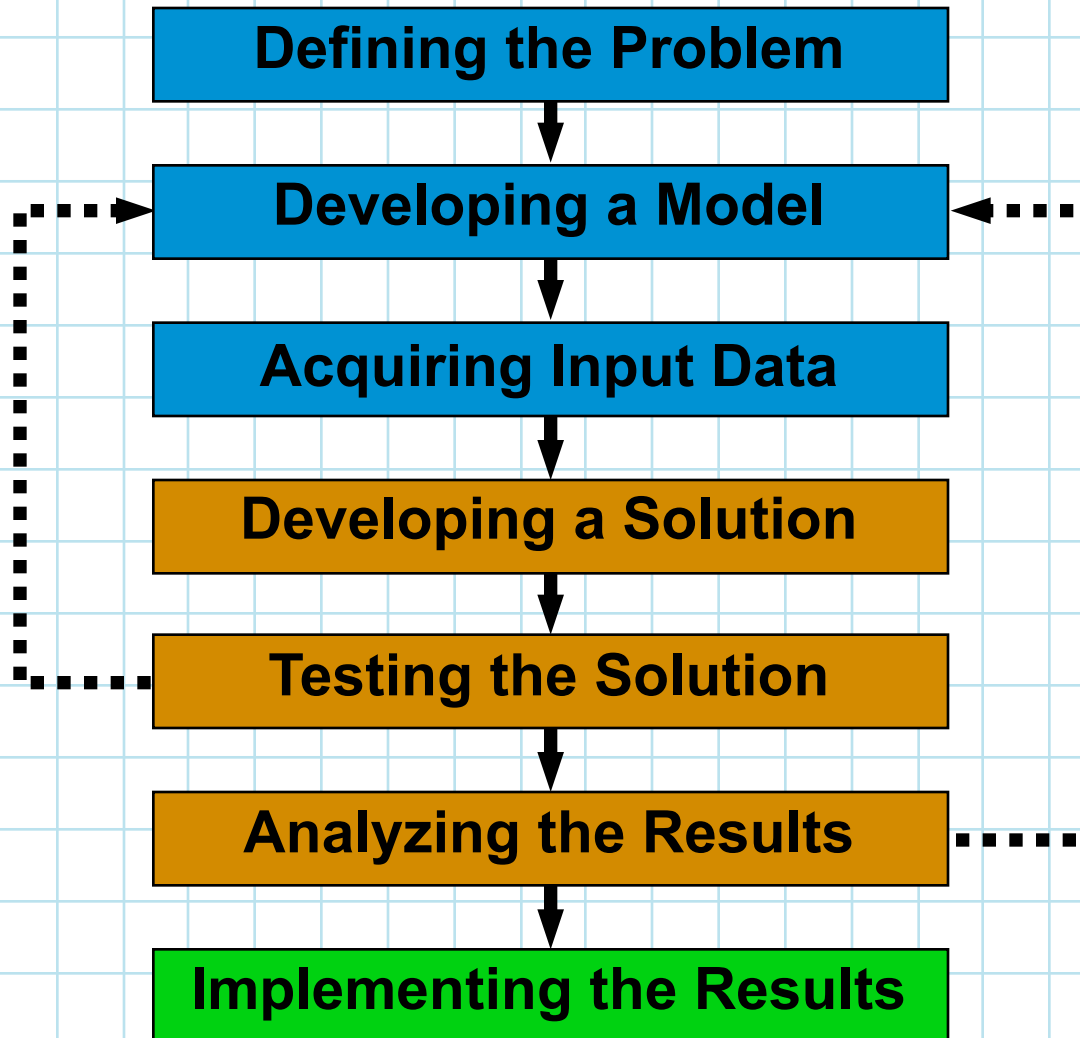


Figure 1.1

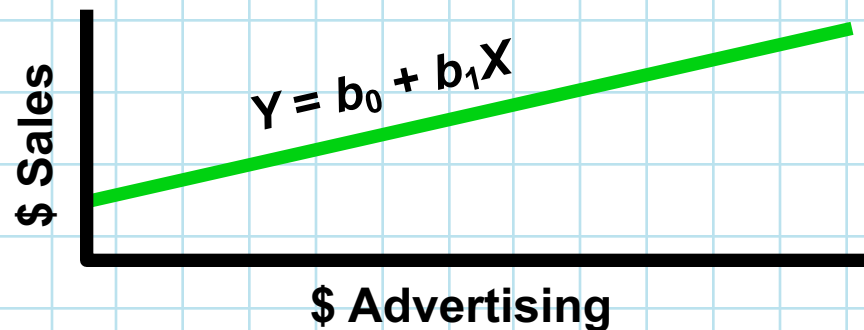
Defining the Problem

Develop a clear and concise statement that gives direction and meaning to subsequent steps.

- **This may be the most important and difficult step.**
- **It is essential to go beyond symptoms and identify true causes.**
- **It may be necessary to concentrate on only a few of the problems – selecting the right problems is very important**
- **Specific and measurable objectives may have to be developed.**

Developing a Model

Quantitative analysis models are realistic, solvable, and understandable mathematical representations of a situation.



There are different types of models:

**Scale
models**



**Schematic
models**



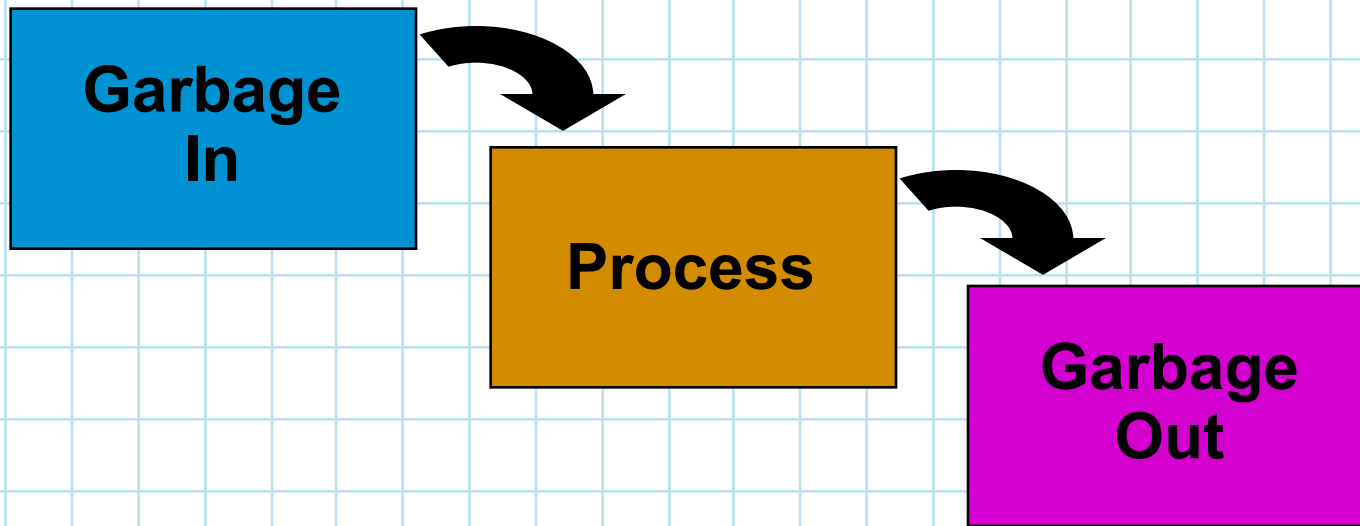
Developing a Model

Models generally contain variables (controllable and uncontrollable) and parameters.

- **Controllable variables are the decision variables and are generally unknown.**
 - **How many items should be ordered for inventory?**
- **Parameters are known quantities that are a part of the model.**
 - **What is the holding cost of the inventory?**

Acquiring Input Data

Input data must be accurate – GIGO rule:



Data may come from a variety of sources such as company reports, company documents, interviews, on-site direct measurement, or statistical sampling.

Developing a Solution

The best (optimal) solution to a problem is found by manipulating the model variables until a solution is found that is practical and can be implemented.

Common techniques are

- *Solving* equations.
- *Trial and error* – trying various approaches and picking the best result.
- *Complete enumeration* – trying all possible values.
- Using an *algorithm* – a series of repeating steps to reach a solution.

Testing the Solution

Both input data and the model should be tested for accuracy before analysis and implementation.

- **New data can be collected to test the model.**
- **Results should be logical, consistent, and represent the real situation.**

Analyzing the Results

Determine the implications of the solution:

- **Implementing results often requires change in an organization.**
- **The impact of actions or changes needs to be studied and understood before implementation.**

Sensitivity analysis determines how much the results will change if the model or input data changes.

- **Sensitive models should be very thoroughly tested.**

Implementing the Results

Implementation incorporates the solution into the company.

- **Implementation can be very difficult.**
- **People may be resistant to changes.**
- **Many quantitative analysis efforts have failed because a good, workable solution was not properly implemented.**

Changes occur over time, so even successful implementations must be monitored to determine if modifications are necessary.

Modeling in the Real World

Quantitative analysis models are used extensively by real organizations to solve real problems.

- **In the real world, quantitative analysis models can be complex, expensive, and difficult to sell.**
- **Following the steps in the process is an important component of success.**

How To Develop a Quantitative Analysis Model

A mathematical model of profit:

$$\text{Profit} = \text{Revenue} - \text{Expenses}$$

How To Develop a Quantitative Analysis Model

Expenses can be represented as the sum of fixed and variable costs. Variable costs are the product of unit costs times the number of units.

$$\text{Profit} = \text{Revenue} - (\text{Fixed cost} + \text{Variable cost})$$

$$\text{Profit} = (\text{Selling price per unit})(\text{number of units sold}) - [\text{Fixed cost} + (\text{Variable costs per unit})(\text{Number of units sold})]$$

$$\text{Profit} = sX - [f + vX]$$

$$\text{Profit} = sX - f - vX$$

where

s = selling price per unit

f = fixed cost

v = variable cost per unit

X = number of units sold

How To Develop a Quantitative Analysis Model

Expenses can be represented by
variable costs and fixed costs
unit costs times the number of units sold

Profit = Revenue

Profit = (Selling price per unit
sold) – [Fixed cost + (Variable
unit)(Number of units sold)]

Profit = $sX - [f + vX]$

Profit = $sX - f - vX$

where

s = selling price per unit

f = fixed cost

v = variable cost per unit

X = number of units sold

The *parameters* of this model are f , v , and s as these are the inputs inherent in the model

The *decision variable* of interest is X

Pritchett's Precious Time Pieces

The company buys, sells, and repairs old clocks. Rebuilt springs sell for \$10 per unit. Fixed cost of equipment to build springs is \$1,000. Variable cost for spring material is \$5 per unit.

$$s = 10 \quad f = 1,000 \quad v = 5$$

Number of spring sets sold = X

$$\text{Profits} = sX - f - vX$$

If sales = 0, profits = $-f = -\$1,000$.

If sales = 1,000, profits = $[(10)(1,000) - 1,000 - (5)(1,000)]$
 $= \$4,000$

Pritchett's Precious Time Pieces

Companies are often interested in the *break-even point* (BEP). The BEP is the number of units sold that will result in \$0 profit.

$$0 = sX - f - vX, \quad \text{or} \quad 0 = (s - v)X - f$$

Solving for X , we have

$$f = (s - v)X$$

$$X = \frac{f}{s - v}$$

$$\text{BEP} = \frac{\text{Fixed cost}}{(\text{Selling price per unit}) - (\text{Variable cost per unit})}$$

Pritchett's Precious Time Pieces

BEP for Pritchett's Precious Time Pieces

$$\text{BEP} = \$1,000/(\$10 - \$5) = 200 \text{ units}$$

Sales of less than 200 units of rebuilt springs will result in a loss.

Sales of over 200 units of rebuilt springs will result in a profit.

$$\text{BEP} = \frac{\text{Fixed cost}}{(\text{Selling price per unit}) - (\text{Variable cost per unit})}$$

Advantages of Mathematical Modeling

- 1. Models can accurately represent reality.**
- 2. Models can help a decision maker formulate problems.**
- 3. Models can give us insight and information.**
- 4. Models can save time and money in decision making and problem solving.**
- 5. A model may be the only way to solve large or complex problems in a timely fashion.**
- 6. A model can be used to communicate problems and solutions to others.**

Models Categorized by Risk

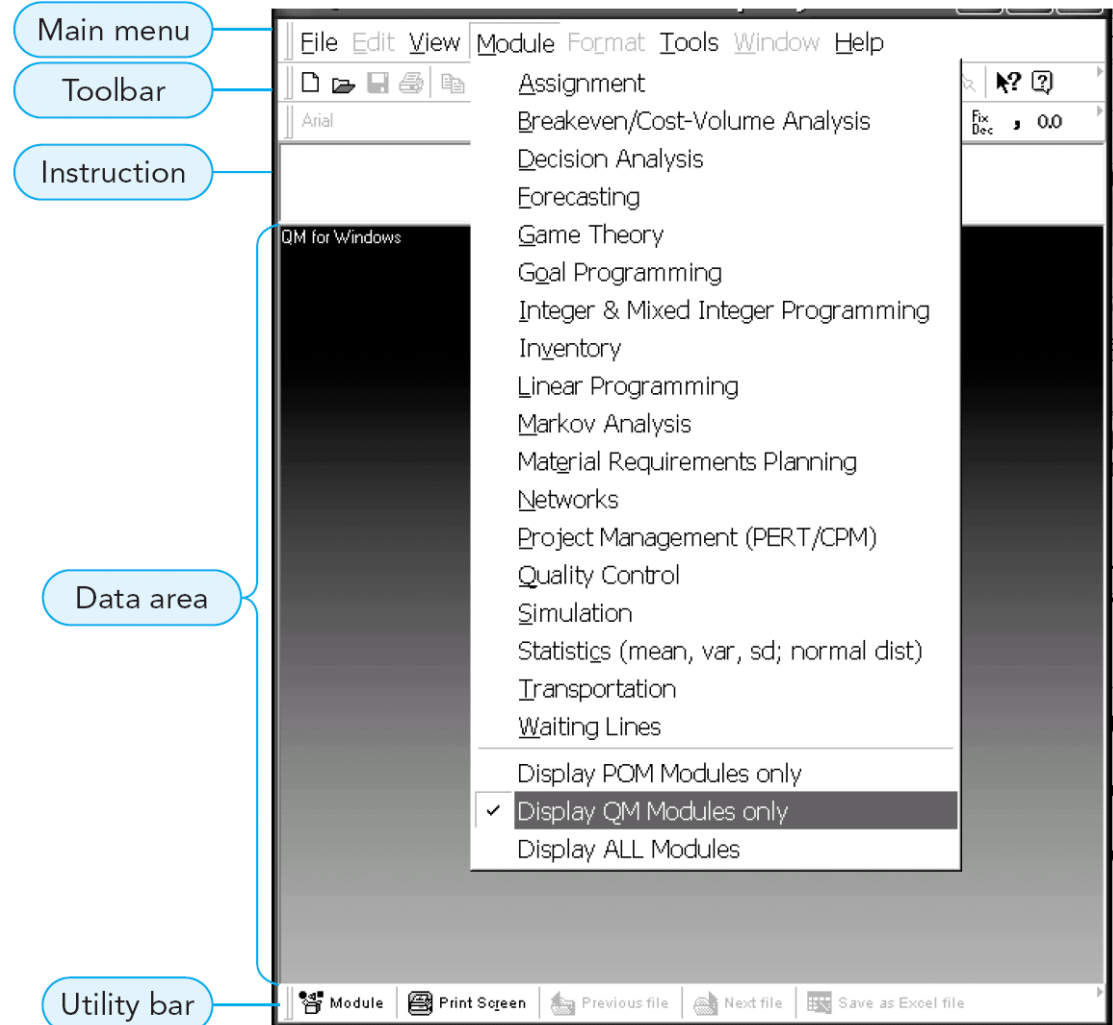
- **Mathematical models that do not involve risk are called *deterministic* models.**
 - **All of the values used in the model are known with complete certainty.**
- **Mathematical models that involve risk, chance, or uncertainty are called *probabilistic* models.**
 - **Values used in the model are estimates based on probabilities.**

Computers and Spreadsheet Models

QM for Windows

- An easy to use decision support system for use in POM and QM courses
- This is the main menu of quantitative models

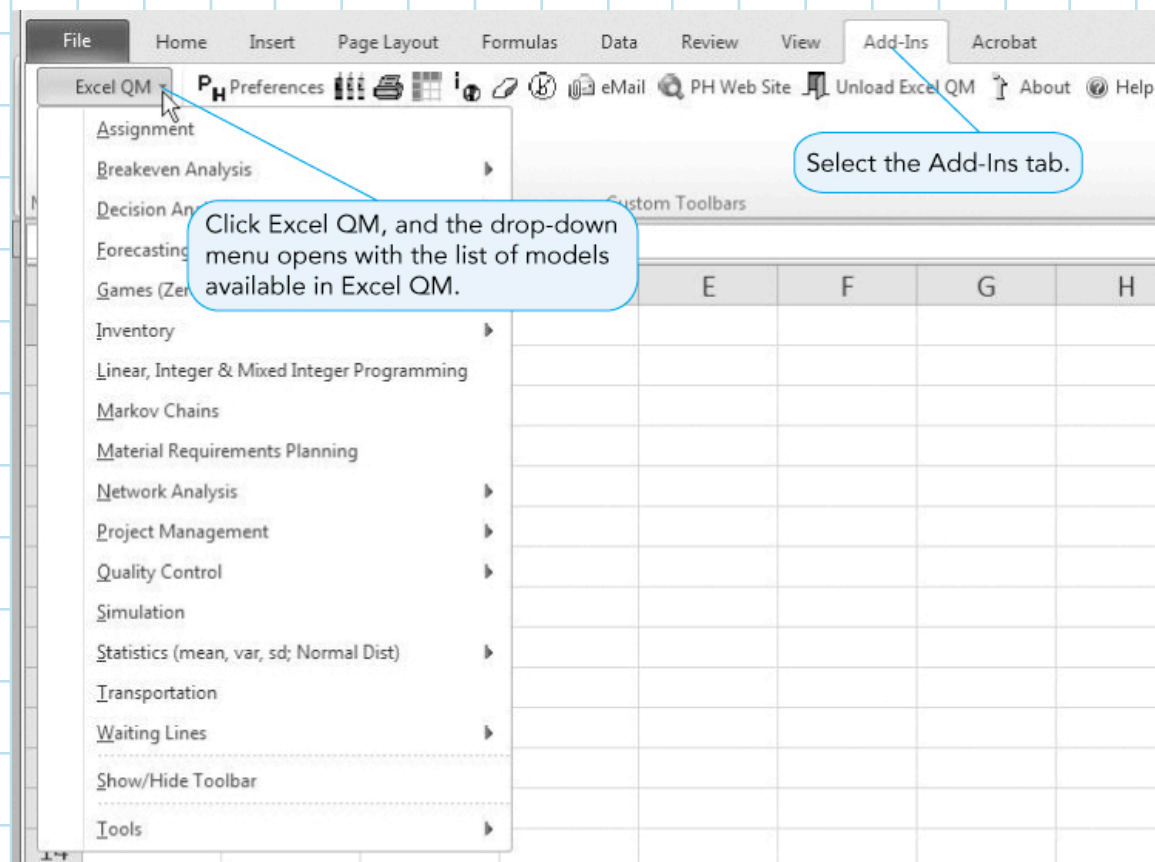
Program 1.1



Computers and Spreadsheet Models

Excel QM's Main Menu (2010)

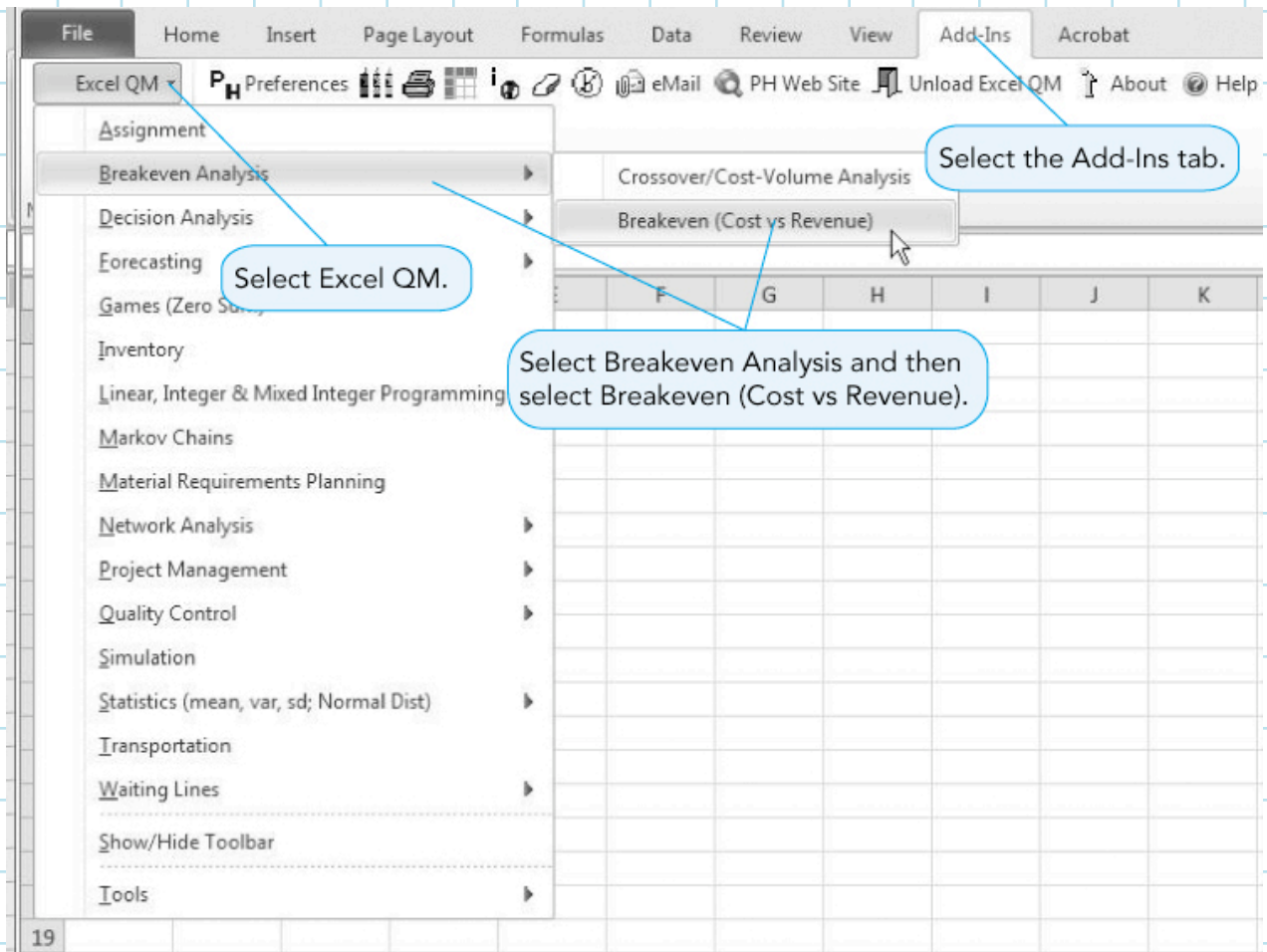
- Works automatically within Excel spreadsheets



Program 1.2

Computers and Spreadsheet Models

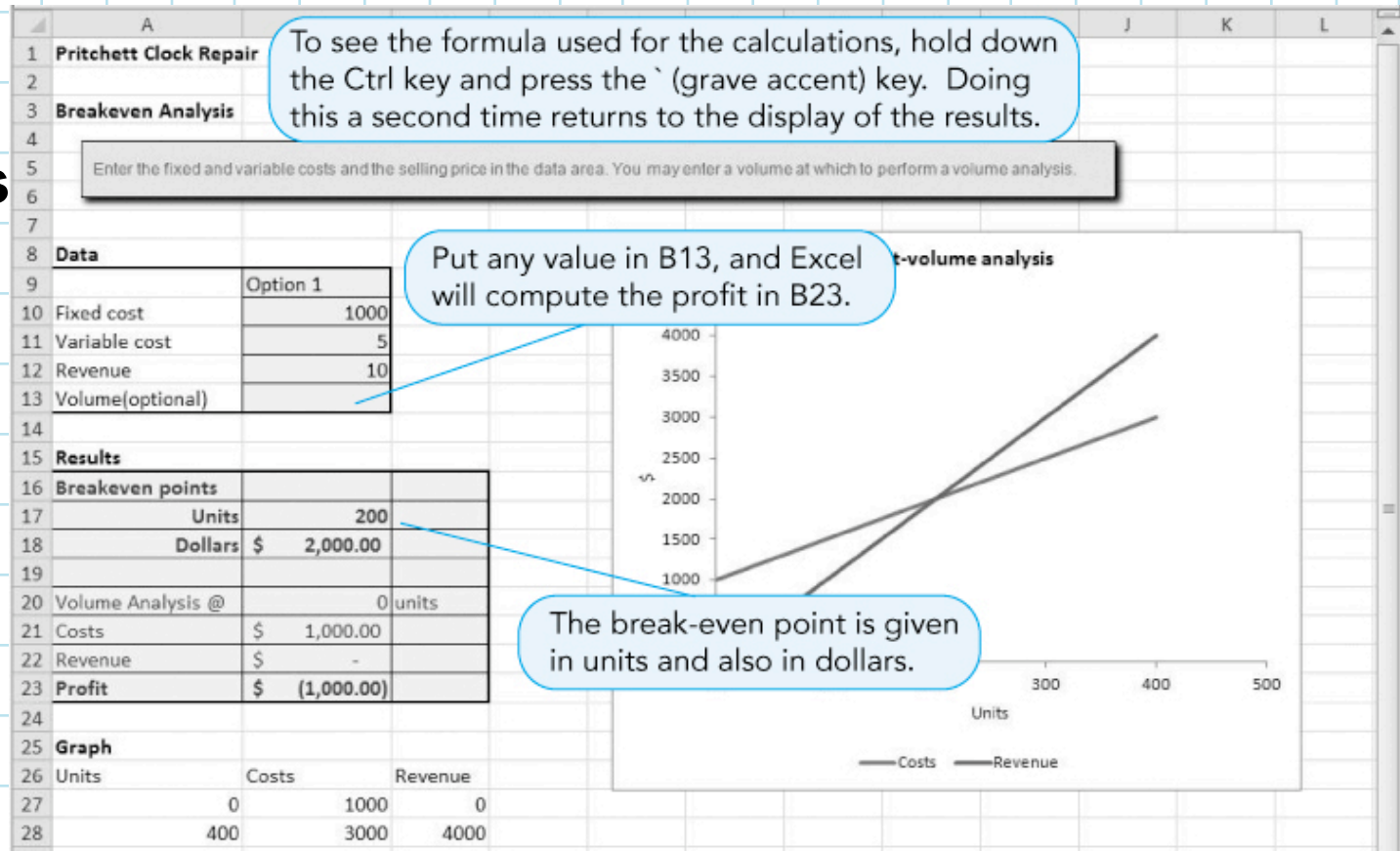
Selecting Break-Even Analysis in Excel QM



Program 1.3A

Computers and Spreadsheet Models

Break-Even Analysis in Excel QM



Program 1.3B

Computers and Spreadsheet Models

Using Goal Seek in the Break-Even Problem

Select the Data tab and then select What-If Analysis. Then select Goal Seek.

Put the cell that has the profit (B23) into the Set Cell window.

Put in the desired profit and specify the location for the volume cell (B13).

Click OK, and Excel will change the value in cell B13. Other cells are changed according to the formulas in those cells.

Data	
Fixed cost	1000
Variable cost	5
Revenue	10
Volume(optional)	235

Results	
Breakeven points	
Volume Analysis @	235 units
Costs	\$ 2,175.00
Revenue	\$ 2,350.00
Profit	\$ 175.00

Graph			
Units	Costs	Revenue	
0	1000	0	
400	3000	4000	

Program 1.4

Possible Problems in the Quantitative Analysis Approach

Defining the problem

- **Problems may not be easily identified.**
- **There may be conflicting viewpoints**
- **There may be an impact on other departments.**
- **Beginning assumptions may lead to a particular conclusion.**
- **The solution may be outdated.**

Developing a model

- **Manager's perception may not fit a textbook model.**
- **There is a trade-off between complexity and ease of understanding.**

Possible Problems in the Quantitative Analysis Approach

Acquiring accurate input data

- Accounting data may not be collected for quantitative problems.
- The validity of the data may be suspect.

Developing an appropriate solution

- The mathematics may be hard to understand.
- Having only one answer may be limiting.

Testing the solution for validity

Analyzing the results in terms of the whole organization

Implementation – Not Just the Final Step

There may be an institutional lack of commitment and resistance to change.

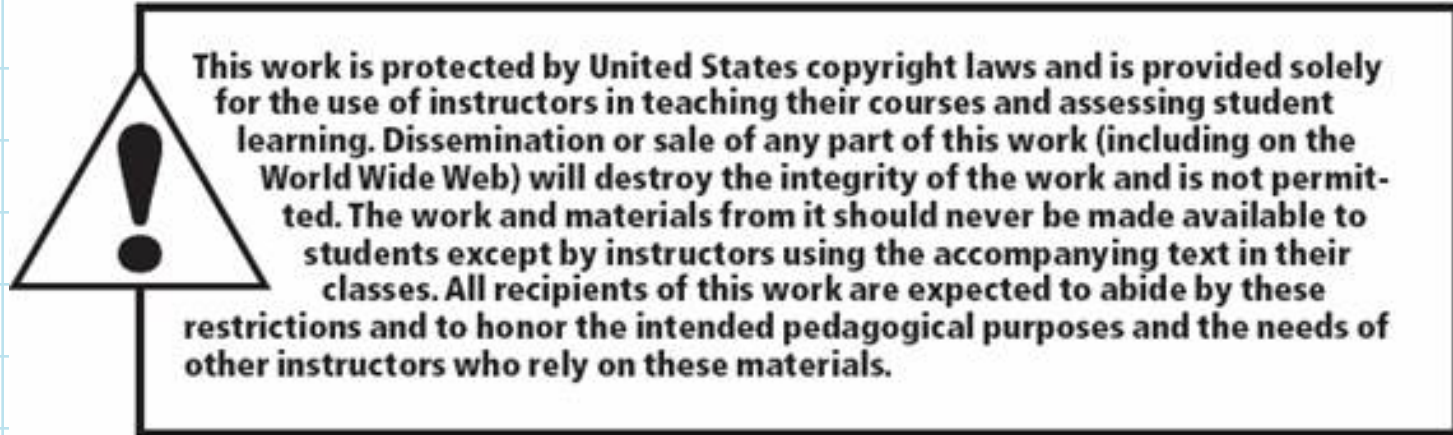
- **Management may fear the use of formal analysis processes will reduce their decision-making power.**
- **Action-oriented managers may want “quick and dirty” techniques.**
- **Management support and user involvement are important.**

Implementation – Not Just the Final Step

There may be a lack of commitment by quantitative analysts.

- **Analysts should be involved with the problem and care about the solution.**
- **Analysts should work with users and take their feelings into account.**

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