CHAPTER 11
DECISION SUPPORT SYSTEMS

Management Information Systems, 10th edition,
By Raymond McLeod, Jr. and George P. Schell

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Learning Objectives

- Understand the fundamentals of decision making and problem solving.
- Know how the DSS concept originated.
- Know the fundamentals of mathematical modeling.
- Know how to use an electronic spreadsheet as a mathematical model.
- Be familiar with how artificial intelligence emerged as a computer application, and its main areas.
- Know the four basic parts of an expert system.
- Know what a group decision support system (GDSS) is and the different environmental settings that can be used.

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Introduction

- The problem-solving process has four basic phases: standards, information, constraints, and alternative solutions
- Problems can vary in structure, and the decisions to solve them can be programmed or non programmed
- While the first DSS outputs consisted of reports and outputs from mathematical models but subsequently a group problem-solving capability was added, followed by artificial intelligence and OLAP
- When groupware is added to the DSS, it becomes a group decision support system (GDSS) that can exist in several different settings that are conducive to group problem solving

WHAT IT'S ALL ABOUT—DECISION MAKING

- Simply put, an MIS is "a system that provides users with information used in decision making to solve problems"
  - Chapter 1: distinguishes between problem solving and decision making
  - Chapter 2: two frameworks useful in problem solving, the general systems model of the firm and the eight-element environmental model, are presented
  - Chapter 7: covers the systems approach, a series of steps grouped in three phases: preparation effort, definition effort, and solution effort

The Importance of a Systems View

- Using the general systems model and the environmental model as a basis for problem solving, means taking **a systems view**
- This means seeing business operations as systems within a larger environmental setting
- With this understanding of the fundamental problem-solving concepts, we can now describe how they are applied in decision support systems

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BUILDING ON THE CONCEPTS

- Several elements (Figure 11.1) must be present if a manager is to successfully engage in problem solving
- The solution to a systems problem is one that best enables the system to meet its objectives, as reflected in the system's performance standards
- These compare the **desired state** against the **current state** to arrive at the **solution criterion**

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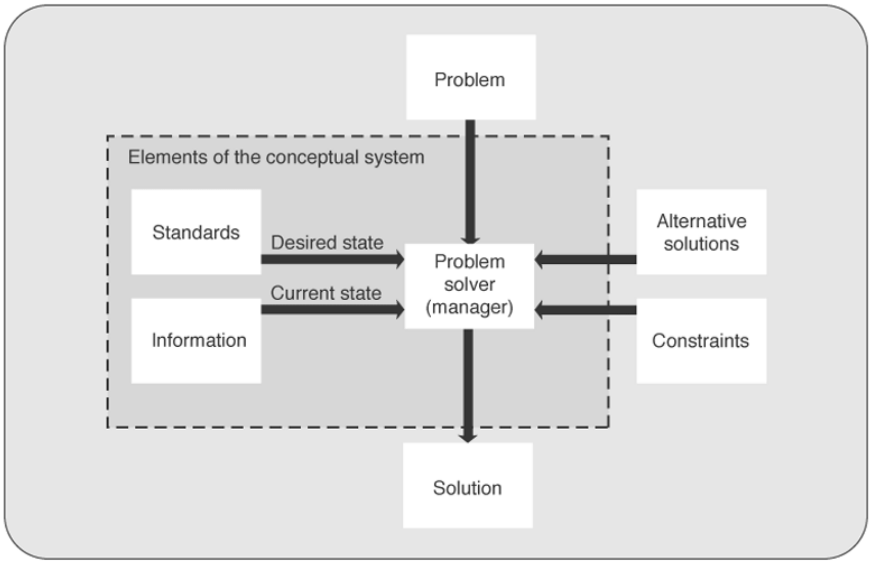
Figure 11.1 Elements of the Problem-Solving Process



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Building the Concepts

- It is the manager's responsibility to identify *alternative solutions*
- Once the alternatives have been identified, the information system is used to evaluate each one
- This evaluation should consider possible *constraints*, which can be either internal or environmental
- The selection of the best solution can be accomplished by:
    - **Analysis, Judgment** or **Bargaining**
- It is important to recognize the distinction between **problems** and **symptoms**

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Problem Structure

- A **structured problem** consists of elements and relationships between elements, all of which are understood by the problem solver
- An **unstructured problem** is one that contains no elements or relationships between elements that are understood by the problem solver
- A **semi structured problem** is one that contains *some* elements or relationships that are understood by the problem solver and some that are not

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Types of Decisions

- **Programmed decisions** are:
  - repetitive and routine
  - a definite procedure has been worked out for handling them
- **Non programmed decisions** are:
  - novel, unstructured, and unusually consequential. There's no cut-and-dried method for handling the problem
  - it needs a custom-tailored treatment

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THE DSS CONCEPT

- Gorry and Scott Morton (1971) argued that an information system that focused on single problems faced by single managers would provide better support
- Central to their concept was a table, called the Gorry-Scott Morton grid (Figure 11.2) that classifies problems in terms of problem structure and management level
- The top level is called the *strategic planning level*, the middle level the *management control level*, and the lower level the *operational control level*
- Gorry and Scott Morton also used the term *decision support system (DSS)* to describe the systems that could provide the needed support

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Figure 11.2 The Gorry and Scott-Morton Grid

Degree of problem structure		*Management levels*		
		Operational control	Management control	Strategic planning
	Structured	Accounts receivable	Budget analysis—engineered costs	Tanker fleet mix
		Order entry	Short-term forecasting	Warehouse and factory location
		Inventory control		
	Semistructured	Production scheduling	Variance analysis—overall budget	Mergers and acquisitions
		Cash management	Budget preparation	New product planning
	Unstructured	PERT/COST systems	Sales and production	R&D planning

Source: G. Anthony Gorry and Michael S. Scott-Morton, "A Framework for Management Information Systems," Sloan Management Review *13 (Fall 1971); 72*

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A DSS Model

- Originally the DSS was conceived to produce periodic and special reports (responses to database queries), and outputs from mathematical models.
- An ability was added to permit problem solvers to work in groups
- The addition of groupware enabled the system to function as a group decision support system
- Figure 11.3 is a model of a DSS. The arrow at the bottom indicates how the configuration has expanded over time
- More recently, artificial intelligence capability has been added, along with an ability to engage in online analytical programming (OLAP)

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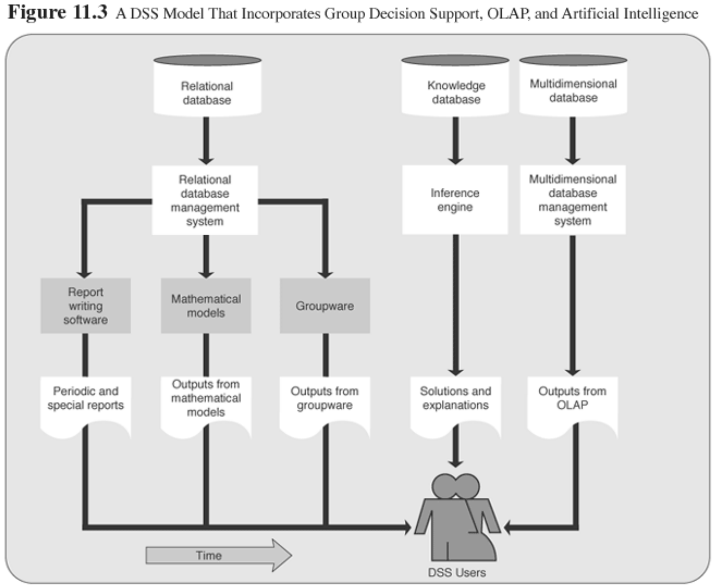
Figure 11.3 A DSS Model That Incorporates Group Decision Support, OLAP, and Artificial Intelligence



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MATHEMATICAL MODELING

- A **model** is an abstraction of something. It represents some object or activity, which is called an **entity**
- There are four basic types of models:
  1. A **physical model** is a three-dimensional representation of its entity
  2. A **narrative model**, which describes its entity with spoken or written words
  3. A **graphic model** represents its entity with an abstraction of lines, symbols, or shapes (Figure 11.4)
  4. A mathematical formula or equation is a **mathematical model**

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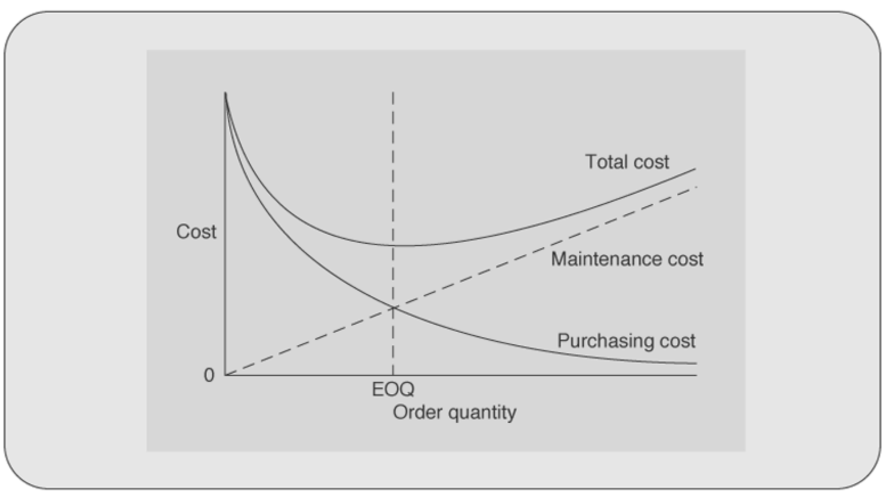
Figure 11.4 A Graphical Model of the Economic Order Quantity Concept



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Uses of Models

- **Facilitate Understanding:** Once a simple model is understood, it can gradually be made more complex so as to more accurately represent its entity
- **Facilitate Communication:** All four types of models can communicate information quickly and accurately
- **Predict the Future:** The mathematical model can predict what might happen in the future but a manager must use judgment and intuition in evaluating the output
- A mathematical model can be classified in terms of three dimensions: the influence of time, the degree of certainty, and the ability to achieve optimization

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Classes of Mathematical Models

- A **static model** doesn't include time as a variable but deals only with a particular point in time
- A model that includes time as a variable is a **dynamic model:** it represents the behavior of the entity over time
- A model that includes probabilities is called a **probabilistic model**. Otherwise, it is a **deterministic model**
- An **optimizing model** is one that selects the best solution among the alternatives
- A **sub optimizing model** does not identify the decisions that will produce the best outcome but leaves that task to the manager

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Simulation

- The act of using a model is called **simulation** while the term **scenario** is used to describe the conditions that influence a simulation
- For example, if you are simulating an inventory system, as shown in Figure 11.5, the scenario specifies the beginning balance and the daily sales units
- Models can be designed so that the **scenario data elements** are variables, thus enabling different values to be assigned
- The input values the manager enters to gauge their impact on the entity are known as **decision variables**
- Figure 11.5 gives an example of decision variables such as order quantity, reorder point, and lead time

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Figure 11.5 Scenario Data and Decision Variables from a Simulation

INVENTORY PLANNING MODEL
OCTOBER 11

SCENARIO:

BEGINNING BALANCE: 200

DAILY SALES UNITS: 20

DECISIONS:

ORDER QUANTITY: 100

REORDER POINT: 175

LEAD TIME: 3

RESULTS:

DAY	BEGINNING BALANCE	RECEIPTS	SALES	ENDING BALANCE	ORDER QUANTITY	RECEIPT DUE DAY
1	200		20	180		
2	180		20	160	100	5
3	160		20	140		
4	140		20	120		
5	120	100	20	200		
6	200		20	180		
7	180		20	160	100	10
8	160		20	140		
9	140		20	120		
10	120	100	20	200		
11	200		20	180		
12	180		20	160	100	15
13	160		20	140		
…						
224	120	100	20	200		
225	200		20	180		

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Simulation Technique and Format of Simulation Output

- The manager usually executes an optimizing model only a single time
- Sub optimizing models, however, are run over and over, in a search for the combination of decision variables that produces a satisfying outcome (known as playing the **what-if game**)
- Each time the model is run, only one decision variable should be changed, so its influence can be seen
- This way, the problem solver systematically discovers the combination of decisions leading to a desirable solution

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A Modeling Example

- A firm's executives may use a math model to assist in making key decisions and to simulate the effect of:
  1. the *price* of the product
  2. the amount of *plant investment*
  3. the amount to be invested in *marketing* activity
  4. the amount to be invested in *R & D*
- Furthermore, executives want to simulate 4 quarters of activity and produce 2 reports: an operating statement and an income statement
- Figures 11.6 and 11.7 shows the input screen used to enter the scenario data elements for the prior quarter and next quarter, respectively.

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Figure 11.6 A Model Input Screen for Entering Scenario Data for the Prior Quarter

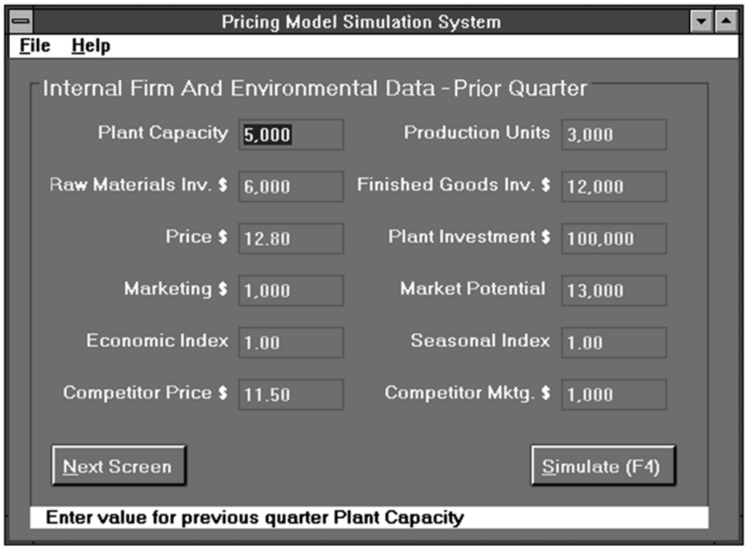

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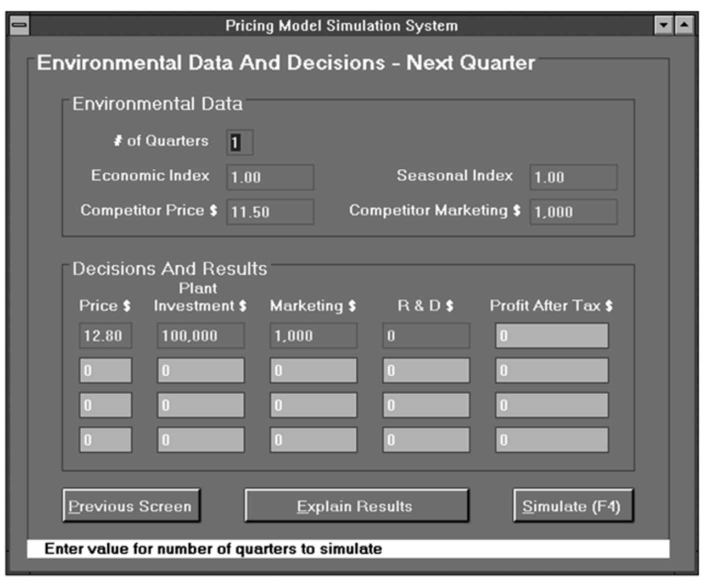
Figure 11.7 A Model Input Screen for Entering Scenario Data for the Next Quarter



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Model Output

- The next quarter's activity (Quarter 1) is simulated, and the after-tax profit is displayed on the screen
- The executives then study the figure and decide on the set of decisions to be used in Quarter 2. These decisions are entered and the simulation is repeated
- This process continues until all four quarters have been simulated. At this point the screen has the appearance shown in Figure 11.8
- The operating statement in Figure 11.9 and the income statement in Figure 11.10 are displayed on separate screens

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Figure 11.8 Summary Output from the Model

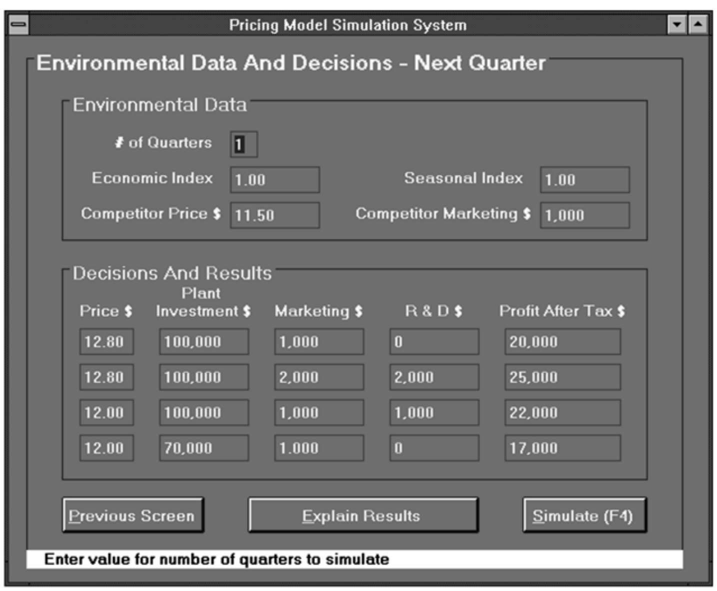

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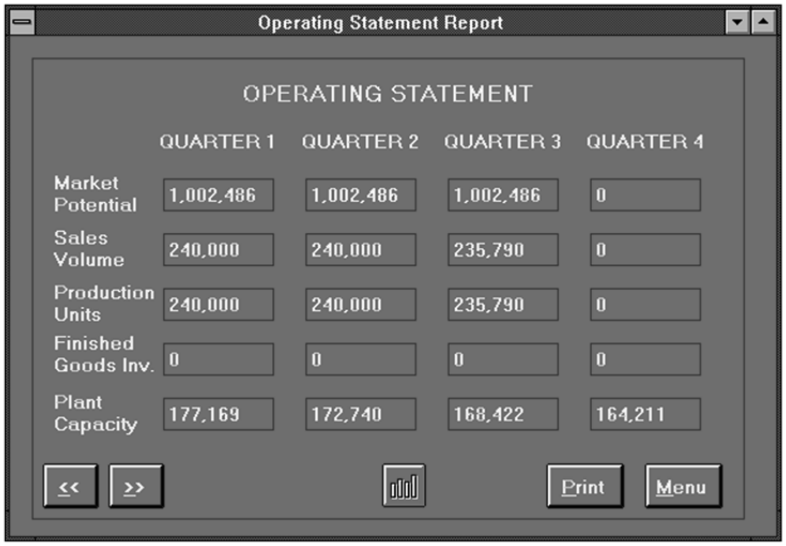
Figure 11.9 The Operating Statement Shows Nonmonetary Results of the Simulation



Operating Statement Report

OPERATING STATEMENT

	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4
Market Potential	1,002,486	1,002,486	1,002,486	0
Sales Volume	240,000	240,000	235,790	0
Production Units	240,000	240,000	235,790	0
Finished Goods Inv.	0	0	0	0
Plant Capacity	177,169	172,740	168,422	164,211

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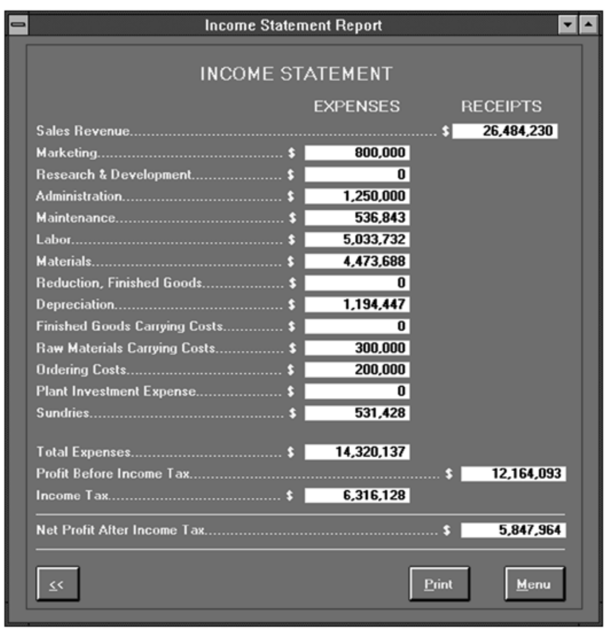
Figure 11.10 The Income Statement Shows Monetary Results of the Simulation



Income Statement Report

INCOME STATEMENT

	EXPENSES	RECEIPTS
Sales Revenue		$ 26,484,230
Marketing	$ 800,000	
Research & Development	$ 0	
Administration	$ 1,250,000	
Maintenance	$ 536,843	
Labor	$ 5,033,732	
Materials	$ 4,473,688	
Reduction, Finished Goods	$ 0	
Depreciation	$ 1,194,447	
Finished Goods Carrying Costs	$ 0	
Raw Materials Carrying Costs	$ 300,000	
Ordering Costs	$ 200,000	
Plant Investment Expense	$ 0	
Sundries	$ 531,428	
Total Expenses	$ 14,320,137	
Profit Before Income Tax		$ 12,164,093
Income Tax	$ 6,316,128	
Net Profit After Income Tax		$ 5,847,964

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Modeling Advantages and Disadvantages

- Advantages:
  - The modeling process is a *learning experience*
  - The speed of the simulation process enables the *consideration of a larger number of alternatives*
  - Models provide a *predictive power* - a look into the future - that no other information-producing method offers
  - Models are *less expensive* than the trial-and-error method
- Disadvantages:
  - The *difficulty of modeling a business system* will produce a model that does not capture all of the influences on the entity
  - A *high degree of mathematical skill* is required to develop and properly interpret the output of complex models

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MATHEMATICAL MODELING USING THE ELECTRONIC SPREADSHEET

- The technological breakthrough that enabled problem solvers to develop their own math models was the electronic spreadsheet
- Figure 11.11 shows an operating budget in column form. The columns are for: the budgeted expenses, actual expenses, and variance, while rows are used for the various expense items
- A spreadsheet is especially well-suited for use as a dynamic model. The columns are excellent for the time periods, as illustrated in Figure 11.12

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Figure 11.11 Spreadsheet Rows and Columns Provide the Format for a Columnar Report.

OPERATING BUDGET

DEPARTMENT 210 – WELDING SHOP

WEEK ENDING JUNE 25

ACCOUNT	BUDGET	ACTUAL	VARIANCE
SALARIES	$9,715.00	$10,317.50	$602.50-
EQUIPMENT	$750.00	$517.50	$232.50
SUPPLIES	$1,400.00	$1,255.59	$144.41
OVERHEAD	$250.00	$250.00	$0.00
TOTAL	$12,115.00	$12,340.59	$225.59-

Source: Raymond McLeod, Jr., Decision Support Software for the IBM Personal Computer *(Chicago, Science Research Associates), 1988, p. 235.*

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Figure 11.12 Spreadsheet Columns Are Excellent for Time Periods in a Dynamic Model.

CASH FLOW MODEL

MONTH

	1	2	3	4	5	6
BEGINNING CASH	5000	5480	6005	6087	5975	6861
CASH IN	1800	2100	1932	1813	2987	2800
CASH OUT	1320	1575	1850	1925	2101	2495
ENDING CASH	5480	6005	6087	5875	6861	7166

Source: Raymond McLeod, Jr., Decision Support Software for the IBM Personal Computer *(Chicago, Science Research Associates), 1988, p. 234.*

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The Spreadsheet Model Interface

- When using a spreadsheet as a mathematical model, the user can enter data or make changes directly to the spreadsheet cells, or by using a GUI
- The pricing model described earlier in Figures 11.6-11.10 could have been developed using a spreadsheet, and had the graphical user interface added
- The interface could be created using a programming language such as Visual Basic and would likely require an information specialist to develop
- A development approach would be for the user to develop the spreadsheet and then have the interface added by an information specialist

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ARTIFICIAL INTELLIGENCE

- **Artificial intelligence (AI)** seeks to duplicate some types of human reasoning
- AI is being applied in business in **knowledge-based systems**, which use human knowledge to solve problems
- The most popular type of knowledge-based system are **expert systems**, which are computer programs that try to represent the knowledge of human experts in the form of heuristics
- These heuristics allow an expert system to consult on how to solve a problem: called a consultation **-** the user consults the expert system for advice

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The Expert System Configuration

- An expert system consists of four main parts:
  - The **user interface** enables the manager to enter *instructions* and *information* into the expert system and to receive information from it
  - The knowledge base contains both facts that describe the **problem domain** and knowledge representation techniques that describe how the facts fit together in a logical manner
  - The **inference engine** is the portion of the expert system that performs reasoning by using the contents of the knowledge base in a particular sequence
  - The **development engine** is used to create the expert system using two basic approaches: programming languages and expert system shells

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The Inference Engine

- The inference engine performs reasoning by using the contents of the knowledge base
- During the consultation, the engine examines the rules of the knowledge base one by one. When a rule's condition is true, the specified action is taken
- The process of examining the rules continues until a pass has been made through the entire rule set
- More than one pass usually is necessary in order to assign a value to the problem solution, which is called the **goal variable**
- The passes continue as long as it is possible to fire rules. When no more rules can be fired, the reasoning process ceases

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The Development Engine

- The fourth major expert system component is the development engine, used to create an expert system.
- There are two basic approaches: programming languages and an **expert system shell** -- a ready-made processor that can be tailored to a specific problem domain through the addition of the appropriate knowledge base
- A popular approach is called **case-based reasoning (CBR)**. Some systems employ knowledge expressed in the form of a **decision tree**
- In business, expert system shells are the most popular way for firms to implement knowledge-based systems

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GROUP DECISION SUPPORT SYSTEMS

- **GDSS** is "a computer-based system supporting groups of people engaged in a common task or goal that provides an interface to a shared environment"
- The software used in these settings is called **groupware**
- The underlying assumption of the GDSS is that improved communications make improved decisions possible
- Figure 11.13 shows four possible GDSS settings based on group size and the location of the members

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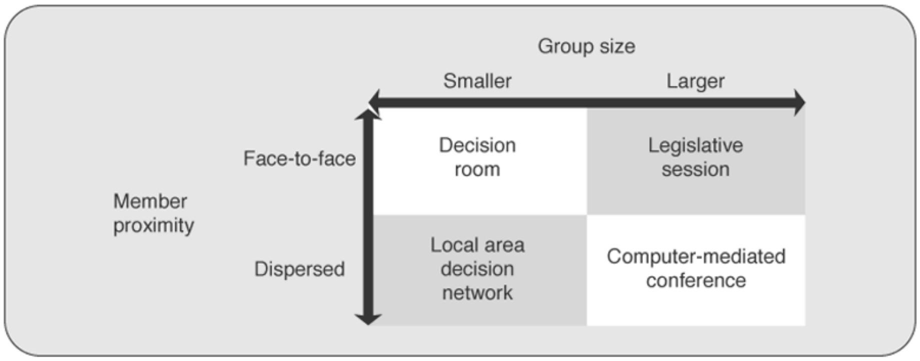
Figure 11.13 Group Size and Location Determine DSS Environmental Settings



Source: Gerardine DeSanctis and R. Brent Gallupe, "A Foundation for the Study of Group Decision Support Systems," **Management Science** *33 (May 1987), 598. Reprinted with permission.*

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GDSS Environmental Settings

- In each setting, group members may meet at the same or at different times. A synchronous exchange occurs if members meet at the same time. When they meet at different times it's called an **asynchronous exchange**
- A **decision room** is the setting for small groups of people meeting face-to-face
- Two unique GDSS features are **parallel communication** (when all participants enter comments at the same time), and **anonymity** (when nobody is able to tell who entered a particular comment)
- When it is impossible for small groups of people to meet face-to-face, the members can interact by means of a local area network, or LAN

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PUTTING THE DSS IN PERSPECTIVE

- The expansion of scope since Gorry and Scott-Morton is testimony to the success that DSSs have enjoyed
- The concept has worked so well that developers are continually thinking of new features to incorporate, such as groupware
- AI can give a DSS an additional level of decision support that was not originally intended by the earliest DSS developers

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END OF CHAPTER 11

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